COURSE CONTENT

Academic Year	AY24-25	**Semester**	1
School/Programme	EEE/ MSc		
Course Coordinator	TBC		
Course Code	EE6483		
Course Title	Artificial Intelligence and Data Mining		
Pre-requisites	NIL		
No of AUs	3		
Contact Hours	39		
Proposal Date ***i.e. date proposal was drafted***	16 July 2023		
Expected Implementation date of new/revised course	2024-25 Semester 1		
Suggested Class Size	50		

Any cross-listing?
Is course opened to all Postgraduate students (including IGP) or specific program (please indicate)?

Within EEE							Outside EEE (Please specify)
MSc Programmes*					MEng	PhD	
CME	CCA	ET	PE	SP			
GE	GE	GE	GE	GE			

* List of MSc programmes

- MSc Communications Engineering (CME) Programme
- MSc Computer Control & Automation (CCA) Programme
- MSc Electronics (ET) Programme
- MSc Power Engineering (PE) Programme
- MSc Signal Processing (SP) Programme

Course Aims

This course introduces the fundamental theory and concepts of Artificial intelligence (AI) and Data Mining methods, in particular state space representation and search strategies, association rule mining, supervised learning, classifiers, neural networks, unsupervised learning, clustering analysis, and their applications in the area of Artificial Intelligence and Data Mining. This can be summarized as:

1. To understand the concepts of knowledge representation for state space search, strategies for the search.
2. To understand the basics of a data mining paradigm known as Association Rule Mining and its application to knowledge discovery problems.
3. To understand the fundamental theory and concepts of supervised learning, unsupervised learning, neural networks, several learning paradigms and its applications

Intended Learning Outcomes (ILO)

Upon completion of this course, students should be able to :

1. Demonstrate and Explain the use of state representation of problems, and strategies for the search
2. Discuss and Illustrate the concepts of state space search algorithms
3. Discuss and Illustrate the concepts of heuristic search algorithms

4. Explain basic data mining concepts/algorithms for association rule mining
5. Explain the basics of machine learning models and algorithms
6. Apply the fundamental theory and concepts of data mining and AI for wide range of data analysis including association, classification, clustering, prediction.

Course Content

Structures and Strategies for State Space Representation & Search. Heuristic Search. Data Mining Concepts and Algorithms. Classification and Prediction methods. Unsupervised Learning and Clustering Analysis.

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Weighting	Team/ Individual	Assessment rubrics
1. Continuous Assessment 1 (CA1): Quiz	1, 2, 3, 4	10%	Individual	N/A
2. Continuous Assessment 2 (CA2): Assignments	4, 5	10%	Individual	Appendix 1
3. Continuous Assessment 3 (CA3): Project Report	5,6	20%^	Individual/ team	Appendix 2 & 3
4. Final Examination	all	60%	Individual	N/A
Total		100%		

^ A more difficult project for Msc students. It also includes an additional component of paper survey mandatory only for MSc students.

Description of Assessment Components:

The assignments are take-home assignments. Homework 1 covers the topics Decision Tree classifier, RBF, Backpropagation, SVM. Homework 2 covers the topics CNN, K-means, HAC.

The quiz is assessments under a proctored environment. Quiz covers the topics State Space representation, Search Strategies, Associate Rule Mining.

The project report is a take-home project assignment. Individual student will submit a Project Report to illustrate the problem and the solution. Included as part of the report is the code, and paper survey. The project will be graded out of 100 points and will then be scaled to 20% of the total marks. 80% of the project assessment will be based on the students' individual survey and analysis, while only 20% dependents on their codes and testing accuracy which can be a team effort. The survey is an additional mandatory component in the project report for Msc students and it requires students to conduct a comprehensive literature survey including current state-of-the-art papers and write a discussion of their results, summary of the learning points, and proposals of future research directions.

Formative feedback

Examination results;
Markers' report on overall examination performance;
Quiz scores and analysis;
Homework assessment scores and analysis;
Project report assessment grade and analysis.

Learning and Teaching Approach

Note: Please include and indicate TEL component.

Approach	How does this approach support students in achieving the learning outcomes?
Lectures	Face-to-face interaction covering all topics, which provide the basic background and essential theory for achieving the Intended Learning Outcomes (ILO) 1-6.
Video recordings (TEL)	Video recordings of all lectures are provided.

Reading and References

Textbooks

1. Luger George F, Artificial Intelligence : Structures and Strategies for Complex Problem Solving, 6th Edition, Addison-Wesley, 2009. (Q335.L951)
2. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining: Pearson 2nd Edition, 2019.
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016. ISBN: 978-0262035613 (Q325.5.G651)

References

1. Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, Morgan Kaufmann, 2011, ISBN: 978-0-12-381479-1.
2. S. Russell and P. Norvig, Artificial Intelligence -A Modern Approach, 4th Edition, Prentice Hall, 2020.
3. Kevin P. Murphy, Probabilistic Machine Learning- An Introduction, The MIT Press, 2022.
4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Course Policies and Student Responsibilities

General: Students are expected to take all scheduled projects and tests by due dates. Students are expected to take responsibility to follow up with course notes, assignments, project and course related announcements. Students are expected to participate in all tutorial/exercise discussions and activities.

Absenteeism: Continuous assessments make up a significant portion of the course total mark. Absence from continuous assessments without officially approved leave will result in no marks and affect the overall course grade.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust, and Justice are at the core of NTU's shared values.

As a student, it is important that you recognise your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain about the definitions of any of these terms, you should refer to the Academic Integrity Intranet Site for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
The contact info will be provided to students at the beginning of each semester.			

Industry Participation

Company Name	Description of involvement (e.g., co-curation of course, speaker or instructor), include no. of course hours if known.	Contact Person	Email
Industry guest speaker to be determined.			

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction to AI & Brief history State Space Representation Search Strategies: data /goal driven	1	Lecture1-3
2	Search Algorithms: Backtracking/BreadthFirst/DepthFirst.	2	Lecture4-6 *Extra Exercise*
3	Heuristic Search: Hill-climbing/Best first MiniMax/ Alpha-Beta.	3	Lecture7-9
4	Introduction to DataMining	4/6	Lecture10-12 *Extra Exercise*

	Association Rule Mining: Apriori/FPGrowth.		
5	Introduction to Machine Learning	5/6	**Quiz (10%)** covering lecture materials in Weeks 1 to 4 Lecture13-15
6	Classification and Decision Trees	5/6	Lecture16-18 ***Project starts***
7	Nearest Neighbor Classifiers and Support Vector Machines	5/6	Lecture19-21
	Recess week		
8	Neural Networks: Perceptrons, The Backpropagation Algorithm	5/6	Lecture22-24 **Homework 1 (5%)**
9	Neural Networks: Convolutional Neural Networks, Other Popular Deep Learning Networks	5/6	Lecture25-27 *Extra Exercise*
10	Unsupervised Learning: Clustering, K-means, HAC	5/6	Lecture28-30
11	Regularization and Optimization for Deep Models	5	Lecture31-33 **Homework 2 (5%)**
12	Dimensionality Reduction and Bayesian Reasoning	5/6	Lecture34-36
13	Bayesian Reasoning	5/6	Lecture37-39 **Project submission** (**20%**)

Other information(s)

Note: Student who has passed IE4483 at NTU-UG programme will be bar from taking this course.

Appendix 1: Assessment Criteria for CA2 (Homework Assignment)

Marks	Criteria
>=90%	Able to achieve ILO4 & ILO5 completely
70% - 89%	Able to achieve ILO4 & ILO5 with some minor issues/misunderstanding
50% - 69%	Able to achieve most ILO4 & ILO5. Some major issues/misunderstanding exist
40% - 49%	Able to achieve only some of ILO4 & ILO5
<40%	Unable to achieve ILO4 & ILO5

Appendix 2: Assessment Criteria for CA3 (Project Report)

Individual student will submit a Project Report to illustrate the problem, survey, and the solution. Included as part of the report is the code. The project will be graded out of 100 points and will then be scaled to 20% of the total marks. 80% of the project assessment will be based on the students' individual survey, analysis, while only 20% dependents on their codes and testing accuracy which can be a team effort.

Criteria	**Standards**		
	Fail standard (0-40)	**Pass standard (41-74)**	**High standard (75-100)**
Identify the core definition of the problem and plan the solution. (ILO 5, 6)	Identifying completely wrong definitions of the problems, and planning solutions that are somewhat related but are not the actual solutions expected for the problems.	Identifying the correct and relevant definitions of the problems in line with the course materials, planning solutions reasonably in line with solutions expected for the problems and trying to relate the course materials to the planned solutions. Accuracy and clarity can be further improved.	Identifying the correct and relevant definitions of the problems in line with the course materials, planning technically accurate steps for the solutions that are expected for the problems, and clearly connecting the course materials to the planned solutions.
Explore the data effectively and devise required models to solve the problem. (ILO 5, 6)	Ad hoc analysis of the data and arbitrary steps in building the model without properly connecting the concepts with relevant concepts from the course. No or little evidence of critical evaluation of the proposed solution.	Logical exploration of the data that demonstrates a good understanding of the concepts from the course and building models with reasonable accuracy to solve the problems. Reasonable evidence of critical thinking related to the proposed solution and producing solutions with some degree of intuition and justification (rigorous steps for model-building or validation of models and results may be missing).	Clear logical flow of data exploration of that demonstrates a good understanding of the concepts from the course (and beyond) and building models with high accuracy to solve the problems. Extensive evidence of critical thinking related to the proposed solution, and producing solutions with clear intuition and proper justification, including rigorous steps for model-building and validation of the models and results.
Overall Organization of the Project Report. (ILO 5)	Disorganised format and arrangement of the code and report, without any comment or little/no mention of references/resources.	Clear logical flow and well-formatted arrangement of the code and report, with all essential components. Reasonable comments and reasonable documentation of references /resources.	Clear logical flow and well-formatted arrangement of the code and report, with all essential components. Detailed set of technical comments to illustrate the choices made towards the solution, and to highlight

			the inferences. Proper documentation of references /resources.

Appendix 3: Assessment Criteria for CA3 (Paper Survey)

Marks	Criteria
>=85%	Outstanding – Comprehensive literature survey including current state-of-the-art papers, a discussion of their results, summary of the learning points, investigations, and implementations of model enhancements.
75%- 84%	Excellent – Comprehensive literature survey including current state-of-the-art papers, a discussion of their results, summary of the learning points, and proposals of future research directions.
65% - 74%	Good – Literature survey based on at least 4 current state-of-the-art papers with a discussion of their results and summary of the learning points.
50% - 64%	Average – Some literature survey based on at least 3 papers with a discussion of their results and summary of the learning points.
40% - 49%	Marginal – Some literature survey based on at least 2 papers with a discussion of their results and summary of the learning points.
< 40%	Poor – Little or no literature survey done.
0%	Not submitted

Annex B

COURSE CONTENT

Academic Year	2022/2023	**Semester**	S1
Course Coordinator	Chen LiHui		
Course Code	IE4483		
Course Title	Artificial Intelligence and Data Mining		
Pre-requisites	EE/IM2007/IE2107 Engineering Mathematics II + IE/EE0005 Introduction to Data Science & Artificial Intelligence, or equivalents		
No of AUs	3		
Contact Hours	Lectures: 39 hours		
Proposal Date	10 Mar 2022; updated on 13 June 2022		

Course Aims

This course aims at introducing you to the fundamental theory and concepts of Artificial intelligence (AI) and Data Mining methods, in particular state space representation and search strategies, association rule mining, supervised learning, classifiers, neural networks, unsupervised learning, clustering analysis, and their applications in the area of AI and Data Mining. This can be summarized as:

1. To understand the concepts of knowledge representation for state space search, strategies for the search.
2. To understand the basics of a data mining paradigm known as Association Rule Mining and its application to knowledge discovery problems.
3. To understand the fundamental theory and concepts of supervised learning, unsupervised learning, neural networks, several learning paradigms and its applications.

Intended Learning Outcomes (ILO)

Upon completion of this course, you should be able to :

1. Demonstrate and Explain the use of state representation of problems, and strategies for the search
2. Discuss and Illustrate the concepts of state space search algorithms
3. Discuss and Illustrate the concepts of heuristic search algorithms
4. Explain basic data mining concepts/algorithms for association rule mining
5. Explain the basics of machine learning models and algorithms
6. Apply the fundamental theory and concepts of data mining and AI for wide range of data analysis including association, classification, clustering, prediction.

Course Content

Structures and Strategies for State Space Representation & Search. Heuristic Search. Data Mining Concepts and Algorithms. Classification and Prediction methods. Unsupervised Learning and Clustering Analysis.

Course Outline

S/N	Topic	Lecture Hours
1	Structures and Strategies for State Space Representation & Search	4
2	Heuristic Search	4
3	Data Mining Concepts and Algorithms	5
4	Classification and Prediction methods	20
5	Unsupervised Learning and Clustering Analysis	6
	Total hours	39

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/ Individual	Assessment rubrics
1. Final Examination	ALL	EAB SLO a,b,c	60%	Individual	
2. Continuous Assessment 1 (CA1): Quiz	1,2,3	EAB SLO a,c	10%	Individual	
3. Continuous Assessment 2 (CA2): Assignment	2,3,4,5	EAB SLO a,b,c,e	10%	Individual	See Appendix 1A
4. Continuous Assessment 3 (CA3): Project Report	5,6	EAB SLO a,b,c,d,e	20%	Individual/team	See Appendix 1B
Total			**100%**		

Mapping of Course SLOs to EAB Graduate Attributes (new requirement to update school database)

Course Student Learning Outcomes	Cat	EAB's 12 Graduate Attributes* (indicate full/partial/weak moon/blank for the whole course for SLO a-l)											
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
IE4483 Artificial Intelligence and Data Mining	• Major PE (for EEE/IEM students) • BDE (for DA students,	●	◐	●	◐	◐	○	○	○	○	○		○

	including EEE / IEM students)												

1. Demonstrate and Explain the use of state representation of problems, and strategies for the search	EAB SLO* (a), (b), (c)
2. Discuss and Illustrate the concepts of state space search algorithms	EAB SLO* (a), (b), (c)
3. Discuss and Illustrate the concepts of heuristic search algorithms	EAB SLO* (a), (b), (c), (d)
4. Explain basics data mining concepts/algorithms for association rule mining	EAB SLO* (a), (b), (c), (d), (l)
5. Explain the basics of machine learning models and algorithms	EAB SLO* (a), (b), (c), (d), (e), (j), (l)
6. Apply the fundamental theory and concepts of data mining and AI for wide range of data analysis including association, classification, clustering, prediction	EAB SLO* (a), (b), (c), (d), (e), (i), (j), (l)

Legend: ● Fully consistent (contributes to more than 75% of Student Learning Outcomes)
◐ Partially consistent (contributes to about 50% of Student Learning Outcomes)
○ Weakly consistent (contributes to about 25% of Student Learning Outcomes)
Blank Not related to Student Learning Outcomes

* Please refer to Appendix 2 on the EAB accreditation SLO

Formative feedback

You would be able to receive the feedback through

- Continuous Assessment 1 (CA1): Quiz ;
- Continuous Assessment 2 (CA2): Homework Assignments 1-5 ;
- Continuous Assessment 3 (CA3): Project Report;
- Examination results; and
- Markets' report on overall examination performance.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
LECTURE	The faculty will present the course contents to you via lecture notes, face-to-face teaching and videos, which provide the basic background and essential theory for achieving the Intended Learning Outcomes (ILO) 1-6.
TUTORIAL	N/A
LABORATORY(if any)	N/A

Reading and References

Textbooks

1. Luger George F, Artificial Intelligence : Structures and Strategies for Complex Problem Solving, 6th Edition, Addison-Wesley, 2009. (Q335.L951)
2. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining: Pearson 2nd Edition, 2019.
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016. ISBN: 978-0262035613 (Q325.5.G651)

References

1. Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, Morgan Kaufmann, 2011, ISBN: 978-0-12-381479-1.
2. S. Russell and P. Norvig, Artificial Intelligence A Modern Approach, 4th Edition, Prentice Hall, 2020.
3. Kevin P. Murphy, Probabilistic Machine Learning - An Introduction, The MIT Press, 2022.
4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Course Policies and Student Responsibilities

General: Students are expected to attend all lectures/tutorials and take and submit all scheduled continuous assessments. During the course period, announcements will be broadcast online. Students are required to check course website regularly and follow up with these announcements closely.

Absenteeism: Continuous assignments make up a significant portion of the total mark. Absence from continuous assignments without official approved leave will result in zero marks and affect the overall course grade.

Academic Integrity

Honesty and good ethical behaviour are pillars of good academic work. Both students and course instructors must adhere to the principles of academic integrity and to the NTU Honor Code.

It is important that students recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you carry out at NTU. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating.

Course Instructors

Instructor	Office Location	Phone	Email
Chen LiHui	S1-B1c-96	67904484	elhchen@ntu.edu.sg
Tan Yap Peng	S1-B1a-16	6790 5872	eyptan@ntu.edu.sg
Wen BiHan	S2-B2b-54	6790 4708	Bihan.wen@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction to AI & Brief history State Space Representation Search Strategies: data /goal driven	ILO1	Lecture1-3 **Homework 1** (Due week 3)
2	Search Algorithms: Backtracking/BreadthFirst/DepthFirst	ILO2	Lecture4-6 **Homework 2** (Due week 4)
3	Heuristic Search: Hill-climbing/ Best-First / MiniMax/ Alpha-Beta	ILO3	Lecture7-9
4	Introduction to DataMining Association Rule Mining: Apriori/FPGrowth	ILO4/ILO6	Lecture10-12
5	Introduction to Machine Learning	ILO5/ILO6	**Quiz1** Lecture14-15
6	Classification and Decision Trees	ILO5/ ILO6	Lecture16-18 **Homework 3** (Due Week 8)
7	Nearest Neighbor Classifiers and Support Vector Machines	ILO5/ ILO6	Lecture19-21 **Project** (Due week 13)
	Recess week		
8	Neural Networks: Perceptrons, The Backpropagation Algorithm	ILO5/ ILO6	Lecture 22-24 **Homework 4** (Due Week 10)
9	Neural Networks: Convolutional Neural Networks, Other Popular Deep Learning Networks	ILO5/ ILO6	Lecture 25-27
10	Unsupervised Learning Clustering & Regression	ILO5/ ILO6	Lecture 28-30 **Homework 5** (Due week 12)
11	Regularization and Optimization for Deep Models	ILO5	Lecture 31-33
12	Dimensionality Reduction + Bayesian Reasoning	ILO5/ ILO6	Lecture 34-36
13	Bayesian Reasoning	ILO5/ ILO6	Lecture 37-39

Appendix 1A: Assessment Criteria for CA2 (Assignment)

Marks	Criteria
>=90%	Able to achieve LO4 & LO6 completely
70% - 89%	Able to achieve LO4 & LO6 with some minor issues/misunderstanding
50% - 69%	Able to achieve most LO4 & LO6. Some major issues/misunderstanding exist
40% - 49%	Able to achieve only some of LO4 & LO6
<40%	Unable to achieve LO4 & LO6

Appendix 1B: Assessment Criteria for CA3 (Project Report)

CA3 can be individual or students can choose to team up with one other partner. If students choose to form a group of two, the two students in the same group may share the same codes and experimental results. However, they MUST clearly state their contributions to the codes and experiments in their submitted individual project report.

Furthermore, students need to answer a list of questions in the project report based on their understanding of the code and experiment design. They need to explain and justify the algorithms they use, and analyse the results based on what they learn from this course. All of these answers MUST be done independently no matter whether they choose to work in team or individually.

Individual student will submit a Project Report to illustrate the problem and the solution. Included as part of the report is the code. The project will be graded out of 100 points and will then be scaled to 20% of the total marks. 80% of the project assessment will be based on students' individual analysis, while 20% is dependent on their codes and testing accuracy which can be a team effort.

Criteria	**Standards**		
	Fail standard (0-40)	**Pass standard (41-74)**	**High standard (75-100)**
Identify the core definition of the problem and plan the solution. (LO 5, 6)	Identifying completely wrong definitions of the problems, and planning solutions that are somewhat related but are not the actual solutions expected for the problems.	Identifying the correct and relevant definitions of the problems in line with the course materials, planning solutions reasonably in line with solutions expected for the problems and trying to relate the course materials to the planned solutions. Accuracy and clarity can be further improved.	Identifying the correct and relevant definitions of the problems in line with the course materials, planning technically accurate steps for the solutions that are expected for the problems, and clearly connecting the course materials to the planned solutions.

Explore the data effectively and devise required models to solve the problem. (LO 5, 6)	Ad hoc analysis of the data and arbitrary steps in building the model without properly connecting the concepts with relevant concepts from the course. No or little evidence of critical evaluation of the proposed solution.	Logical exploration of the data that demonstrates a good understanding of the concepts from the course and building models with reasonable accuracy to solve the problems. Reasonable evidence of critical thinking related to the proposed solution and producing solutions with some degree of intuition and justification (rigorous steps for model-building or validation of models and results may be missing).	Clear logical flow of data exploration of that demonstrates a good understanding of the concepts from the course (and beyond) and building models with high accuracy to solve the problems. Extensive evidence of critical thinking related to the proposed solution, and producing solutions with clear intuition and proper justification, including rigorous steps for model-building and validation of the models and results.
Overall Organization of the Project Report. (LO 5)	Disorganised format and arrangement of the code and report, without any comment or little/no mention of references/resources.	Clear logical flow and well-formatted arrangement of the code and report, with all essential components. Reasonable comments and reasonable documentation of references /resources.	Clear logical flow and well-formatted arrangement of the code and report, with all essential components. Detailed set of technical comments to illustrate the choices made towards the solution, and to highlight the inferences. Proper documentation of references /resources.

Appendix 2: The EAB (Engineering Accreditation Board) Accreditation SLOs (Student Learning Outcomes)

	***EAB Graduate Attributes[1]**
a)	**Engineering Knowledge** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation as specified in WK1 to WK4 respectively to the solution of complex engineering problems.

[1] *Reference: EAB Accreditation Manual*

b)	**Problem Analysis** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. (WK1 to WK4)
c)	**Design / Development of Solutions** Design solutions for complex engineering problems and design systems, components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (WK5)
d)	**Investigation** Conduct investigations of complex problems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e)	**Modern Tool Usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering problems, with an understanding of the limitations. (WK6)
f)	**The Engineer and Society** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (WK7).
g)	**Environment and Sustainability** Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (WK7)
h)	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. (WK7)
i)	**Individual and Team Work** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j)	**Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k)	**Project Management and Finance** Demonstrate knowledge and understanding of engineering management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l)	**Life-long Learning** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

No.	**Knowledge Profile**
WK 1	A systematic, theory-based understanding of the natural sciences applicable to the discipline
WK 2	Conceptually-based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline
WK 3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
WK 4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline
WK 5	Knowledge that supports engineering design in a practice area
WK 6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
WK 7	Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impact of engineering activity: economic, social, cultural, environmental and sustainability
WK 8	Engagement with selected knowledge in the research literature of the discipline