Subject Description Form

Subject Code	EIE557
Subject Title	Computational Intelligence and Its Applications
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	The subject aims to introduce students to (i) fundamentals of key intelligent systems technologies including knowledge-based systems, neural networks, fuzzy systems, and evolutionary computation, and (ii) practice in integration of intelligent systems technologies for engineering applications.
Intended Learning Outcomes	Upon completion of the subject, students shall be able to a. Gain a working knowledge of knowledge-based systems, neural networks, fuzzy systems, and evolutionary computation; b. Apply intelligent systems technologies in a variety of engineering applications including IoT; c. Implement typical computational intelligence algorithms in MATLAB/Python; d. Present ideas and findings effectively; and e. Think critically and learn independently.
Subject Synopsis/ Indicative Syllabus	1. Introduction to Computational Intelligence 1.1 Intelligence machines 1.2 Computational intelligence paradigms 1.3 Data mining for IoT 2. Rule-Based Expert Systems and Fuzzy Expert Systems 2.1 Rule-based expert systems 2.2 Uncertainty management 2.3 Fuzzy sets and operations of fuzzy sets 2.4 Fuzzy rules and fuzzy inference 2.5 Fuzzy expert systems 2.6 Case study: fuzzy logic controller for washing machines 3 Artificial Neural Networks 3.1 Fundamental neurocomputing concepts: artificial neurons, activation functions, neural network architectures, learning rules 3.2 Supervised learning neural networks: multi-layer feedforward neural networks, simple recurrent neural networks, time-delay neural networks, supervised learning algorithms 3.3 Unsupervised learning neural networks: self-organizing feature maps 3.4 Radial basis function networks 3.5 Deep neural networks and learning algorithms 3.6 Case study: anomaly detection for video surveillance 4 Evolutionary computation 4.1 Chromosomes, fitness functions, and selection mechanisms 4.2 Genetic algorithms: crossover and mutation

4.3 Genetic programming
4.4 Evolution strategies
4.5 Case study: cost-sensitive control in wireless sensor networks

5 Hybrid Intelligent Systems
5.1 Neural expert systems
5.2 Neuro-fuzzy systems
5.3 Evolutionary neural networks
5.4 Applications to IoT

Teaching/Learning Methodology

Lecture/case studies (leaning outcomes a and b)

- fundamental principles and key concepts of the subject are delivered to students;
- guidance on further readings, applications and implementation is given.

The formal lectures will be accompanied by case studies of successful real-world engineering applications of intelligent systems technologies.

Tutorial (learning outcomes a and b)

- students will be able to clarify concepts and to have a deeper understanding of the lecture material;
- problems and application examples are given and discussed.

Laboratory exercises (learning outcomes a - e)

Students will make use of the software tools and MATLAB/Python to develop simple computational intelligence systems.

Teaching/Learning Methodology	Intended Subject Learning Outcomes				
	a	b	c	d	e
Lectures	✓	✓			
Tutorials	✓	✓			
Laboratories	✓	✓	✓	✓	✓
Assignments	✓	✓		✓	✓

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)				
		a	b	c	d	e
1. Test	25%	✓	✓			✓
2. Final examination	50%	✓	✓		✓	✓
3. Laboratories (including report writing)	15%	✓	✓	✓	✓	✓
4. Assignments	10%	✓	✓		✓	✓
Total	100%					

Student Study Effort Expected	Class contact:	
	▪ Lecture	26 Hrs.
	▪ Tutorial	7 Hrs.
	▪ Laboratory	6 Hrs.
	Other study efforts:	
	▪ Self-learning	48 Hrs.
	▪ Assignments, laboratory report writing	18 Hrs.
	Total student study effort	105 Hrs.
Reading List and References	1. M. Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Pearson/Addison Wesley, 2011. 2. A.P. Engelbrecht, Computational Intelligence: An Introduction, 2nd Edition, John Wiley & Sons, 2007. 3. H.K. Lam, S.S.H. Ling, and H.T. Nguyen, Computational Intelligence and Its Applications: Evolutionary Computation, Fuzzy Logic, Neural Network and Support Vector Machine, Imperial College Press, 2011. 4. I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning, MIT Press, 2016. 5. C.C. Aggarwal, Neural Networks and Deep Learning, 1st Edition, Springer, 2018. 6. E. Turban, J. E. Aronson, T.-P. Liang, Decision Support Systems and Intelligent Systems, 8th Ed., Pearson Prentice Hall, 2015. 7. E. Cox, The Fuzzy Systems Handbook, Boston: AP Professional, 1998. 8. S. Russell and P. Norvig. Artificial Intelligence – A Modern Approach, Prentice Hall, 2010. 9. S. Haykin, Neural Networks – A Comprehensive Foundation, Prentice Hall, 1999. 10. N. Baba and L.C. Jain, Computational Intelligence in Games, Heidelberg; New York: Physica-Verlag, 2001. 11. F.F. Soulie and P. Gallinari (Editors), Industrial Applications of Neural Networks, Singapore; River Edge, NJ: World Scientific, 1998. 12. S. Chen (editor), Evolutionary computation in economics and finance, Heidelberg; New York: Physica-Verlag, 2002. 13. R.J. Jr., Bauer, Genetic Algorithms and Investment Strategies, John Wiley & Sons, 1994. 14. H.J. Zimmermann et al (Editors), Advances in Computational Intelligence and Learning: Methods and Applications, Boston: Kluwer Academic Publishers, 2002. 15. L.C. Jain and P. de Wilde (Editors), Practical Applications of Computational Intelligence Techniques, Boston: Kluwer Academic Publishers, 2001. 16. Selected papers on computational intelligence techniques for various applications including IoT.	