Subject Description Form

Subject Code	EIE522
Subject Title	Pattern Recognition: Theory and Applications
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	This course offers an up-to-date review of the state of the art in pattern recognition. In particular, it outlines the need for pattern recognition, its different algorithms, decision theoretic, syntactic, and neural network approaches including learning algorithms, and different classical image processing and character recognition techniques. The course will emphasize practical techniques for implementing useful pattern recognition systems. It will also provide a base for practice and progress in matters related to research.
Intended Learning Outcomes	Upon completion of the subject, students shall be able to a. Understand and analyze methods for automatic training of classification systems based on typical statistical, syntactic and neural network approaches; b. Understand common feature extraction methods for pattern recognition; c. Design systems and algorithms for pattern recognition; d. Implement typical pattern recognition algorithms in MATLAB; e. Present ideas and findings effectively; and f. Think critically and learn independently.
Subject Synopsis/ Indicative Syllabus	1. Introduction 1.1 The Subproblems of Pattern Recognition 1.2 Structure of a Pattern Recognition System 1.3 Patterns and Pattern Vectors 2. Feature Extraction and Applications 2.1 Edge-Detection Methods 2.2 Shape Characterization 2.3 Texture Analysis 2.4 Colour Features 2.5 People Detection and Face Recognition 3. Statistical Approaches to Pattern Recognition 3.1 Approaches to Developing StatPR Classifier 3.2 Bayesian Theorem and Bayesian Classifier 3.3 Supervised Learning Using Parametric & Nonparametric Approaches 3.4 Unsupervised Learning and Clustering 3.5 Case Studies 4. Subspace Analysis 4.1 Principal Component Analysis 4.2 Linear Discriminant Analysis 4.3 Applications to Face Detection and Recognition

	5. Support Vector Machines 5.1 SVM Principles 5.2 Linear SVM 5.3 Nonlinear SVM 5.4 Applications of SVM 6. Random Forest 6.1 Decision Tree 6.2 Random-forest Training 6.3 Forest Ensemble 6.4 Applications of Random Forests 7. Neural Networks and Their Applications to Pattern Recognition 7.1 Artificial Neural Networks: Architectures, Output Characteristics, and Learning Algorithms 7.2 Neural Network Structures for Pattern Recognition 7.3 Multilayer Feedforward Networks and Backpropagation Training Algorithms 7.4 Unsupervised Feature Learning and Deep Learning 7.5 Case Studies **Laboratory Exercises:** (1) Face Image Analysis and Representation Using Principal Component Analysis (2) Design of Neural Network PR Systems
Teaching/Learning Methodology	Lecture (leaning outcomes a, b, and c) • fundamental principles and key concepts of the subject are delivered to students; • guidance on further readings, applications and implementation is given. Tutorial (learning outcomes a, b, c and f) • 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 - f) Students will make use of the software tools and MATLAB to develop simple pattern recognition systems. Assignments (learning outcomes a – c , e, and f) • end-of chapter type problems are used to evaluate students' ability in applying concepts and skills learnt in the classroom; • students need to think critically and creatively in order to come with an alternate solution for an existing problem.

Teaching/Learning Methodology	Intended Subject Learning Outcomes					
	a	b	c	d	e	f
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	f
1. Tests	25%	✓	✓	✓		✓	✓
2. Final examination	50%	✓	✓	✓		✓	✓
3. Assignments	10%	✓	✓	✓		✓	✓
4. Laboratories (including report writing)	15%	✓	✓	✓	✓	✓	✓
Total	100%						

Student Study Effort Expected

Class contact:	
▪ Lecture	26 Hrs.
▪ Tutorial	7 Hrs.
▪ Laboratory	6 Hrs.
Other student study effort:	
▪ Self-learning	45 Hrs.
▪ Assignments, laboratory report writing	24 Hrs.
Total student study effort	108 Hrs.

Reading List and References

1. C.M. Bishop**,** *Pattern Recognition and Machine Learning*, Springer, 2006.
2. R.O. Duda, P.E. Hart and D.G. Stork, *Pattern Classification*, 2nd Edition, John Wiley, 2001.
3. R.C. Gonzalez and R.E. Wood, *Digital Image Processing*, 4th Edition, Pearson Prentice Hall, 2018.
4. C.C. Aggarwal, *Neural Networks and Deep Learning*, 1st Edition, Springer, 2018.
5. R. Schalkoff, *Pattern Recognition – Statistical, Structural & Neural Approaches*, John Wiley, 1992.
6. S.T. Bow, *Pattern Recognition and Image Preprocessing*, 2nd Edition, Marcel Dekker, 2002.
7. M. Sonka, V. Hlavac, and R. Boyle, *Image Processing, Analysis and Machine Vision*, 3rd Ed., Thompson Learning, 2008.
8. J.M. Zurada, *Introduction to Artificial Neural Systems*, West Publishing, 1992.
9. M. Nadler and E.P. Smith, *Pattern Recognition Engineering*, John Wiley, 1993.
10. I. Goodfellow, Y. Bengio and A. Courville, *Deep Learning*, MIT Press, 2016.
11. R.M. Bolle, *Guide to Biometrics*, Springer, 2010.
12. A. Webb, *Statistical Pattern Recognition*, 3rd Ed., Wiley-Blackwell, 2011.
13. Selected papers from Pattern Recognition, Pattern Recognition Letters, IEEE Transactions on Pattern Analysis and Machine Intelligence, and other journals on pattern recognition.