Title (Units): **COMP4026 Computer Vision and Pattern Recognition (3,2,1)**

Course Aims: To give students a broad knowledge on, and techniques used in contemporary research on computer vision and pattern recognition.

Prerequisite: COMP3057 Introduction to AI and ML OR
COMP3115 Exploratory Data Analysis and Visualization OR
(i) COMP2015 Data Structures and Algorithms, and (ii) MATH1005 Calculus or MATH1025 Introduction to Mathematics and Statistics

Course Intended Learning Outcomes (CILOs):
Upon successful completion of this course, students should be able to:

No.	Course Intended Learning Outcomes (CILOs)
	Knowledge
1	Explain basic theories and techniques in computer vision and pattern recognition
2	Identify various approaches of computer vision and pattern recognition
3	Design the components of computer vision and pattern recognition systems
4	Describe the basic functions and methods for image processing
	Professional Skill
5	Develop a computer vision and pattern recognition application prototype

Calendar Description: This course gives students a broad knowledge on, and techniques used in contemporary research on computer vision and pattern recognition.

Teaching and Learning Activities (TLAs):

CILOs	Type of TLA
1 - 3	Students will learn knowledge of computer vision and pattern recognition through lectures and tutorials. In order to help students to have good understanding, laboratory sessions will be designed so that students could apply what they have learnt in lectures. Besides, written assignment(s), laboratory exercise(s) and final examination will be designed to evaluate the students' level of understanding.
1 - 4	Based on the theories of computer vision and pattern recognition they have learnt, students are required to have develop an application prototype using an API, such as OpenCV. Students are required to give a preliminary demonstration as well as a final formal presentation on their project. In both cases, instructor(s), teaching assistant and other students would ask questions related to their project. In this way, we could assess their understanding of the theories of computer vision and pattern recognition, as well as their proposed method.

Assessment:

No.	Assessment Methods	Weighting	CILOs to be addressed	Description of Assessment Tasks
1	Written Assignment and Laboratory Exercises	20%	1 - 5	Written assignment and laboratory exercises and project are designed to measure how well students have learned the fundamentals and major concepts of computer vision and pattern recognition.
2	Project	40%	1 - 5	Project is designed to measure how well students have learned the fundamentals and major concepts of computer vision and pattern recognition.
3	Examination	40%	1 - 4	Final examination questions are designed to see how far students have achieved their course intended learning outcomes.

Assessment Rubrics:

Excellent (A)	• Achieve the four CILOs, with strong evidence of having achieved the last CILO, demonstrating a good mastery of both the theoretical and practical aspects of the knowledge and skills associated with computer vision and pattern recognition • Able to develop correct solutions to problems • Demonstrate a thorough understanding and solid knowledge of computer vision and pattern recognition • Able to apply a variety of techniques and relevant knowledge for solving problems in computer vision and pattern recognition
Good (B)	• Achieve most of the four CILOs, with evidence of having achieved the last CILO, demonstrating a good understanding of the knowledge and skills associated with computer vision and pattern recognition • Able to develop correct solutions to problems • Demonstrate a competent level of knowledge of computer vision and pattern recognition • Ability to make use of appropriate techniques and knowledge and apply them to familiar problems
Satisfactory (C)	• Achieve some of the four CILOs, demonstrating a basic level of understanding of the knowledge and skills associated with computer vision and pattern recognition • Able to provide acceptable solutions to problems • Demonstrate an adequate level of knowledge of computer vision and pattern recognition • Ability to make use of some techniques and knowledge and apply them to familiar situations
Marginal Pass (D)	• Achieve few of the four CILOs, with minimal understanding of the associated concepts and underlying methodologies • Able to provide solutions to simple problems • Demonstrate a basic level of knowledge of computer vision and pattern recognition • Ability to apply some techniques and knowledge to a limited number of typical situations
Fail (F)	• Achieve none of the four CILOs, with little understanding of the associated concepts and underlying methodologies • Unable to provide solutions to simple problems • Knowledge of computer vision and pattern recognition falling below the basic minimum level • Unable to apply techniques and knowledge to situations or problems

Course Content and CILOs Mapping:

Content		**CILO No.**
I	Introduction to computer vision and pattern recognition	1,2,3
II	Convention computer vision and pattern recognition algorithms	1,2,3,4
III	Deep learning for computer vision and pattern recognition	1,2,3,4

References:

- R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, 2nd Edition, John Wiley & Sons, Inc, 2000.
- L.G. Shapiro and G. C. Stockman, Computer Vision, Prentice Hall, 2001.

- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010
- Klette, Reinhard, Concise computer vision - An introduction into theory and algorithm, Springer, 2014.
- Goodfellow, Bengio, and Courville, Deep Learning, MIT Press, 2016.
- IEEE Transactions on Pattern Analysis and Machine Intelligence.
- IEEE Transactions on Image Processing.
- International Journal on Computer Vision.
- Journal of Pattern Recognition.

Course Content:

Topic

I. Introduction to computer vision and pattern recognition
   1.
      1. Human vision
      2. Image formation
      3. How machine sees and recognizes things
      4. Applications

II. Convention computer vision and pattern recognition algorithms
   1. Object detection and segmentation

   e.g. Edge, texture, region, detection of sliding windows

   1. Feature extraction,

   e.g. linear binary pattern, principal component analysis, Gabor filters, bags of features

   1. Matching and recognition

   e.g. Bayesian classifier, support vector machine, fusion

III. Deep learning for computer vision and pattern recognition
   1. Key components and basic architecture of deep neural network
   2. Convolution neural network
   3. Object detection using R-CNN
   4. Segmentation using image-to-image neural network
   5. Temporal processing and recurrent neural network