**City University of Hong Kong**
**Course Syllabus**

**offered by Department of Electrical Engineering**
**with effect from Semester B in 2019/2020**

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## Part I Course Overview

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|---|---|
| **Course Title:** | Topics in Image Processing |
| **Course Code**: | EE5806 |
| **Course Duration:** | One Semester (13 weeks) |
| **Credit Units**: | 3 |
| **Level**: | P5 |
| **Medium of Instruction:** | English |
| **Medium of Assessment:** | English |
| **Prerequisites**: *(Course Code and Title)* | Nil |
| **Precursors**: *(Course Code and Title)* | [MA2149 Mathematical Analysis, or<br>MA2170 Linear Algebra and Multi-variable Calculus]; and<br>[EE3210 Signals and Systems, or<br>EE3118 Linear Systems and Signal Analysis] or<br>EE5410 Digital Signal Processing |
| **Equivalent Courses**: *(Course Code and Title)* | Nil |
| **Exclusive Courses**: *(Course Code and Title)* | Nil |

**Part II Course Details**

## 1. Abstract

This course aims to provide students with an understanding of digital image processing techniques, including image reconstruction and restoration, pattern recognition and video analysis.

## 2. Course Intended Learning Outcomes (CILOs)

*(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)*

| No. | CILOs | Weighting (if applicable) | Discovery-enriched curriculum related learning outcomes (please tick where appropriate) | | |
|---|---|---|---|---|---|
| | | | *A1* | *A2* | *A3* |
| 1. | Describe Image transformations. | | ✓ | ✓ | |
| 2. | Describe Image reconstruction and restoration. | | ✓ | ✓ | |
| 3. | Describe Image segmentation and pattern recognition. | | ✓ | ✓ | |
| 4. | Perform Video analysis. | | | | ✓ |
| 5. | Apply computer algorithms to practical problems. | | | | ✓ |
| | | 100% | | | |

*A1: Attitude*
*Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.*

*A2: Ability*
*Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.*

A3: *Accomplishments*
*Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.*

## 3. Teaching and Learning Activities (TLAs)

*(TLAs designed to facilitate students' achievement of the CILOs.)*

| TLA | Brief Description | CILO No. | | | | | | Hours/week (if applicable) |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Lectures | Key mathematical, algorithmic and system concepts are described and illustrated | ✓ | ✓ | ✓ | | | | 2 hrs/wk |
| Tutorials | Key mathematical, algorithmic and system concepts are worked out based on examples and exercises | ✓ | ✓ | ✓ | | | | 1 hr/wk |
| On-line learning | Key mathematical, algorithmic and system concepts concepts are demonstrated with web-based multimedia materials | ✓ | ✓ | ✓ | | | | |
| Computer projects, demo and presentation | Key concepts are applied to solve real-world image and video processing problems | | | | ✓ | ✓ | | |

## 4. Assessment Tasks/Activities (ATs)

*(ATs are designed to assess how well the students achieve the CILOs.)*

| Assessment Tasks/Activities | CILO No. | | | | | | Weighting | Remarks |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | | | |
| Continuous Assessment: 50% | | | | | | | | |
| Tests (min.: 2) | ✓ | ✓ | ✓ | ✓ | ✓ | | 30% | |
| #Assignments (min.: 3) | ✓ | ✓ | ✓ | ✓ | ✓ | | 20% | |
| Examination: 50% (duration: 2 hrs , if applicable) | | | | | | | | |
| Examination | ✓ | ✓ | ✓ | ✓ | ✓ | | 50% | |
| | | | | | | | 100% | |

**Remark:**

To pass the course, students are required to achieve at least 30% in course work and 30% in the examination.

# may include homework, tutorial exercise, project/mini-project, presentation

**5. Assessment Rubrics**

*(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)*

| Assessment Task | Criterion | Excellent (A+, A, A-) | Good (B+, B, B-) | Fair (C+, C, C-) | Marginal (D) | Failure (F) |
|---|---|---|---|---|---|---|
| 1. Examination | Achievements in CILOs | High | Significant | Moderate | Basic | Not even reaching marginal levels |
| 2. Coursework | Achievements in CILOs | High | Significant | Moderate | Basic | Not even reaching marginal levels |

## 6. Constructive Alignment with Programme Outcomes

| PILO | How the course contribute to the specific PILO(s) |
|---|---|
| 1, 2 | By taking this course, students will learn advanced digital image processing techniques, including various image transformations, image reconstruction from incomplete information, image segmentation and recognition and video sequence analysis. |
| 3 | Students will be able to design and conduct digital imaging experiments and analyze and interpret image and video data, as evidenced from computer projects, demo and presentation. Examples include designing a system for image reconstruction from Fourier magnitude only or phase only data and detection of moving objects in video sequences. Students will be encouraged to engage in discovery and innovation related activities, such as studying the latest digital imaging technologies in computer and mobile applications. |
| 4 | Students will be able to identify, formulate and solve engineering problems using digital imaging techniques. An example is how to remove the blurring in an image from a moving object. One has to understand how to model the motion, its effect on image formation and remove the motion artifacts under various real world constraints. |
| 5 | Students will be able to develop new digital imaging technology and industrial products. For example, student can be asked to do a project on human face image identification on a mobile phone. This requires research and development of efficient hardware and software and the knowledge gained in this course can help student achieve the goals. |

**Part III Other Information** (more details can be provided separately in the teaching plan)

## 1. Keyword Syllabus

Basic Image Processing Methods

Image sampling and quantization; filtering in spatial and frequency domains; color imaging; contrast enhancement.

Image Transformations

The two-dimensional Fourier transform (2D DFT); principal component analysis; 2D autoregressive (AR) and moving average (MA) models; non-linear transforms.

Image Reconstruction and Restoration

Spatial and frequency domain representation of 2D signals; image reconstruction from projections, image reconstruction from Fourier magnitude information only or phase information only; medical imaging systems; projection onto convex sets for image reconstruction and restoration.

Image Segmentation and Pattern Recognition

Pattern recognition techniques; image segmentation; point detection, line detection, edge detection; thresholding, clustering, region growing methods; decision function; pattern classification by distance and maximum likelihood; training techniques; application of AI techniques.

Video Analysis

Kalman filtering, linear prediction, motion detection and estimation; point and line matching, object tracking; efficient computer algorithms.

Applications

Examples include artefact removal from highly compressed images, medical image reconstruction from incomplete information, object detection, tracking and recognition.

## 2. Reading List

### 2.1 Compulsory Readings

*(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)*

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|---|---|
| 1. | Gonzalez R. C. and Woods R.E.: Digital Image Processing, Third Edition (Prentice Hall, 2008). |
| 2. | Lecture notes on: http://www.eespeech.cityu.edu.hk/~ebook/ee5806/ |

### 2.2 Additional Readings

*(Additional references for students to learn to expand their knowledge about the subject.)*

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|---|---|
| 1. | Szeliski R.: Computer Vision, Algorithms and Applications, Springer-Verlag, 2011. |
| 2. | Animation movies on: http://www.eespeech.cityu.edu.hk/~ebook/ee5806/ |