

**Hong Kong Baptist University  
Faculty of Science Department  
of Mathematics**

**Title (Units):**     **SCI3710 Digital Image Analysis (3,3,0)**

**Course Aims:**     This course aims to introduce students to the foundation of digital image analysis. Students will learn elementary point operation techniques for image enhancement, and advanced techniques (including the theory of Fourier transform) for image restoration and image analysis. Students will come to understand all the major issues involved in the design and implementation of a digital imaging system.

**Prerequisite:**     MATH1111 Mathematical Analysis I

**Prepared by:**     W.C. Shiu and T. Zeng

**Course Intended Learning Outcomes (CILOs):**

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

<b>No.</b>	<b>Course Intended Learning Outcomes (CILOs)</b>
1	Classify and apply the basic techniques in digital image enhancement
2	Recognize the mathematical theory of transform calculus
3	Apply the theory of transform calculus for image analysis and image compression
4	Manipulate the software MATLAB and Image Processing Toolboxes
5	Design and implement innovative image processing system for achieving special imaging effects or solving basic pattern recognition problems

### Teaching & Learning Activities (TLAs)

<b>CILO</b>	<b>TLAs will include the following:</b>
1, 4	<b>Lecture and in-class activity</b> Instructor will use lectures to introduce the concepts of image processing and provide training for the basic skills in using the MATLAB and its toolboxes for basic image enhancement effects. Students will consolidate the knowledge through discussion within lectures.
2-3, 5	<b>Lecture and assignment</b> Instructor will use lectures and assignments to consolidate understanding in the theory and applications of transform calculus.

### Assessment:

<b>No.</b>	<b>Assessment Methods</b>	<b>Weighting</b>	<b>CILO Addressed</b>	<b>Remarks</b>
1	Continuous Assessment	30%	1-5	Assignments are designed to measure students understanding of the theory of digital image processing (CILO 1-4). This may involve, but not limited to, in class discussions of rigorous technical problems and their solutions.
2	Final Examination	70%	1-3, 5	Final Examination is designed to see how far students have achieved their intended learning outcomes especially in the Knowledge domain. Students should have a thorough understanding of the knowledge and apply them correctly in different context to do well in the exam.

**Course Intended Learning Outcomes and Weighting:**

<b>Content</b>	<b>CILO No.</b>	<b>Teaching (in hours)</b>
I. Introduction and Elementary Image Processing	1, 4	11
II. Fourier Transform and Its Applications in Image Processing	2	10
III. Structural Operations on Images	1, 3-5	10
IV. Image Segmentation	3	10
V. Introduction to Image Compression	3, 5	8

**Textbook:** R.C. Gonzalez and R.E. Woods, Digital Image Processing, 3<sup>rd</sup> Ed., Prentice Hall, 2007.

**References:** K.R. Castleman, Digital Image Processing, Prentice-Hall, 1996.  
John C. Russ, The Image Processing Handbook, 6<sup>th</sup> Ed., CRC Press, 2011.  
M. Petrou and C. Petrou, Image Processing: The Fundamentals, 2nd Ed., Wiley, 2010.  
T. Chan and J. Shen, Image Processing and Analysis: Variational, PDE, Wavelet, and Stochastic Methods, SIAM 2005.

**Software:** Matlab and image processing toolboxes

## Course Content in Outline:

	<u>Topic</u>	<u>Hours</u>
I.	Introduction and Elementary Image Processing	11
	A. Digital image processing: problems and applications	
	B. Image representation and modelling	
	C. Image sampling and quantization	
	D. Point operations such as contrast stretching, clipping and thresholding	
	E. Histogram modelling such as histogram evaluation, histogram equalization and histogram modification	
II.	Fourier Transform and Its Applications in Image Processing	10
	A. Definition and properties	
	B. Sampling theorem	
	C. Image degradation models	
	D. Restoration using inverse and Wiener filtering	
	E. Discrete Fourier transform	
III.	Structural Operations on Images	10
	A. Spatial operations such as spatial averaging, median filtering and Gaussian filtering	
	B. Edge detection including gradient operators, Laplace operators and zero crossings	
	C. Boundary extraction and representation	
	D. Hough transform	
IV.	Image Segmentation	10
	A. Overview of segmentation methods	
	B. Boundary-based approach	
	C. Region-based approach	
	D. Region representation	
	E. Applications to pattern recognition	
V.	Introduction to Image Compression	8
	A. Bitplane compression techniques	
	B. Transform coding techniques	