ESCUELA SUPERIOR POLITÉCNICA DEL LITORAL
Faculty of Electrical and Computer Engineering
COURSE SYLLABUS
Digital Images Processing

1. CODE AND NUMBER OF CREDITS

CODE	FIEC05439	
NUMBER OF CREDITS: 4	**Theoretical: 4**	**Practical: 0**

2. COURSE DESCRIPTION

This course offers students the theoretical and practical tools on the field of Digital Image Processing and Digital Image Analysis. Topics related to image acquisition process, lighting systems, types of camera, optics and camera calibration processes will be addressed in the initial part of the course. Additionally, the student will become familiar with using basic tools and techniques used in image processing applications, such as pre-processing operators, discrete transforms, image enhancement, image restoration and image compression. An important component of this course is to increase the student's ability to solve proposed problems by applying image processing techniques. In this way, problems related to applications: transformation, enhanced, image compression and restoration, among others, are proposed as laboratory work or course projects. Theoretical and practical classes are included in the development of this subject.

3. PRE-REQUISITES AND CO-REQUISITES

PRE-REQUISITES	FIEC04382 SIGNALS AND SYSTEMS
CO-REQUISITES	NONE

4. CORE TEXT AND OTHER REQUIRED REFERENCES FOR THE TEACHING OF THE COURSE

CORE TEXT	1. S.E. Umbaugh, Digital image processing and analysis: human and computer vision applications with CVIPtools, Second edition, Nov. 2010, CRC Press. 2. S.E. Umbaugh, Computer vision and image processing: A practical approach using CVIPtools, First edition, 1998, Ed. Prentice Hall. 3. Gonzalo Pajares, Jesús M. de la Cruz; Visión por computador: imágenes digitales y aplicaciones, 1era Edición, 2008, Ed. Ra-Ma.
REFERENCES	1. R.C. González, Digital image processing, 3rd edition, 2007, Prentice Hall. 2. J.R. Parker, Algorithms for image processing and computer vision, 2nd edition, 2010, Ed. Wiley. 3. Slides. 4. Notes and URL's resources related to the subject. 5. Access to libraries (open source) for image processing and computer vision: OpenCV - Open Computer Vision Library.

5. COURSE LEARNING OUTCOMES

At the end of the course, the student will be able to:
1. Giving the student a general introduction to the field of Processing and Digital Image Analysis.
2. Providing the student basic information about the most important lightning systems and the main types of cameras. Fundaments about the optics and camera calibration processes will also be introduced.
3. Familiarizing the student with the use of techniques and basic tools that generally are used in applications of image processing. Operations pre-processing, discrete transforms, image enhancement, image restoration and image compression, will be studied in theoretical and practical classes.
4. Developing the student's ability in order to solve proposed problems by applying image processing techniques. Those problems can be related with: transforms, enhanced, restoration and image compression, and others.

6. COURSE PROGRAM

1. INTRODUCTION AND OVERVIEW (2 Sessions : 4 hours)
1.1 Course: policies and rules.
1.2 Introduction to digital image processing (DIP) and computer vision (CV): Human visual perception, Artificial vision system, What is DIP ?. What is CV ?. Some applications: DIP – CV.
1.3 Introduction to digital image acquisition process:
1.3.1 Image digitalization.

2. IMAGE ACQUISITION. (2 Sessions : 4 hours)

2.1 Illumination systems.

2.2 Acquisition sensors: types of sensors, solid state cameras vs. tube cameras, interfaces and standards.

2.3 Image digitalization: Sampling and quantization, Gain adjustments and displacement, Hardware for the digitalization, Considerations to select a frame-grabbers card.

2.4 Image representation: Binary image, Gray-scale image, Color image and Multispectral image.

3. LAB # 1 + LAB # 2 + LAB #3. (2 Sessions: 4 hours)

4. OPTICS AND CALIBRATION. (2 Sessions: 4 hours)

4.1 Optics: overview; pinhole lens model.

4.1.1 Thin-lens model: focal length, focus distances, depth of field, aperture (f-number).

4.1.2 Parameters of interest in the capture of images: work distance, vision field, angle of view, increase factor, mount type; optic distortion.

4.2 Calibration: definition, utility, general procedure for calibration.

4.3 Brightness in images.

4.4 Presentation about different subjects of the course.

5. LAB # 4 + HOMEWORK PRESENTATION. (1 Session: 2 hours)

6. IMAGE ANALYSIS: PRE-PROCESSING OPERATIONS. (2 Sessions: 4 hours)

6.1 Introduction.

6.2 Pre-processing operations: Region of interest, Arithmetic operations, Logical operations, Geometric operations, Spatial filers, Image quantization, Morphologic operations.

7. LABS # 5 y # 6. (2 Sessions: 4 hours)

8. TEST EVALUATION. (1 Session: 2 hours)

9. REVIEW: PROJECT # 1. (1 Session: 2 hours)

10. IMAGE ANALYSIS: DISCRETE TRANSFORMS. (2 Sessions: 4 hours)

10.1 Fourier transforms.

10.2 Cosine transforms.

10.3 Walsh-Hadamard transforms.

10.4 Frequencies Filtering.

11. LAB # 7 + EXERCISES. (1 Session: 2 hours)

12. IMAGE ENHANCEMENT. (2 Sessions: 4 hours)

12.1 Introduction.

12.2 Gray-scale modification: histogram modification, adaptive contrast enhancement, color.

12.3 Image sharpening: high-pass filtering, high-frequency emphasis, homomorphic filtering, unsharp masking.

12.4 Image smoothing: mean and median filtering, low-pass filtering.

13. LAB # 8. (1 Session: 2 hours)

14. IMAGE RESTAURATION. (2 Sessions: 4 hours)

14.1 Introduction: System model.

14.2 Noise.

14.3 Noise removal using spatial filters: Order filters, Mean filters, Adaptive filters-Minimum mean-square error filter.

14.4 Noise removal using frequency domain filters: Inverse filter, Wiener filter, Constrained least-squares filter, Geometric mean filters, Notch filter, Practical considerations.

15. LAB # 9. (1 Session : 2 hours)

16. IMAGE COMPRESSION. (2 Sessions: 4 hours)

16.1 Introduction: Fidelity criteria, compression system model.

16.2 Lossless compression methods: Huffman coding, Run-length coding, Lempel-Ziv-Welch coding, Arithmetic coding.

16.3 Lossy compression methods: Gray-level run-length coding, Block truncation coding, Vector quantization, Differential predictive coding, Transform coding, Hybrid methods.

17. TEST EVALUATION + REVIEW: FINAL PROJECT. (2 Sessions: 4 hours)

7. WORKLOAD: THEORY/PRACTICE

- Twice a week, each session 2 hours.
- They are 14 sessions for a 1st Part, 28 sessions in the semester.

8. CONTRIBUTION OF THE COURSE TO THE EDUCATION OF THE STUDENT

This subject contributes the engineering training curriculum as follows:

- Allow the student to study a current topic of computer science such as the use of a computer to process digital images.
- Students are exposed to languages and alternatives computational tools that are specially designed to work with images.
- Students should, through the studied theory, analyze and solve problems in environments such as capture, analysis and image processing.

BASIC TRAINING	PROFESSIONAL TRAINING	SOCIAL SKILLS DEVELOPMENT
	X	

9. THE RELATIONSHIP BETWEEN THE LEARNING OUTCOMES OF THE COURSE AND THE LEARNING OUTCOMES OF THE DEGREE PROGRAM

LEARNING OUTCOMES OF THE DEGREE PROGRAM	CONTRIBUTION (High, Medium, Low)	LEARNING OUTCOMES OF THE COURSE	THE STUDENT MUST:
a) An ability to apply knowledge of computing and mathematics appropriate to the discipline.	High	1,2,3	Apply concepts for digitization, discrete Transforms Convolution, Digital Filters, and Analysis of data.
b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.	High	3,4	Analyze problems relating to digital image processing. Identify potential operators, filters, techniques and algorithms required to solve problems. Establish criteria to determine whether the solution can work properly as required.
c) An ability to design, implement and evaluate a computer-based system, process, component, or program to meet desired needs.	Low		Program components that can be used in the development of Multimedia Systems.
d) An ability to function effectively on teams to accomplish a common goal.	Medium		Work in group or team in order to undertake projects, labs and course exercises.
e) An understanding of professional, ethical, legal, security, and social issues and responsibilities.	-		
f) An ability to communicate effectively with a range of audiences.	Medium		Prepare presentations about projects, labs and expositions.
g) An ability to analyze the local and global impact of computing on individuals, organizations and society.	-		

h) Recognition of the need for, and an ability to engage in, continuing professional development.	-		
i) An ability to use current techniques, skills, and tools necessary for computing practices.	High	3,4	Use algorithms, languages, and current tools for image processing.
j) An ability to lead, manage and undertake projects.	-		
k) Capacity to use the techniques, the abilities, and modern tools for the practice of the engineering.	-		

10. EVALUATION IN THE COURSE

Evaluation activities	
Exams	X
Tests	X
Homework/tasks	X
Projects	X
Laboratory/Experiments	X
Class participation	
Visits	
Other	

11. PERSON RESPONSIBLE FOR THE CREATION OF THE SYLLABUS AND THE DATE OF ITS CREATION

Created by	Boris X. Vintimilla B.
Date	12th August 2013

12. APPROVAL

ACADEMIC SECRETARY OF THE ACADEMIC DEPARTMENT	**DIRECTOR OF TECHNICAL ACADEMIC SECRETARY**
NAME:	NAME:
SIGNATURE:	SIGNATURE:
Date of approval by the Directive Council:	

13. VALIDITY OF THE SYLLABUS

RESOLUTION OF THE POLYTECHNIC BOARD:	
DATE:	