DEPARTMENT OF COMPUTER ENGINEERING

College of Electrical and Mechanical Engineering (CEME)

National University of Sciences and Technology (NUST)

1. Course Information	
Course Number and Title:	EC-312 Digital Image Processing
Credits:	3 (2+1)
Instructor(s)-in-charge:	Dr. Muhammad Usman Akram
Course type:	Lecture + Lab
Required or Elective:	Required
Course pre-requisites	None
Degree and Semester	DE-34, Semester 6
Month and Year	Spring 2015

2. Course Schedule	
Lecture:	2 hrs/week, Meets once weekly
Lab:	3 hrs/week, Meets once in a week
Discussion:	1 hr/discussion, multiple discussion sections offered per quarter
Outside study:	3 hrs/week
Office Hours :	3 hrs/week by instructor, 3 hrs/week by teaching assistant/lab engineer

3. Course Assessment		
Exam:	2 Sessional and 1 Final	
Home work:	5 Assignments	
Lab reports:	15 reports	
Design reports:	2 Design reports based on Mini and Semester Project	
Quizzes:	4 Quizzes	
Grading:	Quizzes:	8%
	Assignments:	7%
	2 One Hour Tests (OHTs):	20%
	Final Exam:	40%
	Lab:	10%
	Mini + Semester Project:	15%

4. Course book and Related Course Material

Textbooks:	1. Digital Image Processing by Rafael C. Gonzalez and Woods, 3rd Edition, 2008
Reference Books:	1. Fundamentals of Digital Image Processing: A Practical Approach with Examples in Matlab by Chris Solomon, Wiley-Blackwel, 2011 2. Digital Image Processing Using Matlab by Rafael C. Gonzalez and Richard E. Woods, Pearson Education, 2009. 3. Digital Image Processing by Kenneth R. Castleman, Prentice Hall International Edition, 1996. 4. http://www.imageprocessingplace.com/

5. Catalog Descriptions

This course is consists of topics related to image processing from introductory to a bit advanced level. The contents include introduction to image processing systems and applications, Image enhancement in spatial and frequency domains, removal of noise using image restoration, analysis of images using wavelets, image compression, shape based analysis using morphological operations, thresholding and clustering based segmentation, feature extraction such as edges, corners and texture based features and image classification. All lectures are supplemented by home works and laboratory implementations of image processing tasks using MATLAB and OpenCV

6. Course Objectives

a) The main objective of this course is to provide a comprehensive presentation of the fundamentals of image processing and analysis both from a theoretical as well as practical point of view.

b) To familiarize the students with the techniques of image enhancement in spatial and frequency domain.

c) To introduce the students to the image restoration techniques.

d) To familiarize students with the basic concepts relating to the color image processing.

e) To provide broader understanding of image compression, image morphology and wavelets.

f) To give them an idea about low and high level feature extraction from images and to apply classification in order to make decision support system for image processing based applications

g) To enable students to implement all theoretical information gained during the lectures in MATLAB and also to program solutions in MATLAB to practical problems.

7. Topics covered in the Course and Level of Coverage	
1. Introduction to image processing and it fundamentals a. Structure of **e**ye b. Digital image **a**cquisition **m**odel c. Different types of images	4 hrs
2. Image enhancement in spatial domain **a. Intensity transformations** **b. Histogram and its analysis** **c. Convolution and spatial filtering**	5 hrs
3. Image enhancement in frequency domain **a. Basic concepts related to Fourier transform** **b. Sampling in frequency domain and introduction to DFT** **c. Filtering in frequency**	3 hrs
4. Image restoration **a. Introduction to restoration model** **b. Different types of noises and their models** **c. Image restoration in spatial and frequency domains**	2 hrs
5. Color image processing **a. Formation of color image** **b. Different color models** **c. Analysis of colored images**	1.5 hrs
6. Image compression **a. Compression models, compression ratio, types of redundancy** **b. Variable length coding** **c. Lossy and lossless compression**	1.5 hrs
7. Introduction to wavelets **a. motivation of wavelets** **b. Wavelet decomposition** **c. Haar wavelet**	2 hrs
8. Morphological operations for binary and gray images **a. Introduction to morphological operations** **b. Morphological operation for binary images** **c. Gray level morphological operations**	3 hrs
9. Segmentation using thresholding and clustering **a. Global, local and adaptive thresholding** **b. K-means and mean shift clustering**	2 hrs
10. Feature extraction (edges, corners, texture based features)	6 hrs
11. Classification	2 hrs
12. Design problems and application examples	Outside study

8. Lab Experiments	
Lab 01	Introduction to MATLAB wrt Image processing
Lab 02	Basics of Image Processing with MATLAB
Lab 03	Logical Operations on Images, Labeling and Connectivity
Lab 04	Bit Plane Slicing, Histogram Equalization
Lab 05	Histogram Based Image Enhancement, Mask processing:- 2D Averaging Filters
Lab 06	Spatial Filtering, Logical Manipulation of Images
Lab 07	Corner Detection, (Eigen Values, Eigen Function, Szeliski, Harris Corner Detector)
Lab 08	Image Enhancement/Restoration by Spatial Filtering, Feature Extraction
Lab 9	Color Image Processing, color scheme conversion, RGB, HSI, Filtering Color Images
Lab 10	Image Segmentation, Local/Global Thresholding, Niblock Local ThresholdingAlgorithm, Color Image Segmentation by Using K-Means Clustering.
Lab 11	Morphological Image Processing, on binary and grayscale images.
Lab 12	Lab Quiz-1
Lab 13	Image in Frequency Domain and Image Analysis in Frequency Domain, Ideal, Gaussian and Butterworth Low Pass, High Pass, Band Pass and Band Stop Filters.
Lab 14	Image Analysis in Frequency Domain-II, Periodic Noise in Freq. domain, Notch Filtering.
Lab 15	Classification, Gabor Filters
Lab 16	Lab Paper

9. CourseOutcomesandtheirRelationtoProgramOutcomes (Mapping CLO to PLO)			
Course Learning Outcome (CLOs)		**PLOs**	**Learning Level**
CLO 1	Understanding the fundamentals and basic concepts of image processing related to image segmentation, compression, enhancement etc	PLO 1, PLO 2	C2
CLO 2	Performing different mathematical transformations and histogram based operations for image enhancement and feature extraction	PLO 1	C3
CLO 3	Combining the concepts of image processing with machine learning to design decision support systems for image processing based applications	PLO 2, PLO 3	C6
CLO 4	Learning the use of MATLAB and OpenCVto implement basic image processing algorithms and to build and execute image processing	PLO 5	P2

	based projects to solve real life problems		

10. Program Learning Outcomes

PLO 1	**Engineering Knowledge**
	An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PLO 2	**Problem Analysis**
	An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
PLO 3	**Design/Development of Solutions**
	An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PLO 4	**Investigation**
	An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.
PLO 5	**Modern Tool Usage**
	An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.
PLO 6	**The Engineer and Society**
	An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.
PLO 7	**Environment and Sustainability**
	An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
PLO 8	**Professional Ethics**
	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
PLO 9	**Individual and Teamwork**
	An ability to work effectively, as an individual or in a team, on multifaceted and /or multidisciplinary settings.
PLO 10	**Communication**
	An ability to communicate effectively, orally as well as in writing, on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PLO 11	**Project Management**
	An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.
PLO 12	**Lifelong Learning**
	An ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments