INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

INFORMATION TECHNOLOGY

COURSE DESCRIPTOR

Course Title	**IMAGE PROCESSING**				
Course Code	ACS511				
Programme	B.Tech				
Semester	IV	CSE			
Course Type	Elective				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Ms. S J Sowjanya, Assistant Professor				
Course Faculty	Ms B Tejaswi, Assistant Professor				

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of image processing techniques as a precise digital component with mathematical and signals concepts, and study on various techniques in the creation of digital model of the image, enhancement of quality, image restoration and compression and color models. The course consists of a strong mathematical component to process in spatial and frequency domains on gray and color images.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS003	I	Computational Mathematics and Integral Calculus	4
UG	AHS002	I	Linear Algebra and Ordinary Differential Equations	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Image Processing	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✗	MOOCs
✔	LCD / PPT	✔	Seminars	✗	Mini Project	✔	Videos
✗	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz/AAT	
CIA Marks	20	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz – Online Examination:

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis,

evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Presentation on real-world problems
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Assignments
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Presentation on real-world problems
PO 5	**Modern tool usage**: 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.	2	Assignments
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1	Mini Project

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of Computer-based systems of varying complexity.	3	Assignments
PSO 2	**Problem-Solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.	2	Seminars

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES :

The course should enable the students to:	
I	Understand the concepts of digital image processing methods and techniques.
II	Study the image enhancement techniques in spatial and frequency domain for image quality improvement.
III	Learn the image restoration and compression techniques for optimization.
IV	Explore on color image features and transformation techniques.
V	Illustrate the techniques of image segmentation to identify the objects in the image.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	To Understand the need for image transforms different types of image transforms and their properties.	CLO 1	Understand the key concepts of Image Processing.
		CLO 2	Identify the origins of the Digital image processing
		CLO 3	Demonstrate the scope of the digital image processing in multiple fields
		CLO 4	Explore on overview of the components contained in the general purpose image processing system and its use in real time applications
		CLO 5	Describe the concept of elements of visual perception.
CO 2	Learn different techniques employed for the enhancement of images.	CLO 6	Use the concept of sampling and quantization in generating digital images
		CLO 7	Explore on the basic relationships existed between the pixels in the image
		CLO 8	Illustrate different mathematical tools used in image intensity transformations for quality enhancement
		CLO 9	Use histogram processing techniques in image enhancement and noise reduction
CO 3	Learn different causes for image degradation and overview of image restoration techniques.	CLO 10	Understand the impact of smoothing and sharpening filters in spatial domain.
		CLO 11	Apply the Fourier transform concepts on image function in frequency domain filters(low pass/high pass).
		CLO 12	Describe the concept of image degradation or restoration of images.
CO 4	Understand the need for image compression and to learn the spatial and frequency domain techniques of image compression.	CLO 13	Understand the various kind of noise present in the image and how to restore the noisy image.
		CLO 14	Understand the differences of inverse, least square and Wiener filtering in restoration process of images
		CLO 15	Understand the color fundamentals and models in image processing
		CLO 16	Memorize the transformation techniques in pseudo color image processing.
		CLO 17	Use wavelet concepts in multi-resolution processing.

COs	Course Outcome	CLOs	Course Learning Outcome
CO 5	Learn different morphological algorithms for image analysis and recognition.	CLO 18	Understand the basic multi-resolution techniques and segmentation methods
		CLO 19	Explore on lossy/lossless compression models using wavelets
		CLO 20	Use morphological operations like dilation and erosion to represent and describe regions, boundaries etc. in identification of the components in images.

3 = High; 2 = Medium; 1 = Low

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACS511.01	CLO 1	Understand the key concepts of Image Processing.	PO1,PO2	2
ACS511.02	CLO 2	Identify the origins of the Digital image processing	PO4	2
ACS511.03	CLO 3	Demonstrate the scope of the digital image processing in multiple fields	PO1,PO3,PO4	3
ACS511.04	CLO 4	Explore on overview of the components contained in the general purpose image processing system and its use in real time applications	PO3,PO4	2
ACS511.05	CLO 5	Describe the concept of elements of visual perception.	PO1	2
ACS511.06	CLO 6	Use the concept of sampling and quantization in generating digital images	PO1,PO2,PO5	2
ACS511.07	CLO 7	Explore on the basic relationships existed between the pixels in the image	PO1,PO2	3
ACS511.08	CLO 8	Illustrate different mathematical tools used in image intensity transformations for quality enhancement	PO1,PO2,PO4, PO5	2
ACS511.09	CLO 9	Use histogram processing techniques in image enhancement and noise reduction	PO1,PO2	3
ACS511.10	CLO 10	Understand the impact of smoothing and sharpening filters in spatial domain.	PO1,PO2,PO3	3
ACS511.11	CLO 11	Apply the Fourier transform concepts on image function in frequency domain filters(low pass/high pass).	PO1,PO2,PO4	2
ACS511.12	CLO 12	Describe the concept of image degradation or restoration of images.	PO1,PO5	2
ACS511.13	CLO 13	Understand the various kind of noise present in the image and how to restore the noisy image.	PO5	2
ACS511.14	CLO 14	Understand the differences of inverse, least square and Wiener filtering in restoration process of images	PO1,PO5	2
ACS511.15	CLO 15	Understand the color fundamentals and models in image processing	PO1,PO2,PO9	2
ACS511.16	CLO 16	Memorize the transformation techniques in pseudo color image processing.	PO1,PO2,PO5, PO9	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACS511.17	CLO 17	Use wavelet concepts in multi-resolution processing.	PO1,PO2,PO3	2
ACS511.18	CLO 18	Understand the basic multi-resolution techniques and segmentation methods	PO2,PO3	2
ACS511.19	CLO 19	Explore on lossy/lossless compression models using wavelets	PO1,PO2,PO3, PO5	2
ACS511.20	CLO 20	Use morphological operations like dilation and erosion to represent and describe regions, boundaries etc. in identification of the components in images.	PO1,PO5	2

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)						Program Specific Outcom (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PSO1	PSO2	PSO3
CO 1	3								
CO 2		2			2				
CO 3		3			3			3	
CO 4	3	2		3		3			
CO 5		2			**3**			2	

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3	2											3	2	
CLO 2				2									2	2	
CLO 3	2		2	1										2	
CLO 4			2	1									2		
CLO 5	3												2	2	
CLO 6	3	2			2								2	2	
CLO 7	3	3													
CLO 8	2	2		2	2									2	

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 9	3	3												2	
CLO 10	3	3	2										2	2	
CLO 11	3	2		1										2	
CLO 12	2				2								2		
CLO 13					2									2	
CLO 14	2				2									2	
CLO 15	2	2							1					2	
CLO 16	2	2			2				1				2		
CLO 17	3	2	2										3		
CLO 18		2	2											2	
CLO 19	2	2	2		2								2	2	
CLO 20	2				2								2		

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1,PO2, PO3, PO4, PO5	SEE Exams	PO1,PO2 , PO3, PO4, PO5	Assignments	PO3	Seminars	PO4
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✗	Assessment of Mini Projects by Experts		

XV. SYLLABUS

Unit-I	INTRODUCTION
What is digital image processing, origins of digital image processing, examples of fields that use dip, fundamental steps in digital image processing, components of an image processing system; Digital image fundamentals: Elements of visual perception, a simple image formation model, basic concepts in sampling and quantization, representing digital images, spatial and gray-level resolution, zooming and shrinking digital images, some basic relationships between pixels, linear and nonlinear operations.	

Unit -II	IMAGE ENHANCEMENT IN THE SPATIAL DOMAIN
Some basic gray level transformations, histogram processing, enhancement using arithmetic/logic operations, basics of spatial filtering, smoothing spatial filters, sharpening spatial filters, combining spatial enhancement methods. Introduction to the fourier transform and the frequency domain, smoothing frequency domain filters, sharpening frequency domain filters, homomorphic filtering.	
Unit -III	**IMAGE RESTORATION AND FILTERING**
A model of the image degradation/restoration process, noise models, restoration in the presence of noise only spatial filtering, periodic noise reduction by frequency domain filtering. Linear position invariant degradations, estimating the degradation function, inverse filtering, minimum mean square error (wiener) filtering, constrained least square filtering, and geometric mean filter.	
Unit -IV	**COLOR IMAGE PROCESSING**
Color models, pseudo color image processing, basics of full-color image processing, color transformations, smoothing and sharpening, color segmentation, noise in color images, color image compression; Wavelets and multi resolution processing: Image pyramids, sub band coding, the haar transform, multi resolution expansions, wavelet transforms in one dimension, fast wavelet transform, wavelet transforms in two dimensions, wavelet packets; Fundamentals, image compression models, error-free (lossless) compression, lossy compression.	
Unit -V	**MORPHOLOGICAL IMAGE PROCESSING**
Preliminaries, dilation and erosion, opening and closing, the hit-or-miss transformation, some basic morphological algorithms; Image segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding, region-based segmentation.	
Text Books:	
1. Rafael C Gonzalez, Richard E. Woods, "Digital Image Processing", PHI, 2nd Edition, 2005.	
References:	
1. K. Jain, "Fundamentals of Digital Image Processing", Pearson, 3rd Edition, 2004. 2. Scott. E. Umbaugh, "Digital Image Processing and Analysis", CRC Press, 2nd Edition, 2014. 3. S. Jayaraman, S. Esakkirajan, T.Veerakumar, "Digital Image Processing", McGraw-Hill Education. (India) Pvt. Ltd., 2013	

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
1-3	What is digital image processing, origins of digital image processing, examples of fields that use DIP, fundamental steps in digital image processing, components of an image processing system; Digital image fundamentals:	CLO1	T1: 1.1-1.5 R1:1.1-1.2
4-9	Elements of visual perception, a simple image formation model, basic concepts in sampling and quantization.	CLO5	T1:2.1-2.4 R1:1.3-1.5
9-13	Representing digital images, spatial and gray-level resolution, zooming and shrinking digital images, some basic relationships between pixels, linear and nonlinear operations.	CLO7	T1:2.5-2.9 R1:1.6-1.7
11-14	Image Enhancement In The Spatial Domain:Some basic gray level transformations, histogram processing, enhancement using arithmetic/logic operations.	CLO9	T1: 3.1-3.3 R1:7.3
15-21	Basics of spatial filtering, smoothing spatial filters, sharpening spatial filters, Combining spatial enhancement methods.	CLO10	T1:3.4-3.6 R1:7.4

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
22-24	Introduction to the fourier transform and the frequency domain, smoothing frequency domain filters, sharpening frequency domain filters, homomorphic filtering	CLO11	T1: 4.1-4.9 R1:7.5
25-28	Image restoration: A model of the image degradation /restoration process, noise models, restoration in the presence of noise only spatial filtering, periodic noise reduction by frequency domain filtering.	CLO12	T1: 5.1-5.4 R1:8.2
29-33	Image filtering: Linear position invariant degradations, estimating the degradation function, inverse filtering, minimum mean square error (wiener) filtering, constrained least square filtering, and geometric mean filter.	CLO14	T1:5.6-5.10 R1:8.3
34-39	Color fundamentals: Color models, pseudo color image processing, basics of full-color image processing, color transformations, smoothing and sharpening, color segmentation, noise in color images, color image compression;	CLO15	T1:6.1-6.9 R1:3.7-3.11
40-43	Wavelets and multi resolution processing: Image pyramids, sub band coding, the haar transform, multi resolution expansions, wavelet transforms in one dimension, fast wavelet transform, wavelet transforms in two dimensions, wavelet packets.	CLO17	T1:7.1-7.6 R1:5.9
44-47	Image compression: Fundamentals, image compression models, error-free (lossless) compression, lossy compression.	CLO19	T1: 8.1-8.2 R1:11.1-11.2
48-51	Morphological image processing: Preliminaries, dilation and erosion, opening and closing, the hit-or-miss transformation, some basic morphological algorithms.	CLO20	T1:9.1-9.5 R1:11.3-11.4
51-54	Image segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding, region-based segmentation.	CLO18	T1:10.1- 10.4 R1:11.5-11.6

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Implementation of simple image enhancement techniques using MATLAB.	Seminars / Guest Lectures / Assignments	PO1,PO2, PO5	PSO1
2	Introduction to Information Theory and Types of Redundancy.	Seminars / Guest Lectures / Assignments	PO2,PO4	PSO1
3	Computer Vision technologies	Seminars / Guest Lectures / Assignments	PO1,PO5	PSO2

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