INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**FUNDAMENTALS OF IMAGE PROCESSING**				
Course Code	**AEC552**				
Programme	B.Tech				
Semester	VII	EEE			
Course Type	Open Elective - II				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mrs. M. Saritha , Assistant Professor				
Course faculty	Mrs. M. Saritha , Assistant Professor				

I. COURSE OVERVIEW:

This course is an introduction to the fundamental concepts and techniques in basic digital image processing and their applications to solve real life problems. The topics covered include Digital Image Fundamentals, Image Transforms, Image Enhancement, Restoration and Compression, Morphological Image Processing, Nonlinear Image Processing, and Image Analysis. Application examples are also included. Upon completion of this course, students will be familiar with basic image processing techniques for solving real problems. Student will also have sufficient expertise in both the theory of two-dimensional signal processing and its wide range of applications, for example, image restoration, image compression, and image analysis.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS011	II	Mathematical Transform Techniques	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Fundamentals of 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 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	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 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five 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 / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

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.	2	Lectures, Assignments, Exercises
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	1	Problem related exercises
PO 4	**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.	2	Design Exercises
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Problem Solving:** Exploit the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	1	Seminars

PSO 2	**Professional Skills:** Identify the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	-	-
PSO 3	**Modern Tools in Electrical Engineering:** Comprehend the technologies like PLC, PMC, process controllers, transducers and HMI and design, install, test, maintain power systems and industrial applications.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the image fundamentals and the relationship between pixels.
II	Understand the image enhancement techniques in spatial domain and frequency domain.
III	Analyze the image restoration technique from degraded image using various filtering techniques.
IV	Design segmentation of the image for boundary detection.
V	Differentiate redundancy techniques and apply for image compression.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Review the fundamental concepts of a Digital Image Processing System. Analyze general terminology of DIP. Examine various types of Transforms	CLO 1	Understand the image fundamentals, image transforms, relationship between pixels.
		CLO 2	Explore sampling and quantization in terms of images.
		CLO 3	Analyze the types of transforms, properties mathematical proofs etc.,
		CLO 4	Determine the Advanced transforms, implementations using software's
CO 2	Examine various types of images, intensity transforms and image enhancement with spatial filtering. Develop FT for Image Enhancement in frequency domain. Analyze images in the frequency domain using various filters.	CLO 5	Explore the Image enhancement in spatial domain, different types of point processing.
		CLO 6	Understand the Histogram , histogram manipulation, Linear and nonlinear gray level transformation
		CLO 7	Analyze the Local or neighborhood operation, median filter processing, Spatial domain high pass filtering etc.

		CLO 8	Generating filters directly in the frequency domain, obtaining frequency domain filters from spatial filters
		CLO 9	Understand the filtering in frequency domain, smoothing and sharpening filters in frequency domain.
CO 3	Evaluate the model, approaches, and filtering techniques for image restoration.	CLO 10	Understand the Image restoration degraded model
		CLO 11	Determine algebraic approach to restore and inverse filtering.
		CLO 12	Understand Least mean square filters
		CLO 13	Determine the constrained least square restoration, restoration, image restoration
CO 4	Interpret image segmentation and representation techniques. Evaluate the methodologies for image segmentation, restoration etc.,	CLO 14	Illustrate the Image segmentation detection of discontinuities and edge linking and boundary detection.
		CLO 15	Determine the threshold and the region oriented segmentation morphological image processing dilation and erosion.
		CLO 16	Understand structuring element decomposition, the strel function, opening and closing and hit and miss transform.
CO 5	Categorize various compression techniques and interpret image compression standards.	CLO 17	Describe the image compression, redundancies and removal methods.
		CLO 18	Understand fidelity criteria, image compression models, source encoder and decoder, error free compression
		CLO 19	Determine lossy compression, JPEG 2000 standards

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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
AEC552.01	CLO 1	Understand the image fundamentals, image transforms, relationship between pixels.	PO 1, PO2	1
AEC552.02	CLO 2	Explore sampling and quantization in terms of images.	PO 1, PO 2 PO 4, PO 12	1
AEC552.03	CLO 3	Analyze the types of transforms, properties mathematical proofs etc.,	PO 2	1

AEC552.04	CLO 4	Determine the Advanced transforms, implementations using software's	PO 1, PO 2	2
AEC552.05	CLO 5	Explore the Image enhancement in spatial domain, different types of point processing.	PO 1, PO 2	1
AEC552.06	CLO 6	Understand the Histogram , histogram manipulation, Linear and nonlinear gray level transformation	PO 1, PO 2	1
AEC552.07	CLO 7	Analyze the Local or neighborhood operation, median filter processing, Spatial domain high pass filtering etc.	PO 2, PO 4	2
AEC552.08	CLO 8	Generating filters directly in the frequency domain, obtaining frequency domain filters from spatial filters	PO 1, PO 2	2
AEC552.09	CLO 9	Understand the filtering in frequency domain, smoothing and sharpening filters in frequency domain.	PO 1, PO 2 PO 4, PO 12	1
AEC552.10	CLO 10	Understand the Image restoration degraded model	PO 4, PO 2	2
AEC552.11	CLO 11	Determine algebraic approach to restore and inverse filtering.	PO 4	2
AEC552.12	CLO 12	Understand Least mean square filters	PO 1, PO 4 PO 12	2
AEC552.13	CLO 13	Determine the constrained least square restoration, restoration, image restoration	PO 1, PO 4 PO 12	2
AEC552.14	CLO 14	Illustrate the Image segmentation detection of discontinuities and edge linking and boundary detection.	PO 1, PO 4	2
AEC552.15	CLO 15	Determine the threshold and the region oriented segmentation morphological image processing dilation and erosion.	PO 1, PO 12	2
AEC552.16	CLO 16	Understand structuring element decomposition, the strel function, opening and closing and hit and miss transform.	PO 1, PO 2	2
AEC552.17	CLO 17	Describe the image compression, redundancies and removal methods.	PO 1, PO 12	1
AEC552.18	CLO 18	Understand fidelity criteria, image compression models, source encoder and decoder, error free compression	PO 1, PO 12	2
AEC552.19	CLO 19	Determine lossy compression, JPEG 2000 standards	PO 2, PO4 PO 12	2

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

Course Outcomes (COs)	Program Outcomes (POs)				Program Specific Outcomes
	PO 1	PO 2	PO 4	PO 12	PSO 1
CO 1	3	2	2	1	1
CO 2		2		2	
CO 3	3	2	2	2	1
CO 4	3	2	1		1
CO 5	3	2		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	2											1	1		
CLO 2	1	2		1								1			
CLO 3		1													
CLO 4	2	1													
CLO 5	1														
CLO 6	1														
CLO 7	1			2											
CLO 8	2			3									1		
CLO 9	2	1		2								1	1		
CLO 10		1		2											
CLO 11		2		1											
CLO 12	3	1		1								3			
CLO 13	3			2								3	1		
CLO 14	1			2											
CLO 15	2											2			
CLO 16	1														
CLO 17	1											3			

CLO 18	1											3	1		
CLO 19		2										2	2		
CLO 20												2			

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XIII. ASSESSMENT METHODOLOGIES–DIRECT:

CIE Exams	PO 1, PO2, PSO1, PO 4	SEE Exams	PO 1, PO 2 PO 4	Assignments	PO 1 PO 2	Seminars	PO 1
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
Digital image fundamentals and image transforms digital image fundamentals, sampling and quantization, relationship between pixels.	
UNIT - II	**IMAGE ENHANCEMENT**
Introduction, image enhancement in spatial domain, enhancement through point processing, types of point processing, histogram manipulation, linear and non-linear gray level transformation, local or neighbourhood operation, median filter processing; Spatial domain high pass filtering, filtering in frequency domain, obtaining frequency domain filters from spatial filters, generating filters directly in the frequency domain, low pass (smoothing) and high pass (sharpening) filters in frequency domain.	
UNIT - III	**IMAGE RESTORATION**
Image restoration degradation model, algebraic approach to restoration, inverse filtering. Least mean square filters, constrained least square restoration, interactive restoration	
UNIT - IV	**IMAGE SEGMENTATION**
Image segmentation detection of discontinuities, edge linking and boundary detection, threshold, region oriented segmentation morphological image processing dilation and erosion, structuring element decomposition, the Strel function, erosion; Combining dilation and erosion: Opening and closing the hit and miss transformation.	

UNIT - V	IMAGE COMPRESSION
Image compression: Redundancies and their removal methods, fidelity criteria, image compression models, source encoder and decoder, error free compression, lossy compression, JPEG 2000 standard.	
Text Books:	
1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", Pearson, 3rd Edition, 2008. 2. S. Jayaraman, S. Esakkirajan, T. Veerakumar, "Digital Image Processing", TMH, 3rd Edition, 2010.	
Reference Books:	
1. Rafael, C. Gonzalez, Richard E woods, Stens L Eddings, "Digital Image Processing using MAT LAB", Tata McGraw Hill, 2nd Edition, 2010. 2. A.K. Jain, "Fundamentals of Digital Image Processing", PHI, 1 st Edition, 1989. 3. Somka, Hlavac, Boyle, "Digital Image Processing and Computer Vision", Cengage Learning, 1st Edition, 2008. 4. Adrain Low, "Introductory Computer vision Imaging Techniques and Solutions", Tata McGraw-Hill, 2nd Edition, 2008. 5. John C. Russ, J. Christian Russ, "Introduction to Image Processing & Analysis", CRC Press, 1st Edition, 2010.	
Web References:	
1. https://imagingbook.com/ 2. https://en.wikipedia.org/wiki/Digital_image_processing 3. http://www.tutorialspoint.com/dip/ 4. http://www.imageprocessingplace.com/ 5. http://web.stanford.edu/class/ee368/ 6. https://sisu.ut.ee/dev/imageprocessing/book/1 7. https://in.mathworks.com/discovery/digital-image- 8. processing.html?requestedDomain=www.mathworks.com	
E-Text Books:	
1. http://www.sci.utah.edu/~gerig/CS6640-F2010/dip3e_chapter_02.pdf 2. http://www.faadooengineers.com/threads/350-Digital-Image-Processing 3. http://newwayofengineering.blogspot.in/2013/08/anil-k-jain-fundamentals-of-digital.html 4. http://bookboon.com/en/digital-image-processing-part-one-ebook	

XVI. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No.	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Introduction to Digital image fundamentals and image transforms digital image fundamentals	CLO 1	T1:1.4-1.5
3-5	Analyze sampling and quantization, relationship between pixels and Image transforms	CLO 2	T1:2.4-2.5
6-8	Understand 2-D FFT, properties, Walsh transform, Hadamard transform, discrete cosine transform,	CLO 3	T1:2.6-2.6.8
9-11	Determine Haar transform, Slant transform, Hoteling transform	CLO 4	T1:2.6-2.6.8
12-13	Introduction to image enhancement in spatial domain	CLO 5	T1:3.1-3.6

14-16	Understand enhancement through point processing, types of point processing, histogram manipulation	CLO 5 CLO 6	T1:3.1-3.6
17-19	Understand linear and non-linear gray level transformation, local or neighbourhood operation	CLO 6	T1:3.1-3.8
20-22	Understand median filter processing; Spatial domain high pass filtering	CLO 7	T1:3.1-3.8
23-25	Understand filtering in frequency domain, obtaining frequency domain filters from spatial filters, generating filters directly in the frequency domain	CLO 8	T1:4.1-4.6
26-27	low pass (smoothing) and high pass (sharpening) filters in frequency domain.	CLO 8	T1:4.1-4.6
28-30	Introduction to Image restoration degradation model, algebraic approach to restoration	CLO 10 CLO 11	T1:5.1-5.10
31-32	Understand inverse filtering. Least mean square filters	CLO 12	T1:5.1-5.10
33-34	Understand constrained least square restoration, interactive restoration	CLO 13	T1:5.1-5.10
35-36	Introduction to Image segmentation detection of discontinuities and edge linking and boundary detection, threshold	CLO 14	T1:10.1-10.6
37-38	Understand region oriented segmentation morphological image processing dilation and erosion	CLO 15	T1:10.1-10.6 T1:9.1-9.6
39-41	Understand structuring element decomposition, the Strel function, erosion; Combining dilation and erosion: Opening and closing the hit and miss transformation	CLO 16	T1:9.1-9.6
42-43	Introduction to Image compression: Redundancies and their removal methods, fidelity criteria, image compression models	CLO 18	T1:8.1-8.3
44-45	Understand source encoder and decoder, error free compression, lossy compression, JPEG 2000 standard.	CLO 19	T1-8.1-8.1.7

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

S.No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Digital Image Enhancement Techniques	Seminars	PO 1, PO 2	PSO 1
2	Restoration Techniques	Seminars / Guest	PO 2, PO 4	PSO 1
3	Image Segmentation and Compression Techniques	Guest Lectures	PO 1	PSO 1

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