

<b>COURSE TITLE</b>	<b>VISUAL COMPUTING</b>
<b>COURSE CODE</b>	<b>01AD0504</b>
<b>COURSE CREDITS</b>	<b>4</b>

**Objective:**

- 1 This course introduces the fundamental concepts and techniques of Visual Computing, an interdisciplinary field integrating computer graphics, computer vision, and image processing. The course focuses on the acquisition, representation, processing, analysis, and synthesis of visual information. Students will gain theoretical foundations as well as practical exposure to visual data handling, image formation, geometric modeling, rendering pipelines, and image analysis techniques.

**Course Outcomes:** After completion of this course, student will be able to:

- 1 Apply the principles of human vision, color models, and image representation in visual computing
- 2 Apply image processing techniques for enhancement, restoration, and segmentation
- 3 Analyze and implement geometric transformations and projections in 2D and 3D.
- 4 Analyze the role and interaction of graphics pipelines, shading, texture mapping, and rendering techniques in producing realistic computer-generated images.
- 5 Evaluate Model and analyze curves, surfaces, and meshes for in visual computing.

**Pre-requisite of course:**Basics of computer science including algorithms, data structure, Basic Linear algebra and Fundamental Image Processing.

**Teaching and Examination Scheme**

<b>Theory Hours</b>	<b>Tutorial Hours</b>	<b>Practical Hours</b>	<b>ESE</b>	<b>IA</b>	<b>CSE</b>	<b>Viva</b>	<b>Term Work</b>
3	0	2	50	30	20	25	25

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
1	<b>Visual Computing Fundamentals</b> Introduction to Visual Computing, Physiological Foundations of Human Visual System, Representation of Light and Color, Fundamental Image Processing Steps: Image Acquisition, Enhancement, Restoration, Color Processing, Compression, Segmentation, Recognition.	6
2	<b>Digital Image Processing (Fundamentals)</b> Image representation and pixel relationships (4-connected, 8-connected)., Image sampling and quantization, Sampling Theorem, Spatial and intensity resolution., Gray level and color quantization, vector quantization., Point operations, histogram processing (equalization, specification), contrast stretching. , Spatial filtering: smoothing and sharpening filters.	6

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
3	<b>Geometric Transformations and Camera Models</b> 2D and 3D transformations, homogeneous coordinates, Translation, rotation, scaling, shearing, Coordinate systems and viewing transformations. , Camera geometry, perspective projection, orthographic projection., Introduction to 3D viewing pipeline.	8
4	<b>Advanced Image Processing &amp; Frequency Domain Techniques</b> Frequency domain fundamentals, Fourier Transform (DFT, FFT), Discrete Cosine Transform (DCT), Frequency domain filtering (low-pass, high-pass)., Image enhancement and restoration techniques, Wiener filtering, median filtering, nonlinear diffusion.	8
5	<b>Image Analysis and Motion Understanding</b> Multi-resolution analysis, Gaussian-Laplacian pyramids, wavelets, scale-space representation, Image and video compression basics, Image segmentation, thresholding, edge-based and region-based methods, Feature matching: template matching, point matching, Motion analysis: optical flow, stereo vision., Feature descriptors and learning-based vision concepts (fundamentals).	10
6	<b>Graphics Pipeline and Geometric Modeling</b> Graphics pipeline architecture, Lighting and reflection models, Shading techniques (Gouraud, Phong)., Texture mapping and texture analysis, Aliasing and anti-aliasing, Global illumination basics: ray tracing, radiosity, Introduction to graphics APIs (OpenGL) and hardware, Parametric curves: Bézier curves, B-splines, Introduction to surfaces and mesh representation (triangle meshes, basics only)	10
<b>Total Hours</b>		<b>48</b>

#### Suggested List of Experiments:

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
1	<b>Practical 1</b> Image representation: RGB, HSV, grayscale and noise models	2
2	<b>Practical 2</b> Pixel relationships (4-connected, 8-connected).	2
3	<b>Practical 3</b> Sampling and quantization techniques	2
4	<b>Practical 4</b> Geometric transformations using homogeneous coordinates	2
5	<b>Practical 5</b> Projection models (orthographic & perspective).	2
6	<b>Practical 6</b> Spatial filtering: mean, median, Laplacian filters.	2
7	<b>Practical 7</b> Fourier Transform and DCT implementation.	2

### Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
8	<b>Practical 8</b> Image segmentation techniques (thresholding, edge detection).	2
9	<b>Practical 9</b> Optical flow and stereo vision basics.	2
10	<b>Practical 10</b> Graphics pipeline and shading (Phong/Gouraud).	2
11	<b>Practical 11</b> Bézier curves, B-splines, and mesh basics.	2
<b>Total Hours</b>		<b>22</b>

### Textbook :

- 1 Digital image Processing , Rafael C. Gonzalez and Richard E. Woods, Pearson Education International, 2018

### References:

- 1 Computer Graphics , Computer Graphics , Zhigang Xiang, Roy A Plastock, McGraw Hill Professional, 2000
- 2 Computer Vision Algorithms and Applications, Computer Vision Algorithms and Applications, Richard Szeliski, Springer Cham, 2022

### Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
20.00	20.00	25.00	15.00	15.00	5.00

### Instructional Method:

- 1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
- 2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
- 3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
- 4 Students will use resources like online videos, NPTEL course videos, e- courses, Virtual Laboratory.

**Supplementary Resources:**

- 1 <https://www.edx.org/learn/computer-graphics>
- 2 [nptel.ac.in/courses/106106090](https://nptel.ac.in/courses/106106090)