MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

Department of Computer Science and Engineering
Course Hand-out

1. Basic Details:

Programme Name:	B.Tech. (CSE)
Course Name:	Computer Vision
Course Code:	CSE3241
LTPC *(Lecture Tutorial Practical Credits):*	3 0 0 3
Session:	Jan-May, 2026
Class:	Semester – VI
Course Coordinator:	Dr. Mohit Kushwaha
Course Instructor(s):	Dr. Mohit Kushwaha, Dr. Bali Devi, Dr. Sachin Gupta, Mr. Harish Sharma, Dr. Pranshu Pranjal

2. Introduction:

This course introduces the theoretical foundations and practical applications of Computer Vision. Students will study image formation, image processing, feature extraction, motion estimation, depth perception, and recognition tasks, along with modern deep learning approaches. The course emphasizes real-world applications such as autonomous vehicles, surveillance, AR/VR, and medical imaging, preparing students to design and implement intelligent vision-based systems.

3. Course Outcomes (COs):

CO Statement	CO	Bloom's Level	Target Attainment %	Target Attainment Level
Apply principles of image formation, sampling, interpolation, and transformations for image processing.	CSE3241.1	Apply (Level 3)	≥ 80	3
Implement feature detection and description techniques for extracting image information.	CSE3241.2	Apply (Level 3)	≥ 80	3
Analyze image segmentation and grouping methods for effective image interpretation.	CSE3241.3	Analyze (Level 4)	≥ 70% < 80%	2
Discuss geometric vision concepts for camera calibration, stereo vision, and 3D reconstruction.	CSE3241.4	Apply (Level 5)	≥ 70% < 80%	2
Develop recognition and learning frameworks, including deep learning for object detection and classification.	CSE3241.5	Apply/ Evaluate (Level 5)	≥ 80	3

Bloom's Level: Revised Bloom's Taxonomy

Target Attainment Level: Tentative/Estimated attainment as per MUJ guidelines

4. Program Outcomes (POs):

PO.1. **Engineering knowledge**:_Apply the knowledge of basic science and fundamental computing in solving complex engineering problems.

PO.2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO.3. **Design/development of Computing solutions**: Design solutions for complex IT engineering problems and design system components or processes_that meet the specified needs with appropriate consideration for the Information oriented public health and safety, and the cultural, societal, and environmental considerations

PO.4. **Conduct investigations of complex problems**: Use IT domain research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

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

PO.6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

PO.7. **Environment and sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PO.8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

PO.9. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse IT teams, and in multidisciplinary settings.

PO.10. **Communication**: Communicate effectively on complex computing 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.

PO.11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as member and leader in a team, to manage projects and in multidisciplinary environments .

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

5. Program Specific Outcomes (PSOs):

PSO1: Apply mathematical concepts, algorithms, and AI techniques to analyze, model, and simulate complex engineering and real-world problems effectively.

PSO2: Design and develop cost-effective, secure, and scalable software systems addressing user requirements with environmental and societal considerations.

PSO3: Will be able to design, manage, and secure wired/ wireless computer networks for transfer and sharing of information.

6. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	MTE	30
	1. Two Quizzes (10 marks) **2.** Two Assignment (10 marks) **3.** Project on CV (05 marks) **4.** Attendance (05marks)	30
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Attendance Rubric:
90–100% = 5 marks; 85–90% = 4 marks; 80–84% = 3 marks;
75–80% = 2 marks; <75% = 0 marks

7. Syllabus:

Fundamentals of Image Formation and Processing: Image formation principles: camera models, light, shading, and color; Image sampling, interpolation, and transformations; Linear filtering, convolution, and Fourier analysis; Histogram processing, enhancement, and restoration techniques; **Feature Detection and Description: Edge detection:** Canny, LoG, DoG methods; Corner detection: Harris, Hessian-Affine; Keypoint descriptors: SIFT, SURF, HOG; **Image Segmentation and Grouping: Segmentation techniques:** region growing, edge-based; Texture segmentation and analysis using Gabor filters; Grouping methods: least squares fitting, RANSAC; Image alignment and stitching; **Geometric Vision and 3D Reconstruction:** Camera calibration and epipolar geometry; Two-view and multi-view stereo vision; Structure from motion and 3D reconstruction frameworks; Shape-from-X techniques: shading, texture, motion, and edges; **Recognition and Learning in Vision:** Statistical learning frameworks: supervised, unsupervised, semi-supervised; Classification techniques: Bayes, KNN, ANN models; Dimensionality reduction: PCA, LDA, ICA; Object detection and image classification methodologies; **Advanced Topics in Computer Vision:** Motion analysis: optical flow, KLT tracking, dynamic stereo; Deep learning in vision: CNNs, object detection, segmentation; Vision and language integration, video analysis.

8. Text Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2nd Ed., 2022.
2. David Forsyth & Jean Ponce, Computer Vision: A Modern Approach, Pearson, 2nd Ed., 2011.

9. Reference Books:

1. Richard Hartley & Andrew Zisserman, Multiple View Geometry in Computer Vision, Cambridge, 2nd Ed., 2004.
2. R.C. Gonzalez and R.E. Woods, Digital Image Processing, (4e),Pearson Education, 2018.

10. Lecture Plan:

Lec.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode Of Assessing CO
1.	Introduction and Course Hand-out briefing	To acquaint and clear teacher's expectations and understand student expectations	PPT	NA	NA
2.	Image Formation Principles: Camera Models	Explain camera models and image formation	PPT, Lecture	CSE3241.1	Quiz, Mid-Term Assignments & End-Term
3.	Light and Shading Models	Understand light interaction and shading principles	PPT, Lecture	CSE3241.1	Quiz, Mid-Term Assignments & End-Term
4.	Color Models and Representation	Explain color spaces and conversions	PPT, Lecture	CSE3241.1	Quiz, Mid-Term Assignments & End-Term
5.	Image Sampling and Quantization	Apply sampling and quantization techniques	PPT, Lecture	CSE3241.1	Quiz, Mid-Term Assignments & End-Term
6.	Interpolation Techniques	Implement interpolation methods for image resizing	PPT, Lecture	CSE3241.1	Quiz, Mid-Term Assignments & End-Term
7.	Image Transformations: Scaling, Rotation, Translation	Apply geometric transformations	PPT, Lecture	CSE3241.1	Quiz, Mid-Term Assignments & End-Term
8.	Linear Filtering and Convolution Basics	Understand filtering and convolution operations	PPT, Lecture	CSE3241.1	Quiz, Mid-Term Assignments & End-Term
9.	Fourier Analysis in Image Processing	Apply Fourier transform for image analysis	PPT, Lecture	CSE3241.1	Quiz, Mid-Term Assignments & End-Term
10.	Histogram Processing and Equalization	Implement histogram-based enhancement	PPT, Lecture	CSE3241.1	Quiz, Mid-Term Assignments & End-Term
11.	Image Restoration Techniques	Apply restoration filters to degraded images	PPT, Lecture	CSE3241.1	Quiz, Mid-Term Assignments & End-Term

12.	Noise Models and Reduction Methods	Analyze noise and apply reduction techniques	PPT, Lecture	CSE3241.1	Quiz, Mid-Term Assignments & End-Term
13.	Edge Detection: Canny Algorithm	Implement Canny edge detection	PPT, Lecture	CSE3241.2	Quiz, Mid-Term Assignments & End-Term
14.	Edge Detection: LoG and DoG Methods	Apply LoG and DoG techniques	PPT, Lecture	CSE3241.2	Quiz, Mid-Term Assignments & End-Term
15.	Corner Detection: Harris Method	Implement Harris corner detection	PPT, Lecture	CSE3241.2	Quiz, Mid-Term Assignments & End-Term
16.	Corner Detection: Hessian-Affine	Apply Hessian-Affine technique	PPT, Lecture	CSE3241.2	Quiz, Mid-Term Assignments & End-Term
17.	Keypoint Descriptors: SIFT and SURF	Explain and implement SIFT and SURF	PPT, Lecture	CSE3241.2	Quiz, Mid-Term Assignments & End-Term
18.	Feature Descriptors: HOG	Apply Histogram of Oriented Gradients	PPT, Lecture	CSE3241.2	Quiz, Mid-Term Assignments & End-Term
19.	Segmentation: Region Growing Technique	Implement region growing segmentation	PPT, Lecture	CSE3241.3	Quiz, Mid-Term Assignments & End-Term
20.	Segmentation: Edge-based Methods	Apply edge-based segmentation	PPT, Lecture	CSE3241.3	Quiz, Mid-Term Assignments & End-Term
21.	Texture Analysis using Gabor Filters	Analyze texture using Gabor filters	PPT, Lecture	CSE3241.3	Quiz, Mid-Term Assignments & End-Term
22.	Grouping: Least Squares Fitting	Apply least squares for grouping	PPT, Lecture	CSE3241.3	Quiz, Mid-Term Assignments & End-Term
23.	Grouping: RANSAC Algorithm	Implement RANSAC for robust grouping	PPT, Lecture	CSE3241.3	Quiz, Mid-Term Assignments & End-Term
24.	Image Alignment and Stitching	Perform image stitching techniques	PPT, Lecture	CSE3241.3	Quiz, Mid-Term Assignments & End-Term
25.	Camera Calibration Techniques	Demonstrate camera calibration methods	PPT, Lecture	CSE3241.4	Quiz, Assignments & End-Term
26.	Epipolar Geometry Concepts	Explain epipolar geometry in vision	PPT, Lecture	CSE3241.4	Quiz, Assignments & End-Term

27.	Stereo Vision Basics	Apply stereo vision for depth estimation	PPT, Lecture	CSE3241.4	Quiz, Assignments & End-Term
28.	Structure from Motion	Implement structure from motion techniques	PPT, Lecture	CSE3241.4	Quiz, Assignments & End-Term
29.	3D Reconstruction Frameworks	Analyze frameworks for 3D reconstruction	PPT, Lecture	CSE3241.4	Quiz, Assignments & End-Term
30.	Shape-from-X Techniques	Explain shading, texture, motion-based shape recovery	PPT, Lecture	CSE3241.4	Quiz, Assignments & End-Term
31.	Learning Frameworks: Supervised and Unsupervised	Explain supervised and unsupervised learning	PPT, Lecture	CSE3241.5	Quiz, Assignments & End-Term
32.	Semi-supervised Learning in Vision	Discuss semi-supervised approaches	PPT, Lecture	CSE3241.5	Quiz, Assignments & End-Term
33.	Classification Techniques: Bayes and KNN	Apply Bayes and KNN classifiers	PPT, Lecture	CSE3241.5	Quiz, Assignments & End-Term
34.	Classification Techniques: ANN Models	Implement ANN for image classification	PPT, Lecture	CSE3241.5	Quiz, Assignments & End-Term
35.	Dimensionality Reduction: PCA and LDA	Apply PCA and LDA for feature reduction	PPT, Lecture	CSE3241.5	Quiz, Assignments & End-Term
36.	Dimensionality Reduction: ICA	Explain ICA and its applications	PPT, Lecture	CSE3241.5	Quiz, Assignments & End-Term
37.	Deep Learning in Vision: CNN Basics	Implement CNN for object detection	PPT, Lecture	CSE3241.5	Quiz, Assignments & End-Term
38.	Advanced Topics: Motion Analysis, Optical Flow, Video Analysis	Analyze motion and video analysis techniques	PPT, Lecture	CSE3241.5	Quiz, Assignments & End-Term

11. Learner Centric & Outside Class Activities:

- Low difficulty: Tutorials on image filtering and feature extraction; peer discussions on OpenCV basics.
- Medium difficulty: MOOC certification (e.g., “Deep Learning for Computer Vision”), group projects on object detection.
- High difficulty: Mini-research projects on depth estimation or AR/VR; participation in hackathons or Kaggle competitions.

12. Course Articulation Matrix (CO–PO–PSO):

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CSE 3241.1	Apply principles of image formation, sampling, interpolation, and transformations for image processing.	3	3	2	1	1	-	2	2	-	1	-	**3**	2	**2**	-
CSE 3241.2	Implement feature detection and description techniques for extracting image information.	**3**	**3**	**2**	-	-	3	-	-	-	-	-	**3**	**2**	2	-
CSE 3241.3	Analyze image segmentation and grouping methods for effective image interpretation.	**3**	2	**2**	2	3	2	3	-	-	-	-	**2**	**1**	**2**	-
CSE 3241.4	Demonstrate geometric vision concepts for camera calibration, stereo vision, and 3D reconstruction.	3	2	3	-	1	2	2	-	-	-	-	2	1	3	-
CSE 3241.5	Apply recognition and learning frameworks, including deep learning, for object detection and classification.	3	**2**	**3**	**2**	**2**	**3**	-		**2**	-	-	**3**	**2**	**3**	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation