VI Semester

COMPUTER GRAPHICS AND FUNDAMENTALS OF IMAGE PROCESSING			
Course Code	**21CS63**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Objectives:

CLO 1. Overview of Computer Graphics along with its applications.
CLO 2. Exploring 2D and 3D graphics mathematics along with OpenGL API's.
CLO 3. Use of Computer graphics principles for animation and design of GUI's .
CLO 4. Introduction to Image processing and Open CV.
CLO 5. Image segmentation using Open CV.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.
6. IntroduceTopicsin manifold representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Overview: Computer Graphics hardware and software and OpenGL: Computer Graphics: Video Display Devices, Raster-Scan Systems Basics of computer graphics, Application of Computer Graphics. OpenGL: Introduction to OpenGL, coordinate reference frames, specifying two-dimensional world coordinate reference frames in OpenGL, OpenGL point functions, OpenGL line functions, point attributes, line attributes, curve attributes, OpenGL point attribute functions, OpenGL line attribute functions, Line drawing algorithms(DDA, Bresenham's).

Textbook 1: Chapter -1,2,3, 5(1 and 2 only)
Self-study topics : Input devices, hard copy devices, coordinate representation, graphics functions, fill area primitives, polygon fill areas, pixel arrays, Parallel Line algorithms

Teaching-Learning Process	Chalk & board, Active Learning Virtual Lab

Module-2

2D and 3D graphics with OpenGL: 2D Geometric Transformations: Basic 2D Geometric Transformations, matrix representations and homogeneous coordinates, 2D Composite transformations, other 2D transformations, raster methods for geometric transformations, OpenGL raster transformations, OpenGL geometric transformations function,

3D Geometric Transformations: Translation, rotation, scaling, composite 3D transformations, other 3D transformations, OpenGL geometric transformations functions

Textbook 1: Chapter -6, 8
Self-study topics: Transformation between 2D coordinate system, OpenGL geometric-transformation, Transformation between 3D coordinate system.

Teaching-Learning Process	Chalk & board, Active Learning, Problem based learning Virtual Lab:

Module-3

Interactive Input Methods and Graphical User Interfaces: Graphical Input Data ,Logical Classification of Input Devices, Input Functions for Graphical Data , Interactive Picture-Construction Techniques, Virtual-Reality Environments, OpenGL Interactive Input-Device Functions, OpenGL Menu Functions , Designing a Graphical User Interface.

Computer Animation : Design of Animation Sequences, Traditional Animation Techniques, General Computer-Animation Functions, Computer-Animation Languages, Character Animation, Periodic Motions, OpenGL Animation Procedures.

Textbook 1: Chapter -11, 18
Self-study topics: Raster methods for computer animation, Key frame systems, Motion specification.

Teaching-Learning Process	Chalk & board, MOOC, Active Learning

Module-4

Introduction to Image processing: overview, Nature of IP, IP and its related fields, Digital Image representation, types of images.

Digital Image Processing Operations: Basic relationships and distance metrics, Classification of Image processing Operations.
Text book 2: Chapter 3

(Below topics is for experiential learning only , No questions in SEE)
Computer vision and OpenCV*: What is computer vision, Evolution of computer vision, Application of Computer vision, Feature of OpenCV, OpenCV library modules, OpenCV environment, Reading, writing and storing images using OpenCV. OpenCV drawing Functions. OpenCV Geometric Transformations*.

(Note : Computer vision and OpenCV for experimental learning or Activity Based Learning using web sources, Preferred for assignments. No questions in SEE)
Web Source: https://www.tutorialspoint.com/opencv/

Teaching-Learning Process	Chalk& board, Problem based learning Lab practice for OpenCV for basic geometric objects and basic image operation

Module-5

Image Segmentation: Introduction, classification, detection of discontinuities, Edge detection (up to canny edge detection(included)).
Text Book 2: Chapter 9: 9.1 to 9.4.4.4

(Below topics is for experiential learning only , No questions in SEE)
Image processing with Open CV: *Resizing , Rotation/ Flipping, Blending, Creating region of Interest (ROI), Image Thresholding, Image Blurring and smoothing, Edge Detection, Image contours and Face Detection on images using OpenCV.*

(Note :Image Processing withOpenCV for experimental learning or Activity Based Learning using web sources, Preferred for assignments. No questions in SEE)

Web source: https://medium.com/analytics-vidhya/introduction-to-computer-vision-opencv-in-python-fb722e805e8b

Teaching-Learning Process	Chalk & board, MOOC Lab practice on image processing. Virtual Lab:

Course Outcomes:

At the end of the course the student will be able to:

CO 1. Construct geometric objects using Computer Graphics principles and OpenGL APIs.
CO 2. Use OpenGL APIs and related mathematics for 2D and 3D geometric Operations on the objects.
CO 3. Design GUI with necessary techniques required to animate the created objects
CO 4. Apply OpenCV for developing Image processing applications.
CO 5. Apply Image segmentation techniques along with programming, using OpenCV, for developing simple applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(To have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

3. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
4. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Textbooks

1. Donald D Hearn, M Pauline Baker and WarrenCarithers: Computer Graphics with OpenGL 4th Edition, Pearson, 2014
2. S. Sridhar, Digital Image Processing, second edition, Oxford University press 2016.

Reference Books

1. Edward Angel: Interactive Computer Graphics- A Top Down approach with OpenGL, 5th edition. Pearson Education, 2008
2. James D Foley, Andries Van Dam, Steven K Feiner, John F Huges Computer graphics with OpenGL: Pearson education

Web links and Video Lectures (e-Resources):

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1. https://nptel.ac.in/courses/106/106/106106090/
2. https://nptel.ac.in/courses/106/102/106102063/
3. https://nptel.ac.in/courses/106/103/106103224/
4. https://nptel.ac.in/courses/106/102/106102065/
5. https://www.tutorialspoint.com/opencv/ (Tutorial, Types of Images, Drawing Functions)

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

2. Mini project on computer graphics using Open GL/Python/Open CV.

VI Semester

<table>
<tr><th colspan="5">COMPUTER GRAPHICS AND IMAGE PROCESSING LABORATORY</th></tr>
<tr><td colspan="2">Course Code</td><td>21CSL66</td><td>CIE Marks</td><td>50</td></tr>
<tr><td colspan="2">Teaching Hours/Week (L:T:P: S)</td><td>0:0:2:0</td><td>SEE Marks</td><td>50</td></tr>
<tr><td colspan="2">Total Hours of Pedagogy</td><td>24</td><td>Total Marks</td><td>100</td></tr>
<tr><td colspan="2">Credits</td><td>1</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="5">Course Objectives:
CLO 1: Demonstrate the use of Open GL.
CLO 2: Demonstrate the different geometric object drawing using openGL
CLO 3: Demonstration of 2D/3D transformation on simple objects.
CLO 4: Demonstration of lighting effects on the created objects.
CLO 5: Demonstration of Image processing operations on image/s.</td></tr>
<tr><th>Sl. No.</th><th colspan="4">Practise Programs</th></tr>
<tr><td></td><td colspan="4">• Installation of OpenGL /OpenCV/ Python and required headers
• Simple programs using OpenGL (Drawing simple geometric object like line, circle, rectangle, square)
• Simple programs using OpenCV (operation on an image/s)</td></tr>
<tr><td></td><td colspan="4">PART A
List of problems for which student should develop program and execute in the Laboratory using openGL/openCV/ Python</td></tr>
<tr><td>1.</td><td colspan="4">Develop a program to draw a line using Bresenham’s line drawing technique</td></tr>
<tr><td>2.</td><td colspan="4">Develop a program to demonstrate basic geometric operations on the 2D object</td></tr>
<tr><td>3.</td><td colspan="4">Develop a program to demonstrate basic geometric operations on the 3D object</td></tr>
<tr><td>4.</td><td colspan="4">Develop a program to demonstrate 2D transformation on basic objects</td></tr>
<tr><td>5.</td><td colspan="4">Develop a program to demonstrate 3D transformation on 3D objects</td></tr>
<tr><td>6.</td><td colspan="4">Develop a program to demonstrate Animation effects on simple objects.</td></tr>
<tr><td>7.</td><td colspan="4">Write a Program to read a digital image. Split and display image into 4 quadrants, up, down, right and left.</td></tr>
<tr><td>8.</td><td colspan="4">Write a program to show rotation, scaling, and translation on an image.</td></tr>
<tr><td>9.</td><td colspan="4">Read an image and extract and display low-level features such as edges, textures using filtering techniques.</td></tr>
<tr><td>10.</td><td colspan="4">Write a program to blur and smoothing an image.</td></tr>
<tr><td>11.</td><td colspan="4">Write a program to contour an image.</td></tr>
<tr><td>12.</td><td colspan="4">Write a program to detect a face/s in an image.</td></tr>
<tr><td></td><td colspan="4">PART B
Practical Based Learning</td></tr>
<tr><td></td><td colspan="4">Student should develop a mini project and it should be demonstrate in the laboratory examination, Some of the projects are listed and it is not limited to:
➢ Recognition of License Plate through Image Processing
➢ Recognition of Face Emotion in Real-Time
➢ Detection of Drowsy Driver in Real-Time
➢ Recognition of Handwriting by Image Processing
➢ Detection of Kidney Stone
➢ Verification of Signature
➢ Compression of Color Image
➢ Classification of Image Category
➢ Detection of Skin Cancer
➢ Marking System of Attendance using Image Processing
➢ Detection of Liver Tumor
➢ IRIS Segmentation
➢ Detection of Skin Disease and / or Plant Disease
➢ Biometric Sensing System .
➢ Projects which helps to formers to understand the present developments in agriculture.</td></tr>
</table>

	➢ Projects which helps high school/college students to understand the scientific problems. ➢ Simulation projects which helps to understand innovations in science and technology

Course Outcome (Course Skill Set)

At the end of the course the student will be able to:

CO 1: Use openGL /OpenCV for the development of mini Projects.
CO 2: Analyze the necessity mathematics and design required to demonstrate basic geometric transformation techniques.
C0 3: Demonstrate the ability to design and develop input interactive techniques.
C0 4: Apply the concepts to Develop user friendly applications using Graphics and IP concepts.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).
  The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course is 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Students can pick one experiment from the questions lot of PART A with equal choice to all the students in a batch.
- **PART B :** Student should develop a mini project and it should be demonstrated in the laboratory examination (with report and presentation).
- Weightage of marks for **PART A is 60%** and for **PART B is 40%.** General rubrics suggested to be followed for part A and part B.
- Change of experiment is allowed only once (in part A) and marks allotted to the procedure part to be made zero.
- The duration of SEE is 03 hours.

Suggested Learning Resources:

1. Donald Hearn & Pauline Baker: Computer Graphics with OpenGL Version,3rd/4th Edition, Pearson Education,2011
2. James D Foley, Andries Van Dam, Steven K Feiner, John F Huges Computer graphics with OpenGL: Pearson education

Weblinks and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/106/106/106106090/
2. https://nptel.ac.in/courses/106/102/106102063/
3. https://nptel.ac.in/courses/106/103/106103224/
4. https://nptel.ac.in/courses/106/102/106102065/
5. https://www.tutorialspoint.com/opencv/
6. https://medium.com/analytics-vidhya/introduction-to-computer-vision-opencv-in-python-fb722e805e8b