Program Name : **Computer Engineering Program Group**

Program Code : **CO/CM/CW**

Semester : **Third**

Course Title : **Computer Graphics**

Course Code : **22318**

1. RATIONALE

This course provides an introduction to the principles of computer graphics. In particular, the course will consider methods for object design, transformation, scan conversion, visualization and modeling of real world. The emphasis of the course will be placed on understanding how the various elements that underlie computer graphics (algebra, geometry, algorithms) interact in the design of graphics software systems and also enables student to create impressive graphics easily and efficiently.

2. COMPETENCY

The aim of this course is to help the student to attain the following ***industry identified*** competency through various teaching learning experiences:

- **Develop programs using core graphical concepts.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Manipulate visual and geometric information of images.
b. Implement standard algorithms to draw various graphics objects using C program.
c. Develop programs for 2-D and 3-D Transformations.
d. Use projections to visualize objects on view plane.
e. Implement various clipping algorithms.
f. Develop programs to create curves using algorithms.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

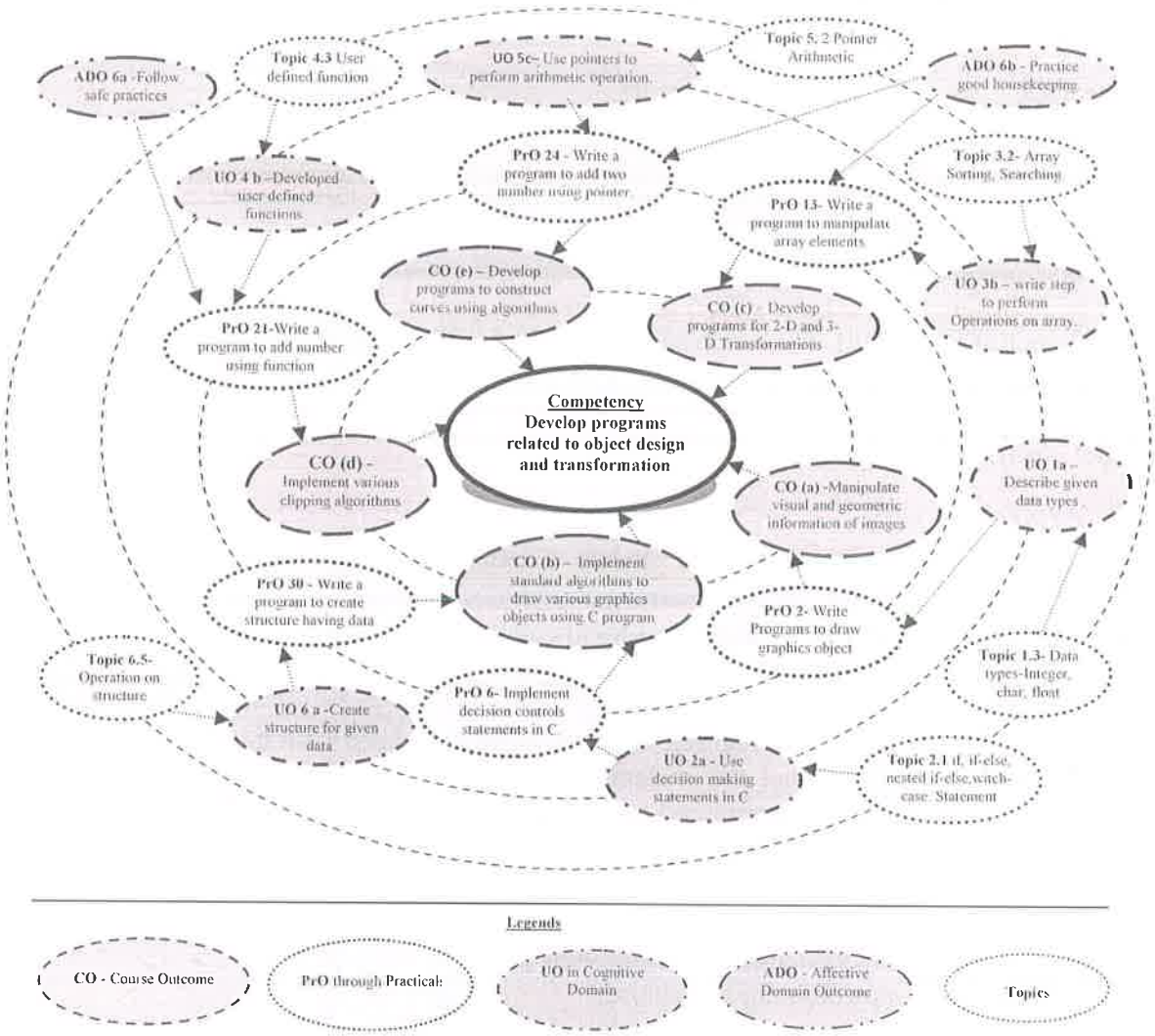

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Write Programs to draw following graphics object using built-in "C" functions. i) Pixel ii) Lines iii) Circles iv) Rectangle v) Ellipse	I	02*
2	Implement following algorithms to draw line. i) DDA algorithm	II	02*
3	ii) Bresennham's algorithm	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	Implement Bresennham's algorithm to draw a circle.	II	02
5	Write a program to fill Polygon using following methods: i) Flood fill	II	02
6	ii) Boundary fill	II	02
7	Write a program for two-dimensional transformation i) Translation ii) Scaling	III	02*
8	iii) Rotation	III	02
9	iv) Reflection v) Shearing	III	02
10	Write a program for three-dimensional transformation i) Translation ii) Scaling	III	02
11	iii) Rotation	III	02
12	Write a program to clip line using following algorithms. Cohen- Sutherland algorithm	IV	02*
13	Write a program to clip line using following algorithms. Cohen Midpoint subdivision algorithm	IV	02
14	Write a program to clip polygon using Sutherland -Hodgeman. Algorithm.	IV	02
15	Write a program to draw (any one) following type of curves. i) Hilbert's Curve	V	02*
16	Write a program to draw (any one) following type of curves. i) Koch curve ii) Bezier curves	V	02*
		Total	**32**

Note

*i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S.No.	Performance Indicators	Weightage in %
1	Write program to draw graphics objects.	20
2	Use graphics software tool for programming to create, edit, compile the programs/applications	40
3	Debug, test and execute the programs/applications	20
4	Able to answer oral questions.	10
5	Submission of report in time.	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Handle command prompt environment.
b. Experiment with graphics environment.
c. Plan, construct, compile, debug and test programs.
d. Maintain tools and equipment.
e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year and
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. S.No.
1	Hardware: Personal computer, (i3-i5 preferable), RAM minimum 2 GB onwards.	For all Experiments
2	Operating system: Windows XP/Windows 7/LINUX onwards.	
3	Software: turbo C with dosbox or Emulated C.	

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Basics of Computer Graphics	1a. Differentiate attributes of the given mode. 1b. Compare features of the given Scan Display. 1c. Write a program to draw the given type of primitives using "C". 1d. Describe application of the given display device. 1e. Convert the given 2D co-ordinates to physical device co-ordinates.	1.1 Image and Objects, pixel and resolution, Text mode, Graphics mode, Basic Graphics Pipeline, Bitmap and Vector Based Graphics, Applications of Computer Graphics. 1.2 Display Devices: Raster-Scan Display, Random-Scan Display, Flat Panel Display, LED, LCD display, Plasma, Touch screen. 1.3 Output primitives: line, polygon, marker, text. 1.4 Graphics functions and standards. 1.5 Latest trends in Computer Graphics: Virtual reality, Augmented reality.
Unit– II	2a. Write a program to draw a	2.1 Basic concepts in line drawing: Line

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Raster Scan Graphics	line using the given algorithm. 2b. Use the given algorithm to rasterize the given line. 2c. Apply the given algorithm to generate the circle. 2d. Draw the Polygon using the given algorithm. 2e. Apply character generation method to display the given character.	drawing algorithms: Digital Differential Analyzer (DDA) algorithm, Bresenham's algorithm. 2.2 Circle generating algorithms: Symmetry of circle, Bresenham's circle drawing algorithm. 2.4 Polygons – Types of polygons, inside –outside test, Polygon Filling : Seed fill algorithms: Flood fill, Boundary fill, scan line algorithms 2.5 Scan conversion, Frame Buffers. 2.6 Character generation methods: stroke, starburst, bitmap.
Unit– III Overview of Transformations	3a. Perform the given operation in 2D transformation. 3b. Perform the given operation in 3D transformation. 3c. Solve the given problem based on Composite Transformations. 3d. Apply the given type of projection on object.	3.1 Two Dimensional Transformations: Translation, Scaling, Rotation, Reflection, Shearing. 3.2 Matrix representations and homogeneous coordinates: Translation Scaling, Rotation, Reflection, Shearing. 3.3 Composite Transformations- rotation about an arbitrary point. 3.4 Three dimensional transformations: Translation, Scaling, Rotation. 3.5 Types of Projections: Perspective and Parallel projection.
Unit-IV Windowing and clipping	4a. Apply Window to-viewport transformation on the given object, 4b. Write a program using the given line clipping algorithms. 4c. Apply the given line clipping algorithms to clip the line. 4d. Apply text clipping on the given text. 4e. Write a program using the given polygon clipping algorithm.	4.1 Windowing and clipping concepts: Window to-viewport transformation. 4.2 Line clipping: Cohen Sutherland clipping algorithm, Cyrusbeck, Liang Barsky, Midpoint subdivision. 4.3 Polygon clipping: Sutherland -Hodgeman. 4.4 Text clipping.
Unit –V Introduction to Curves	5a. Describe the given curve generation methods. 5b. Draw curve using the given curve algorithms. 5c. State properties of the given curve. 5d. Generate arc using the given algorithm.	5.1 Curve generation: Arc generation using DDA algorithm, Interpolation 5.2 Types of curves: Hilbert's Curve, Koch curve, B-Spline, Bezier curves.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Computer Graphics	06	04	04	-	08
II	Raster Scan Graphics	12	02	06	10	18
III	Overview of Transformations	12	02	06	10	18
IV	Windowing and clipping	10	-	06	08	14
V	Introduction to Curves	08	-	04	08	12
Total		**48**	**8**	**26**	**36**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*
This specification table also provides a general guideline for teachers to frame internal end semester practical theory exam paper which students have to undertake.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare journals based on practical performed in laboratory.
b. Draw perspective and parallel projection for any object on view plane.
c. Give seminar on relevant topic.
d. Prepare power point presentation or animation for showing different types of graphics Applications.
e. Undertake a market survey of different graphics application and compare with the following points.
    i. Available Applications.
    ii. Application Profile.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).

d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. No. of practical's selection to be performed should cover all units.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a) Program to Design Flying Balloons - Each group will design balloons using pieslice (), ellipse () functions and apply delay operation of process.h header file.
b) Program to Display a moving car.
c) Develop a miniature tic-tac-toe game.
d) Design an analog clock.
e) Design a rotating fan.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Computer Graphics	Donald Hearn , Baker M.Pauline	Pearson Education , New Delhi June 2012, , ISBN:817758765X.
2	Computer Graphics	Maurya Rajesh K.	Wiley-India 2011, Delhi ISBN: 978-81-265-3100-4.
3	Computer Graphics	Dr. Chopra Rajiv	S.Chand 2016, New Delhi. ISBN: 978-93-856-7633-8.
4	Computer Graphics principles and practices	Foley James	Pearson Education. New Delhi 2014, ISBN:978-0-321-39952-6.

14. SOFTWARE/LEARNING WEBSITES

a. https://www.tutorialspoint.com/computer_graphics
b. http://www.dailyfreecode.com/tutorial_simple_cpp-16/computer-graphics-215.aspx
c. http://www.newtechnologysite.com/graphics.html
d. http://www.nptelvideos.in/2012/11/computer-graphics.html
e. https://www.khanacademy.org/