



GALGOTIAS  
UNIVERSITY

**School of Computing  
Science and Engineering**

Program: B.C.A.

Course Code: BCAS3003

Course Name: Computer Graphics

## **Course Prerequisites**

- Knowledge of Mathematics**
- Fundamental knowledge of Computer**

# Syllabus

## Unit 3 – Attributes of Output Primitives

**(8 hours)**

- Line Attributes**
- Curve Attributes**
- Color and Gray-Scale levels**
- Area-Fill Attributes**
- Character Attributes**
- Bundled attributes**
- Inquiry functions.**

## Recommended Books

### Text books

- ❑ D. Hearn, P. Baker, "Computer Graphics - C Version", 2nd Edition, Pearson Education, 1997

### Reference Book

- ❑ Heam Donald, Pauline Baker M: "Computer Graphics", PHI 2nd Edn. 1995.
- ❑ Harrington S: "Computer Graphics - A Programming Approach", 2nd Edn. Mc GrawHill.
- ❑ Shalini Govil-Pai, Principles of Computer Graphics, Springer, 2004

### Additional online materials

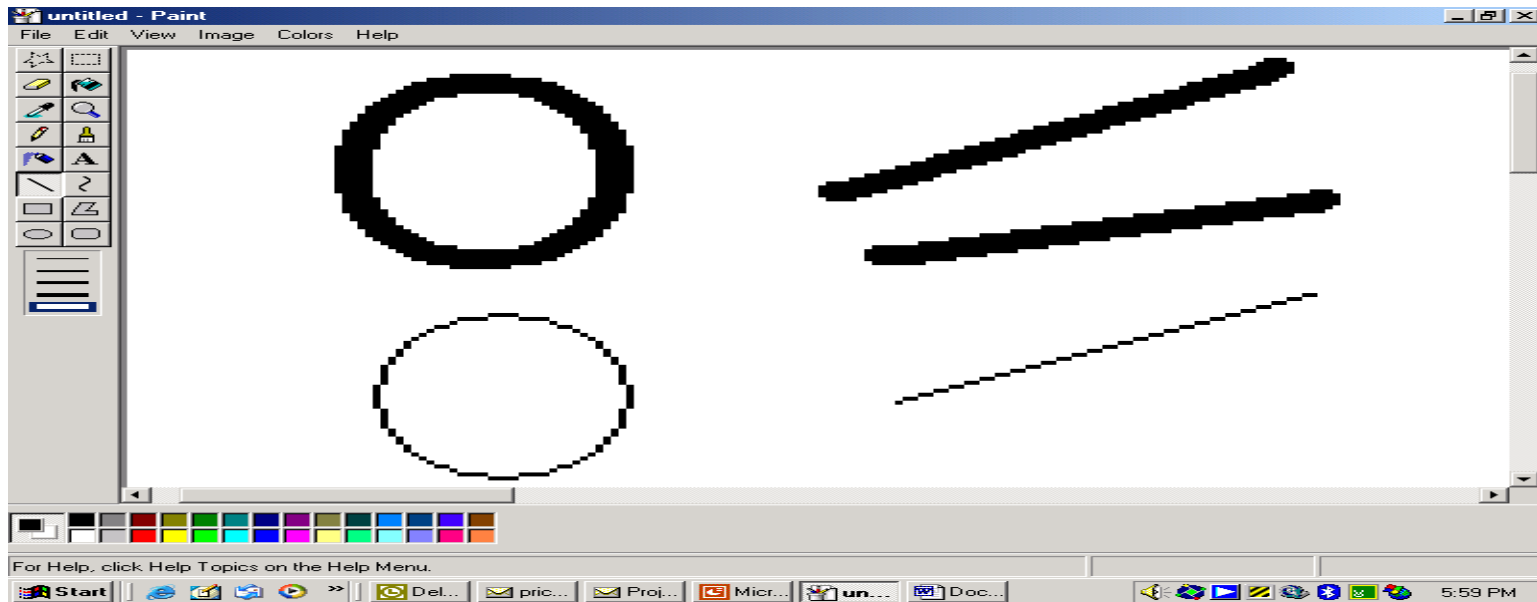
- ❑ Coursera - <https://www.coursera.org/learn/fundamentals-of-graphic-design>
- ❑ <https://www.youtube.com/watch?v=fwzYuhduME4&list=PLE4D97E3B8DB8A590>
- ❑ NPTEL - <https://nptel.ac.in/courses/106/106/106106090/>
- ❑ <https://www.coursera.org/learn/research-methods>
- ❑ <https://www.coursera.org/browse/physical-science-and-engineering/research-methods>

## **Attributes of Output Primitives**

- ❑ Any parameter that affects the way a primitive is to be displayed is referred to as an attribute parameter.
- ❑ Example attribute parameters are color, size etc.
- ❑ A line drawing function for example could contain parameter to set color, width and other properties.
- ❑ Line Attributes, Curve Attributes, Color and Grayscale Levels, Area Fill Attributes, Character Attributes, Bundled Attributes

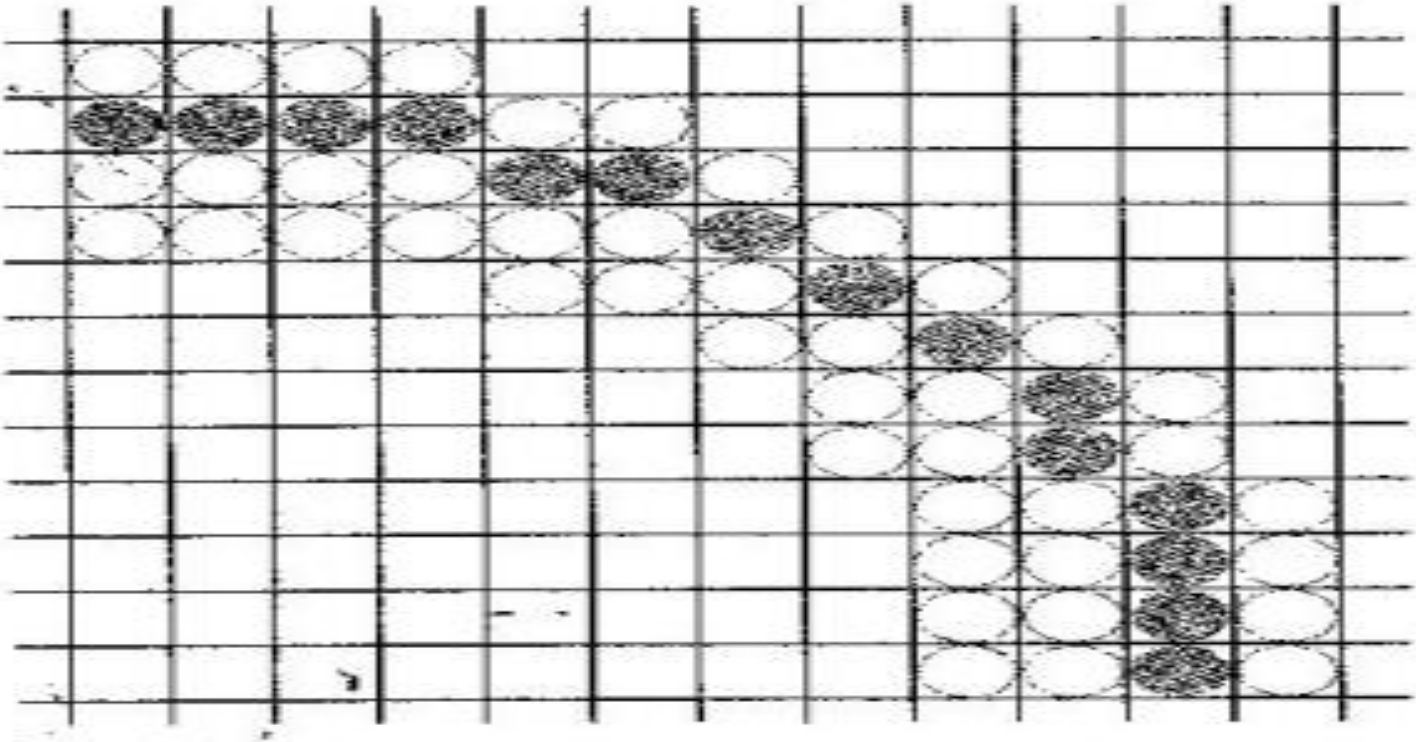
## Curve Attributes

- ❑ Parameters for curve attribute are same as those for line segments.
- ❑ Curves displayed with varying colors, widths, dot – dash patterns and available pen or brush options
- ❑ Thicker curves can be produced by:
  1. Plotting additional pixel,
  2. Filling the space between two concentric circles,
  3. Using thicker pen or brush



# Curve Attributes

□ Width



## Color and Grayscale Levels

- ❑ Various color and intensity-level options can be made available to a user, depending on the capabilities and design objectives of a particular system

### Color

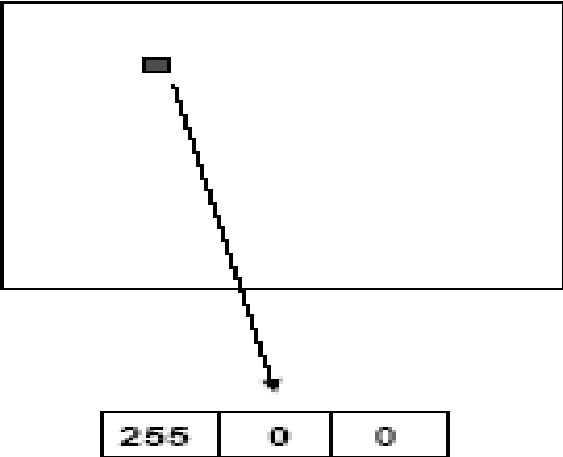
- ❑ Colors are represented by colors codes which are positive integers.
- ❑ Color information is stored in frame buffer or in separate table and use pixel values as index to the color table.
- ❑ Two ways to store color information: 1. Direct and 2. Indirect
- ❑ With the direct storage scheme, whenever a particular color code is specified in an application program, the corresponding binary value is placed in the frame buffer for each-component pixel in the output primitives to be displayed in that color.



## Color Levels

### ❑ Direct Storage

### Full-color (RGB) displays



The diagram shows a rectangular screen with a small black square in the top-left corner. A dashed line connects this square to a horizontal register below. The register is divided into three boxes containing the values 255, 0, and 0, representing the Red, Green, and Blue color channels respectively.

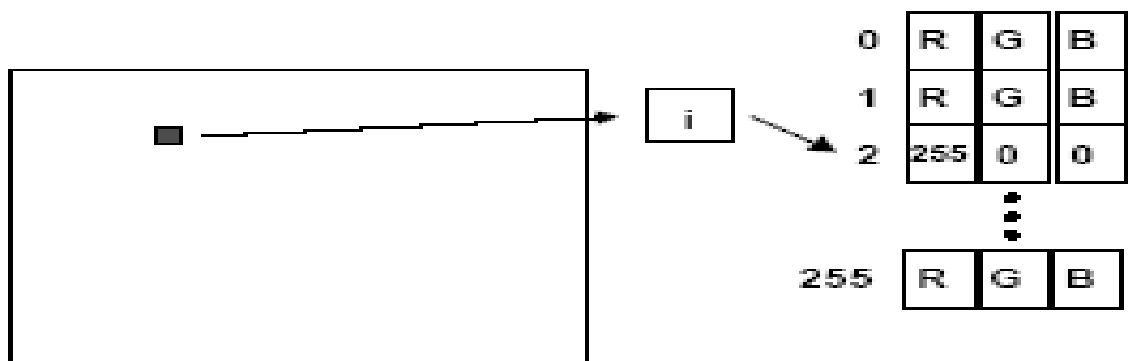
- For 24 bit color:
  - store 8 bits each of red, green, and blue per pixel.
  - E.g. (255,0,0) is pure red, and (255, 255, 255) is white.
  - Yields  $2^{24} = 16$  million colors.
- For 15 bit color:
  - 5 bits red + 5 green + 5 blue
- The video hardware uses the values to drive the R,G, and B guns.
- You can mix different levels of R, G, and B to get any color you want

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# Color Levels

## □ Indirect Storage

**Color maps (LUT's)**



The diagram illustrates the indirect storage of color. A pixel in a frame is represented by a small square. An arrow points from this pixel to a box containing the index 'i'. Another arrow points from 'i' to a row in a table. The table is titled 'Color maps (LUT's)' and has three columns labeled 'R', 'G', and 'B'. The rows are indexed from 0 to 255. The row for index 0 contains 'R', 'G', and 'B'. The row for index 1 contains 'R', 'G', and 'B'. The row for index 2 contains '255', '0', and '0'. There are three vertical dots between the row for index 2 and the row for index 255. The row for index 255 contains 'R', 'G', and 'B'.

- A single number (e.g. 8 bits) stored at each pixel.
- Used as an *index* into an array of RGB triples.
- With 8 bits per pixel, you get 256 colors of your choice
- Simple things to fill up color-maps with:
  - A grey ramp (for grey scale pictures)
  - A bunch of random colors (for color drawings.)
  - A very poor representation of full color

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## Color Levels

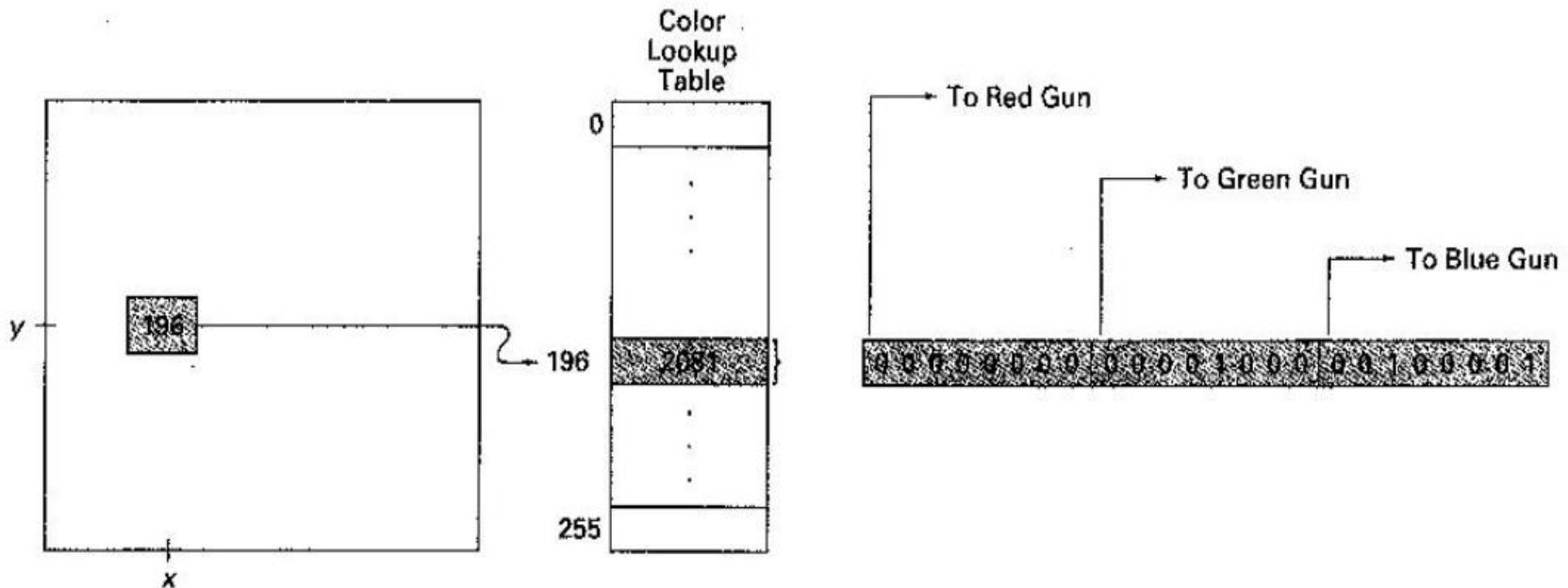
### Color Lookup Table

THE EIGHT COLOR CODES FOR A THREE-BIT PER PIXEL FRAME BUFFER

<i>Color</i>	<i>Stored Color Values in Frame Buffer</i>			<i>Displayed Color</i>
<i>Code</i>	<i>RED</i>	<i>GREEN</i>	<i>BLUE</i>	
0	0	0	0	Black
1	0	0	1	Blue
2	0	1	0	Green
3	0	1	1	Cyan
4	1	0	0	Red
5	1	0	1	Magenta
6	1	1	0	Yellow
7	1	1	1	White

# Color Levels

## Color Lookup Table



A color lookup table with 24 bits per entry accessed from a frame buffer with 8 bits per pixel. A value of 196 stored at pixel position  $(x, y)$  references the location in this table containing the value 2081. Each 8-bit segment of this entry controls the intensity level of one of the three electron guns in an RGB monitor.

## Grayscale Levels

- ❑ Apply for monitor that have no color
- ❑ Shades of grey (white->light grey->dark grey->black)
- ❑ Color code mapped onto grayscale codes: 2 bits can give 4 level of grayscale and 8 bits per pixel will allow 256 combination
- ❑ Dividing the actual code with 256 will give range of 0 and 1
- ❑ Ex:

Color code in color display is 118

To map to nearest grayscale then

$$118/256 = 0.45$$

light gray

INTENSITY CODES FOR A FOUR-LEVEL GRAYSCALE SYSTEM

<i>Intensity Codes</i>	<i>Stored Intensity Values In The Frame Buffer (Binary Code)</i>		<i>Displayed Grayscale</i>
0.0	0	(00)	Black
0.33	1	(01)	Dark gray
0.67	2	(10)	Light gray
1.0	3	(11)	White

## Questions

- Explain Color and Gray scale levels.
- Justify color and grey scale system.



Thank You