

Arab Academy For Science and Technology & Maritime Transport

College of Engineering & Technology

Computer Engineering Department



EXAMINATION PAPER – Week 7

Course Title: Computer Graphics

Course Code: CC416

Date: Thurs. Dec, 18-2014

Lecturer: Dr. Manal Helal

Time allowed: 60 Minutes

Start Time: 08:30 a.m.

Student's name:

Reg.# :

Question #	Marks	
	Available	Actual
Curves	6	
2D Transformation	7	
2D Viewing Mapping	7	
Total	20	
Lecturer	Name : Dr. Manal Helal	
	Signature :	
	Date:	

MPC6/1-1

1) Assuming that a graphics library has the following functions to draw curves:

a. **quadBezier** (p_s, p_c, p_e).

where p_s is the starting point coordinate vector, p_c is the control point for interpolation, and p_e is the ending point,

b. **cubicBezier** (p_s, p_{c1}, p_{c2}, p_e).

where p_s is the starting point coordinate vector, p_{c1} and p_{c2} are two control points to use for interpolation, and p_e is the ending point,

c. **polyBezier** ($p_s, p_c[], p_e$).

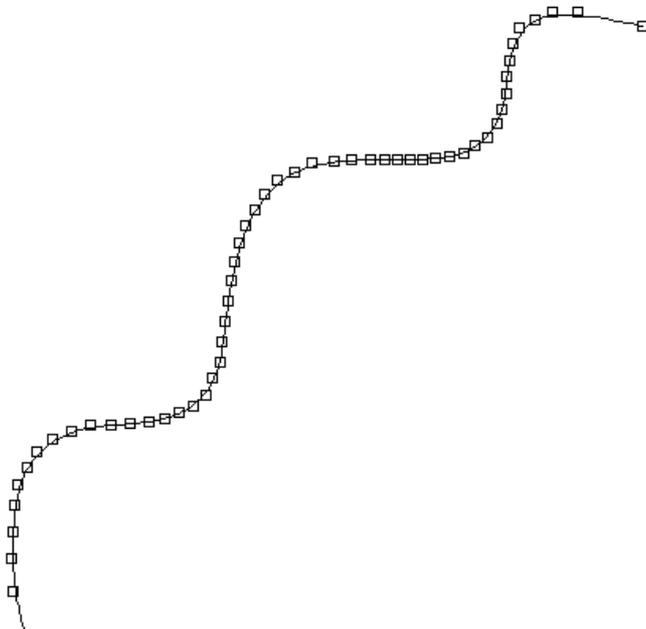
where p_s is the starting point coordinate vector, $p_c[]$ array is a list of control points to use in interpolation, and p_e is the ending point,

d. **spline** ($p[]$).

where $p[]$ array is a list of points to interpolate to form the spline curve,

How can you call these functions to draw the following curve, such that:

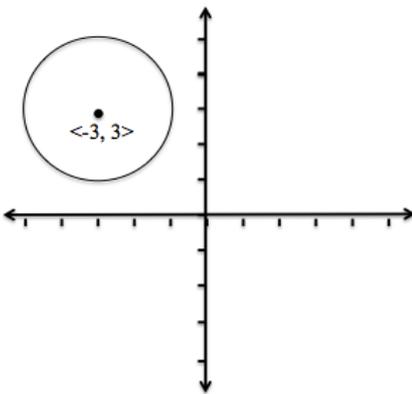
- you use the minimum number of control points
- you avoid using the spline functions



2) Derive the transformation matrices required to transform the circle shown in the figure and centered on point $\langle -3, 3 \rangle$ with radius = 2,

- rotated on angle 45,
- then reflected on the y-axis.

Describe your steps.



3) Given a window in the world coordinates $(W.l, W.r, W.b, W.t) = (10, 2, 40, 30)$, and a viewing port with coordinates $(V.l, V.r, V.b, V.t) = (100, 50, 250, 300)$, how would you map a point at $(8, 35)$ in the world coordinates to the view port:

Hint:

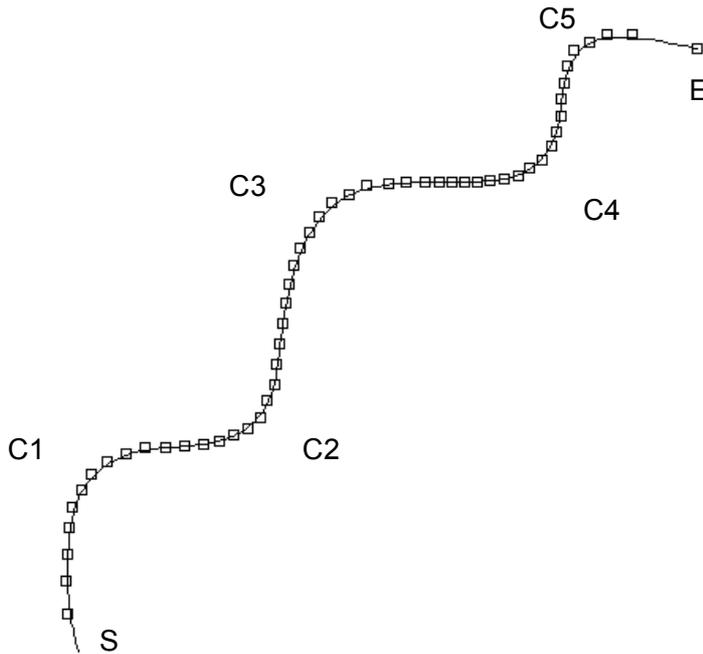
$$Sx = Ax - (A(W.l) - V.l) \quad Sy = By - (B(W.b) - V.b)$$

$$A = \frac{V.r - V.l}{W.r - W.l}$$

$$B = \frac{V.t - V.b}{W.t - W.b}$$

Answers:

1. Minimum points, start point, 5 control points and end point, roughly as follows. [2 points]



- a) The easy way to model this curve using the given hypothetical graph library and functions, is by arranging the points (including start and finish) in order from start to end in an array p and call the $\text{spline}(p[])$ function [1 mark]
- b) Otherwise, using minimum number of statements as well, we can have a polynomial curve with 5 control points in an array p and calling the $\text{polyBezier}(S, p[], E)$ function, [3 marks]

Other (sub optimal) solutions that doesn't include minimum number of statements [partial credit based on how far from optimal and how well explained.]:

2 function calls, but notice we are touching on control point C3 as an end point for first call and start point for second call, which is not Bezier (2.5 marks)

$\text{cubicBezier}(S, C1, C2, C3)$
 $\text{cubicBezier}(C3, C4, C5, E)$

all variations of cubicBezier and quadBezier combinations of calls analogous to the last example, will result in 2 overlapping points, and hence two different interpolations, and overlapping curves, such as C4 and C5 repetitions in the last two calls in the following (1 marks):

$\text{cubicBezier}(S, C1, C2, C3)$
 $\text{quadBezier}(C3, C4, C5)$
 $\text{quadBezier}(C4, C5, E)$

3 function calls of quadBezier as follows, notice that we are touching C2 and C4 which is not optimal (2 marks):

$\text{quadBezier}(S, C1, C2)$
 $\text{quadBezier}(C2, C3, C4)$
 $\text{quadBezier}(C4, C5, E)$

P.S. defining extra points on the curve to join the intermediate curves away from the interpolation points (not on the curve) will fix the late three solutions, and won't miss marks.

2)

a) Rotating on 45 angle using this matrix:

Defining the matrices is worth = 4 marks, defining the resulting point and using it in the next transformation is worth 3 marks

$$\begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix} = \begin{pmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix}$$

Applying this to the center only and then redrawing the circle from the new location. This will result on a new center point as follows:

$$x' = x \cdot \cos 45 - y \cdot \sin 45 = (-3 * 0.707) - (3 * 0.707) = 4.24 = 3\sqrt{2}$$

$$y' = x \cdot \sin 45 + y \cdot \cos 45 = (-3 * 0.707) + (3 * 0.707) = 0$$

P.S. $\cos 45 = \sin 45 = 1/\sqrt{2} = 0.7071$, so any form of the answer is accepted

b) then reflected on the y axis using this matrix

$$\begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix} = \begin{pmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix}$$

$$x' = -x = -4.24 = -3\sqrt{2}$$

$$y' = y = 0$$

3) Substitute the coordinates to get values for A and B, then substitute to get the S_x and S_y

$$A = 6.25$$

$$B = -5$$

$$S_x = 87.5$$

$$S_y = 275$$