מרצה : ד"ר אלה שפר
מתרגל : דני ברונשטיין

מבחן סופי
מועד א'

שם : _____

מס' סטודנט : _____

הנחיות :

1. בבחינה שלפניכם 4 דפים כולל דף זה. בדקו זאת.
2. הבחינה מחולקת לשני חלקים. עליכם לענות על 2 מתוך 3 שאלות בחלק הראשון, ו 5 מתוך 6 שאלות בחלק השני.
3. כתבו בקצרה. כל המאריך גורע!
4. משך הבחינה : שלוש שעות.
5. יש לכתוב את כל התשובות במחברת המצורפת.
6. יש להגיש את טופס הבחינה והמחברת המצורפת.
7. חומר עזר **מותר** : כל חומר כתוב ו/או מודפס אחר (ספר, חוברת, מחברת, שקפים, הדפסות וכו...)
8. חומר עזר **אסור** : כל פריט אלקטרוני.

בהצלחה

	חלק 2		חלק 1
נקודות	שאלה	נקודות	שאלה
	1		1
	2		2
	3		3
	4		
	5		
	6		
			סה"כ

Section 1: (40 points)

Answer 2 of the following 3 questions. Each question costs 20 points. Mark clearly which two you want to be checked.

1. Write a midpoint (Bresenham) algorithm for drawing the parabola $y - x^2 = 0$ for $1 \leq y \leq 25$.
2. Given a cubic Bézier curve with control points P_1, P_2, P_3, P_4, write the control points (Q_1, Q_2, Q_3, Q_4 and R_1, R_2, R_3, R_4) for two cubic Bézier curves Q and R defining the **same curve**, one for [0, 0.5] and the other for [0.5, 1] (Hint, use De Casteljau algorithm).
3. Given a closed convex polygon $P = P_1$, P_2, ... P_n ($P_1 = P_n$) in 2D and an axis aligned cell $C=[x_1, x_2] \times [y_1, y_2]$. Write a function that returns 1 if P contains C, returns -1 if C contains P, and returns 0 otherwise.

Section 2: (60 points)

Answer 5 of the following 6 questions. Each question costs 12 points. Mark clearly which five you want to be checked.

1. Given six axis aligned parallel light sources at infinity (at -x, x, -y, y, -z, z) and an axis aligned cube model (from (-1,-1,-1) to (1,1,1)). Normal at vertices are averages of adjacent face normals.
   a. Is using flat shading on the cube equivalent to ambient light shading? (4 points)
   b. Is using Gouraud shading on the cube equivalent to ambient light shading? (4 points)
   c. Is using flat Phong shading on the cube equivalent to ambient light shading? (4 points)

2. Given the matrix $D_4 = \begin{pmatrix} 0 & 8 & 2 & 10 \\ 12 & 4 & 14 & 6 \\ 3 & 11 & 1 & 9 \\ 15 & 7 & 13 & 5 \end{pmatrix}$ for 2 color dithering on the range {0-15},

write a pseudo-code using it for three gray levels (0,1,2) dithering on the same input range.

3. $\alpha_1(u)$ and $\alpha_2(v)$ are two curves on the range $u,v \in [0..1]$. We have $\alpha_1(0) = \alpha_2(0) = P_1$, $\alpha_1(1)= P_2$ and $\alpha_2(1)= P_3$ and a point P_4. Write the formula of a tensor product patch $S(u,v)$, $(u,v) \in [0..1] \times [0..1]$ that interpolates the two curves and P_4.
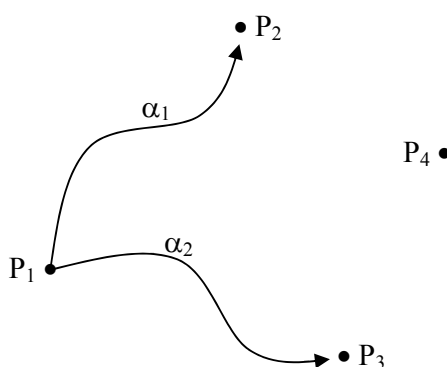
4. Raytracing.
    a. Compute the intersection of a ray $R(t) = P + V \cdot t$ with the extruded parabola surface $S(x, y, z) = \{x^2 + y = 0\}$. (6 points)

    b. Using the basic Ray Tracing method below, for a model with no reflective objects, will the algorithm terminate with no extra stopping conditions? If yes, explain. If not, will it terminate with additional assumptions, and which assumptions are necessary? (6 points)

```
RayTrace(ray)
    Obj = first intersection of the ray;
    if( no Obj) then
            Return backgroundColor;
    else
    begin
            if (Transparent(obj)) then
                    refractColor = RayTrace( RefractRay(Obj,ray));
            else
                    refractColor = backgroundColor;
            endif;
            return Shade( refractColor, Obj);
    end
```

5. Given a grid checkerboard image I_1 of size N×N.
    a. Will the following correctly translate the grid to an N/2×N/2 image I_2? (where $L(x,y)=(x/2,y/2)$) Explain. (6 points)

```
Clear I₂ to background color
for x from 0 to Xmax(I₁)
    for y from 0 to YMax(I₁)
    I₂(L(x,y)) = I₁(x,y)
```

    b. What about to an 2N×2N image I_2 (where $L(x,y)=(2x,2y)$)? Explain. (6points)

6. Answer yes/no (no explanation). All the transformations are in 3D.
    a. Does Perspective preserves parallel lines? (2 points)
    b. Does Perspective Warp preserves angles? (2 points)
    c. Is there an α for which the Perspective Warp becomes a Perspective Projection? (2 points)
    d. Is shear * rotate = rotate * shear? (2 points)
    e. Is $rotate_1$ * $rotate_2$ = $rotate_2$ * $rotate_1$? (2 points)
    f. Does shear preserve parallel lines? (2 points)