HACETTEPE UNIVERSITY

ELECTRICAL AND ELECTRONICS ENGINEERING

ELE338 MICROPROCESSOR ARCHITECTURE AND PROGRAMMING LAB.

PRELIMINARY WORK 4
PROCEDURE AND INTERRUPT USAGE
2020-2021 SPRING

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1. Question

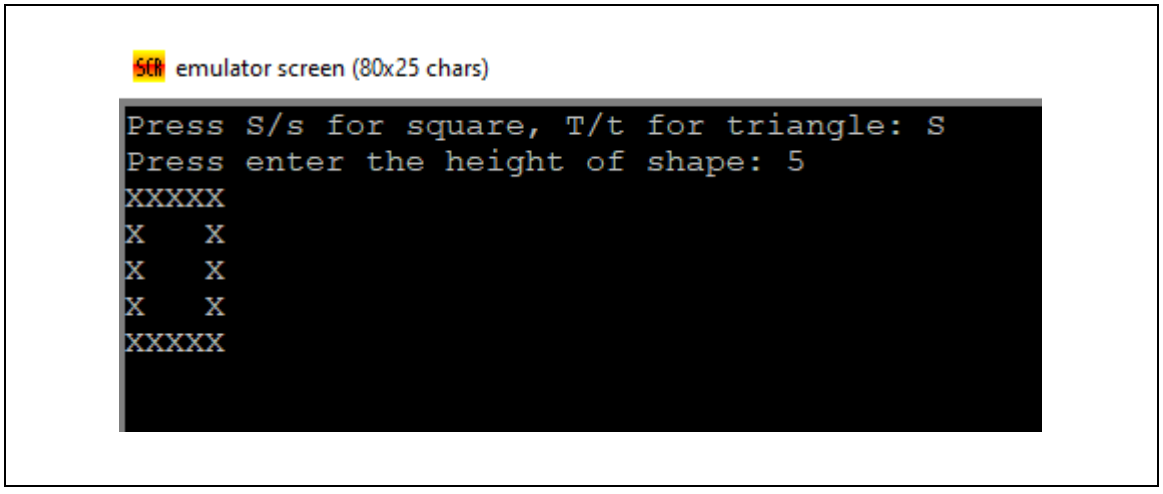
EMU 8086 CODE

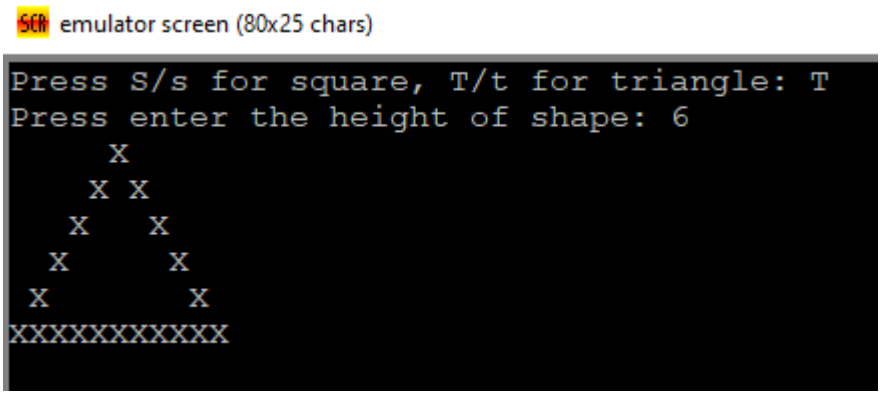
```
.Model Small
.Stack 64
.Data
String1 DB "Press S/s for square, T/t for triangle: ","$"
String2 DB 0Ah,0Dh,"Press enter the height of shape: ","$"
Select DB 1 dup(?)
Height DB 1 dup(?)
NotValid DB "It is not valid input","$"
Cross1 DB 0ah,0dh,"X","$"
Cross2 DB "X","$"
SpaceX DB " ","$"
NextLine DB 0Ah,0Dh,"$"

.Code
Proc Main
MOV AX,Data
MOV DS,AX

Start:
Lea BX,Select            ; To keep the SELECTION in memory
Lea BP,Height            ; To keep the HEIGHT in memory

Mov AH,9h
Mov DX,OFFSET String1    ; To printf String1
Int 21h
Mov AH,01h
Int 21h                  ; To get the selection
Mov [BX],AL              ; To keep selection

Mov AH,9h
Mov DX,OFFSET String2    ; To printf String2
Int 21h
Mov AH,01h
Int 21h                  ; To get the height
Mov [BP],AL              ; To keep height
SUB [BP],48d             ; Numbers in ASCII start at 48
                         ; I subtract 48 from the height to find exact number

Mov AH,9h
Mov DX,OFFSET NextLine   ; To pass next line
Int 21h

Cmp [BX],53h             ; IF Select Data is S/s
Je Square                ; Jump to Square
Cmp [BX],73h
Je Square
Cmp [BX],54h             ; IF Select Data is T/t
Je Triangle              ; Jump to Triangle
Cmp [BX],74h
Je Triangle
Jne Invalid              ; If the select is not S/s or T/t, the code jumps to Invalid.

Square:
CALL DrawSquare          ; To draw square
Jmp Finish

Triangle:
CALL DrawTriangle        ; To draw triangle
Jmp Finish
Invalid:
Mov AH,9h
Mov DX,OFFSET NotValid   ; When the select is not S/s or T/t
Int 21h                  ; To print screen "It is not valid input".
Mov AH,9h
Mov DX,OFFSET NextLine
Int 21h
Jmp Start                ; It jumps to Start to select a valid input.
Endp Main
```

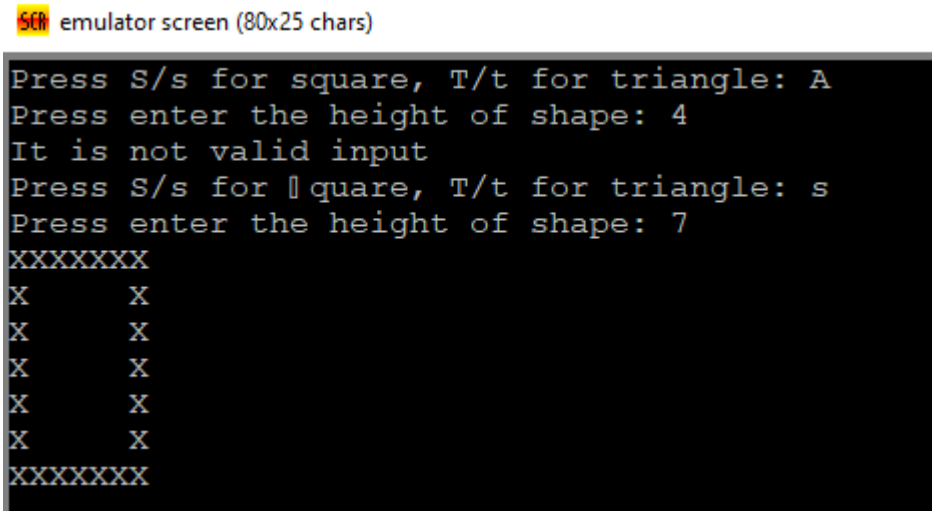
```
Proc DrawSquare
  MOV CL,[BP]             ; To keep height
  MOV CH,CL
  SUB CH,2d               ; To keep the height of the middle area

 TOP:                     ; TOP OF THE SQUARE
  Mov AH,9h
  Mov DX,OFFSET Cross2
  Int 21h                 ; To print top of the square
  Dec CL
  Cmp CL,00d
 JNE TOP

 ALLSIDE:                 ; MIDDLE PART OF SQUARE
  MOV CL,[BP]
  DEC CH
  FirstX:
  Mov AH,9h
  Mov DX,OFFSET Cross1    ; To print first X
  Int 21h
  Dec CL
  Space:
  Mov AH,9h
  Mov DX,OFFSET SpaceX    ; To print spaces
  Int 21h
  Dec CL
  Cmp CL,01h
  JNE Space
  FinalX:
  Mov AH,9h
  Mov DX,OFFSET Cross2    ; To print final X
  Int 21h
  Cmp CH,00d
 JNE ALLSIDE

  Mov AH,9h
  Mov DX,OFFSET NextLine
  Int 21h

  MOV CL,[BP]
 BOTTOM:                  ; BOTTOM OF THE SQUARE
  Mov AH,9h
  Mov DX,OFFSET Cross2    ; To print bottom of the square
  Int 21h
  Dec CL
  Cmp CL,00d
 JNE BOTTOM
Ret
Endp DrawSquare

Proc DrawTriangle
 TriTop:
  Mov CX,[BP]             ; To keep height
  Sub CX,01h              ; To print space
  Mov CH,00h              ; I gave 0 to CH to fix the number.
  Spa1:
  Mov AH,9h
  Mov DX,OFFSET SpaceX    ; To print space up to the HEİGHT-1
  Int 21h
  Loop Spa1

  Mov AH,9h
  Mov DX,OFFSET Cross2    ; To print X
  Int 21h
  Mov AH,9h
  Mov DX,OFFSET NextLine
  Int 21h

  Mov DI,01h
  Mov BX,01h
  Mov CX,[BP]             ; I edited registers for other parts
  Sub CX,02h
  MOV CH,00h
```

```
TriSide:
  Mov SI,CX

  Spa2:
  Mov AH,9h               ; First Spaces
  Mov DX,OFFSET SpaceX    ; To print space up to the HEİGHT-2
  Int 21h
  Dec SI
  Cmp SI,00h
  Jne Spa2

  Mov AH,9h
  Mov DX,OFFSET Cross2    ; To printf X
  Int 21h

  OtherSpa2:
  Mov AH,9h               ; Second Spaces
  Mov DX,OFFSET SpaceX
  Int 21h
  Dec DI
  Cmp DI,00h
  Jne OtherSpa2

  Mov AH,9h
  Mov DX,OFFSET Cross2    ; To print other X on the same line
  Int 21h

  Add BX,02h              ; To adjust other spaces ın the lower line
  Mov DI,BX

  Mov AH,9h
  Mov DX,OFFSET NextLine
  Int 21h
 Loop TriSide

  Mov BX,[BP]
  Sub BX,01h
  Mov BH,00h              ; I edited registers for other parts
  mov CX,[BP]
  Mov CH,00h
  Add CX,BX

TriBottom:
  Mov AH,9h
  Mov DX,OFFSET Cross2    ; To print bottom of the triangle
  Int 21h
  Loop TriBottom
Ret
Endp DrawTriangle
Finish:
Ends
```

RESULTS







COMMENT

In the first question, I wrote the algorithm of the shapes that I will create on paper. I drew the shapes and made an outline based on the shapes.

In my code, I first put a lot of strings and free memory in the .data part. In the .code section, first of all, I have specified the addresses to go to the input values that I will get with the LEA command. The reason I do this is to keep the initial values I get until the end of my code. After getting my selection and height values on the screen, I compared my selection input first. If S / s or T / t moved to the next step. If not, I went back to getting input.

If the value I chose is S or s, I started drawing a square with the procedure. In the square plotting part, I first put 'X' up to height of square on top of the square. For the other sides of the square, I put an 'X' first. Then I put space as much as the height-2. And I put another 'X'. I repeat this process up to the height-2. For the bottom of the square, I put 'X' as much as the height.

If the value I chose is T or t, I started drawing a triangle with the procedure. I put space up to height-1 to make the top of the triangle. And I put an 'X'. To do the other sides, I first left spaces, then put 'X', then space again and put 'X' again. I repeat this process up to the height-2. For the bottom of the triangle, I put 'X' as much as the 2*height-1 .

2. Question

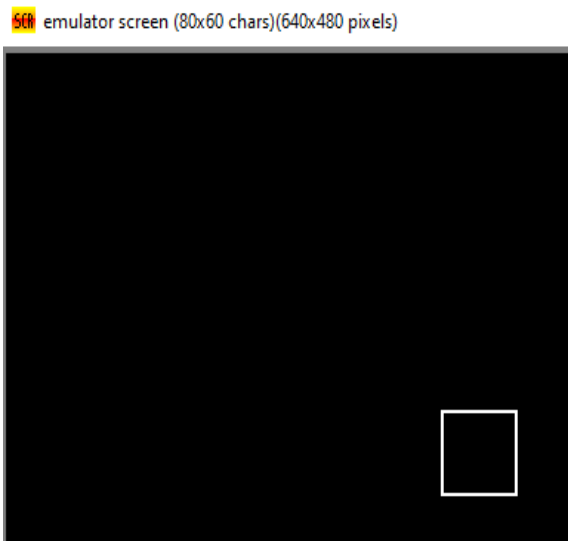
EMU8086 CODE

```
.Model Small
.Stack 64
.Data
String1 DB "Press S/s for square, T/t for triangle: ","$"
String2 DB 0Ah,0Dh,"Press enter the height of shape: ","$"
Select DB 1 dup(?)
Height DB 1 dup(?)
NotValid DB "It is not valid input","$"
NextLine DB 0Ah,0Dh,"$"
.Code

PROC Main
Mov AX,Data
Mov DS,AX

Start:
 Lea BX,Select            ; To keep the SELECTION in memory
 Lea BP,Height            ; To keep the HEIGHT in memory

 Mov AH,9h
 Mov DX,OFFSET String1    ; To printf String1
 Int 21h
 Mov AH,01h
 Int 21h                  ; To get the selection
 Mov [BX],AL              ; To keep selection

 Mov AH,9h
 Mov DX,OFFSET String2    ; To printf String2
 Int 21h
 Mov AH,01h               ; To get the height
 Int 21h



 Mov [BP],AL              ; To keep height
 Sub [BP],48d             ; Numbers in ASCII start at 48
 Mov AL,10d               ; I subtract 48 from the height to find exact number
 Mul [BP]                 ; I multiplied the number by ten because to enlarge the image on the screen
 Mov [BP],AL              ; I put the number back into memory.

 Mov AH,9h
 Mov DX,OFFSET NextLine
 Int 21h

 Cmp [BX],53h             ; IF Select Data is S/s
 Je Square                ; Jump to Square
 Cmp [BX],73h
 Je Square
 Cmp [BX],54h             ; IF Select Data is T/t
 Je Triangle              ; Jump to Triangle
 Cmp [BX],74h
 Je Triangle
 Jne Invalid              ; If the select is not S/s or T/t, the code jumps to Invalid.

Square:
 CALL DrawSquare          ; To draw square
 Jmp Finish
Triangle:
 CALL DrawTriangle        ; To draw triangle
 Jmp Finish
Invalid:
 Mov AH,9h
 Mov DX,OFFSET NotValid   ; When the select is not S/s or T/t
 Int 21h                  ; To print screen "It is not valid input".
 Mov AH,9h
 Mov DX,OFFSET NextLine
 Int 21h
 Jmp Start                ; It jumps to Start to select a valid input.
 ENDP Main
```

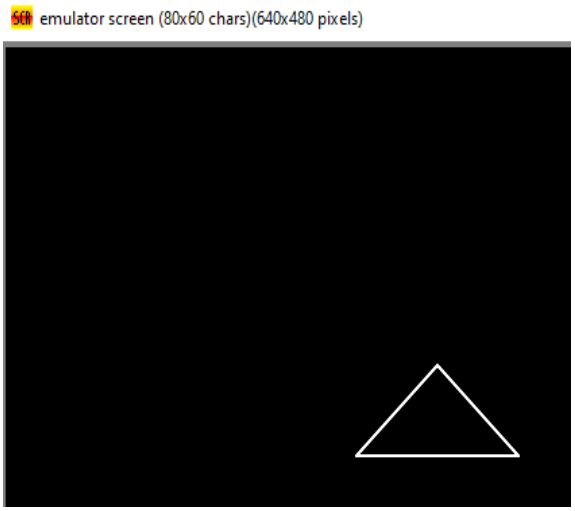
```
Proc DrawTriangle          ; TO DRAW TRIANGLE
 Mov AX,0012H              ; To set 640*480 pixels
 Int 10H
 Int 10H

 Mov AX,[BP]
 Mov AH,00h
 Mov BL,02h
 Div BL
 Mov CX,320                ; Starting points
 Mov DX,240
 Sub DX,AX

 Mov BX,[BP]               ; To keep height
RightT:                    ; THE RİGHT EDGE OF THE TRIANGLE
 Mov AH,0CH                ; Places a single pixel
 Mov AL,0FH                ; Pixel color is white
 Int 10H

 Inc DX
 Inc CX
 Dec BL                    ; CX and DX increase until it reaches its height.
 Cmp BL,00h
 Jne RightT

 Mov BX,[BP]               ; To keep height
 Mov AL,2                  ; I multiplied the height by two for the bottom.
 Mul BL
 Mov BL,AL

BottomT:                   ; THE BOTTOM OF THE TRIANGLE
 Mov AH,0CH
 Mov AL,0FH
 Int 10H

 Dec CX
 Dec BL
 Cmp BL,00h                ; CX decrease until it reaches its bottom height.
 Jne BottomT

 Mov BX,[BP]               ; To keep height
LeftT:                     ; THE LEFT EDGE OF THE TRIANGLE
 Mov AH,0CH
 Mov AL,0FH
 Int 10H

 Inc CX
 Dec DX
 Dec BL                    ; DX decrease, CX increase until it reaches its height.
 Cmp BL,00h
 Jne LeftT

 Ret
Endp DrawTriangle

PROC DrawSquare            ; TO DRAW SQUARE
 Mov AX,0012H              ; To set 640*480 pixels
 Int 10H
 Int 10H

 Mov AX,[BP]
 Mov AH,00h
 Mov BL,02h
 Div BL
 Mov CX,320
 Add CX,AX                 ; Starting points
 Mov DX,240
 Sub DX,AX

 Mov BX,[BP]               ; To keep height
RightS:                    ; THE RIGHT EDGE OF THE SQUARE
 Mov AH,0CH
 Mov AL,0FH
 Int 10H
```

```
 Inc DX
 Dec BL
 Cmp BL,00h              ; DX increase until it reaches its height.
 Jne RightS

 Mov BX,[BP]             ; To keep height
BottomS:                 ; THE BOTTOM OF THE SQUARE
 Mov AH,0CH
 Mov AL,0FH
 Int 10H

 Dec CX
 Dec BL
 Cmp BL,00h              ; CX decrease until it reaches its height.
 Jne BottomS

 Mov BX,[BP]              ; To keep height
LeftS:                    ; THE LEFT EDGE OF THE SQUARE
 Mov AH,0CH
 Mov AL,0FH
 Int 10H

 Dec DX
 Dec BL
 Cmp BL,00h               ; DX decrease until it reaches its height.
 Jne LeftS

 Mov BX,[BP]              ; To keep height
TopS:                     ; THE RIGHT SIDE OF THE SQUARE
 Mov AH,0CH
 Mov AL,0FH
 Int 10H

 Inc CX
 Dec BL
 Cmp BL,00h               ; CX increase until it reaches its height.
 Jne TopS

 Ret
ENDP DrawSquare
Finish:
Ends
```

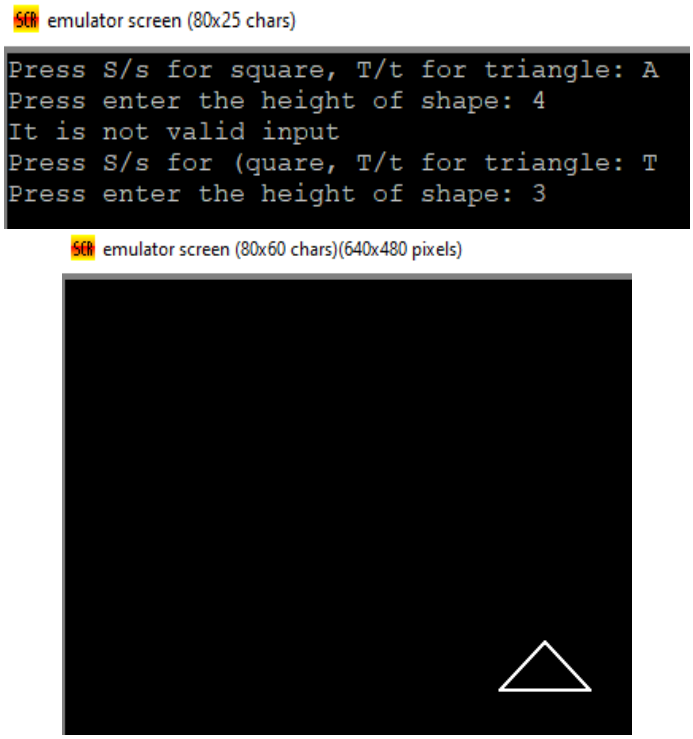
RESULTS



Center of Square CX=320, DX = 240 ; Height = 50 pixels



Center of Triangle CX=320, DX = 240 ; Height = 60pixels



Center of Triangle CX=320, DX = 240; Height = 30pixels

COMMENT

In my code, I first put a lot of strings and free memory in the .data part. In the .code section, first of all, I have specified the addresses to go to the input values that I will get with the LEA command. The reason I do this is to keep the initial values I get until the end of my code. After getting my selection and height values on the screen, I compared my selection input first. If S / s or T / t moved to the next step. If not, I went back to getting input.

First of all I set the screen to 640x480 pixels. Then I adjusted my starting points so that the center of the shape I drew was in the middle.

The triangle drawing process consisted of 3 parts, and the square drawing process consisted of 4 parts. My CX Register behaves like the 'x' axis, my DX Register as the 'y' axis. I decreased or increased my CX or DX recorder with each transaction. These operations continued until the height each time. It only continued until the height*2 in the bottom of the triangle.

3.Question

EMU8086 Code

```
.Model Small
.Stack 64
.Data
SquareEdges DW 4 dup(0)
String1 DB "Press S/s for square, T/t for triangle: ","$"
String2 DB 0Ah,0Dh,"Press enter the height of shape: ","$"
Select DB 1 dup(?)
Height DB 1 dup(?)
NotValid DB "It is not valid input","$"
NextLine DB 0Ah,0Dh,"$"
.Code

PROC Main
Mov AX,Data
Mov DS,AX

Start:
Lea BX,Select             ; To keep the SELECTION in memory
Lea BP,Height             ; To keep the HEIGHT in memory

Mov AH,9h
Mov DX,OFFSET String1     ; To printf String1
Int 21h
Mov AH,01h
Int 21h                   ; To get the selection
Mov [BX],AL               ; To keep selection

Mov AH,9h
Mov DX,OFFSET String2     ; To printf String2
Int 21h
Mov AH,01h                ; To get the height
Int 21h

Mov [BP],AL               ; To keep height
Sub [BP],48d              ; Numbers in ASCII start at 48
Mov AL,10d                ; I subtract 48 from the height to find exact number
Mul [BP]                  ; I multiplied the number by ten because to enlarge the image on
the screen
Mov [BP],AL               ; I put the number back into memory.

Mov AH,9h
Mov DX,OFFSET NextLine
Int 21h

Cmp [BX],53h              ; IF Select Data is S/s
Je Square                 ; Jump to Square
Cmp [BX],73h
Je Square
Cmp [BX],54h              ; IF Select Data is T/t
Je Triangle               ; Jump to Triangle
Cmp [BX],74h
Je Triangle
Jne Invalid               ; If the select is not S/s or T/t, the code jumps to Invalid.

Square:
CALL DrawSquare           ; To draw square
CALL DetectionSquare      ; To detect square
Jmp Finish
```

```
Triangle:
CALL DrawTriangle         ; To draw triangle
Jmp Finish

Invalid:
Mov AH,9h
Mov DX,OFFSET NotValid    ; When the select is not S/s or T/t
Int 21h                   ; To print screen "It is not valid input".
Mov AH,9h
Mov DX,OFFSET NextLine
Int 21h
Jmp Start                 ; It jumps to Start to select a valid input.
ENDP Main
Proc DrawTriangle         ; TO DRAW TRIANGLE
Mov AX,0012H              ; To set 640*480 pixels
Int 10H
Int 10H

Mov AX,[BP]
Mov AH,00h
Mov BL,02h                ; Center of the Triangle(320,240)
Div BL
Mov CX,320                ; Starting points
Mov DX,240
Sub DX,AX

Mov BX,[BP]               ; To keep height
RightT:                   ; THE RİGHT EDGE OF THE TRIANGLE
    Mov AH,0CH            ; Places a single pixel
    Mov AL,0FH            ; Pixel color is white
    Int 10H
    Inc DX
    Inc CX
    Dec BL                ; CX and DX increase until it reaches its height.
    Cmp BL,00h
    Jne RightT

Mov BX,[BP]               ; To keep height
Mov AL,2                  ; I multiplied the height by two for the bottom.
Mul BL
Mov BL,AL
BottomT:                  ; THE BOTTOM OF THE TRIANGLE
    Mov AH,0CH
    Mov AL,0FH
    Int 10H
    Dec CX
    Dec BL
    Cmp BL,00h            ; CX decrease until it reaches its bottom height.
    Jne BottomT

Mov BX,[BP]               ; To keep height
LeftT:                    ; THE LEFT EDGE OF THE TRIANGLE
    Mov AH,0CH
    Mov AL,0FH
    Int 10H
    Inc CX
    Dec DX
    Dec BL                ; DX decrease, CX increase until it reaches its height.
    Cmp BL,00h
    Jne LeftT
Ret
Endp DrawTriangle
```

```
PROC DrawSquare          ; TO DRAW SQUARE
Mov AX,0012H             ; To set 640*480 pixels
Int 10H
Int 10H

Mov AX,[BP]
Mov AH,00h              ; Center of the Square(320,240)
Mov BL,02h
Div BL
Mov CX,320
Add CX,AX               ; Starting points
Mov DX,240
Sub DX,AX


Mov BX,[BP]              ; To keep height
RightS:                  ; THE RIGHT EDGE OF THE SQUARE
    Mov AH,0CH
    Mov AL,0FH
    Int 10H

    Inc DX
    Dec BL
    Cmp BL,00h           ; DX increase until it reaches its height.
    Jne RightS

Mov BX,[BP]              ; To keep height
BottomS:                 ; THE BOTTOM OF THE SQUARE
    Mov AH,0CH
    Mov AL,0FH
    Int 10H

    Dec CX
    Dec BL
    Cmp BL,00h           ; CX decrease until it reaches its height.
    Jne BottomS

Mov BX,[BP]              ; To keep height
LeftS:                   ; THE LEFT EDGE OF THE SQUARE
    Mov AH,0CH
    Mov AL,0FH
    Int 10H

    Dec DX
    Dec BL
    Cmp BL,00h           ; DX decrease until it reaches its height.
    Jne LeftS

Mov BX,[BP]              ; To keep height
TopS:                    ; THE RIGHT SIDE OF THE SQUARE
    Mov AH,0CH
    Mov AL,0FH
    Int 10H

    Inc CX
    Dec BL
    Cmp BL,00h           ; CX increase until it reaches its height.
    Jne TopS

Ret
ENDP DrawSquare
```

```
Proc DetectionSquare

    Mov AX,[BP]
    Mov AH,00h                      ; AL Register is holding my height
    Mov BP,OFFSET SquareEdges       ; All edges of square
    Mov [SquareEdges],CX            ; 1. Edge
    Mov [SquareEdges+2],DX
    Add [SquareEdges+2],AX          ; 2. Edge
    Mov [SquareEdges+4],CX
    Sub [SquareEdges+4],AX          ; 3. Edge
    Mov [SquareEdges+6],DX          ; 4. Edge

  GetXY:
    Mov AX,03
    Int 33H
    Shr CX,1
    Cmp BX,1                        ; When I press the left mouse button.
    Je Interval                     ; Goes to Interval control
  JMP GetXY

; It checks whether the mouse's position is inside or outside of the square by looking at
the edges one by one.
   Interval:
   Cmp CX,[SquareEdges]
   Jnc Getxy
   Cmp CX,[SquareEdges+4]
   Jc Getxy
   Cmp DX,[SquareEdges+6]
   Jc Getxy
   Cmp DX,[SquareEdges+2]
   Jnc Getxy
Ret
Endp DetectionSquare
Finish:
Ends
```

COMMENT

I could not do the Triangle control part of this problem. Only Square control part.

My explanations about drawing triangle and square are available in the previous question. I will only explain the mouse control part.

I opened a 4 Word-size data in memory for mouse control. Here I think of the sides of the square as axes and record them in the data. If I press the left mouse button. The code jumps into the interval check. Then, I checked whether my mouse is above or below these axes one by one. If it is outside of the square, my code always worked, the moment the mouse entered the square, my code was finished.

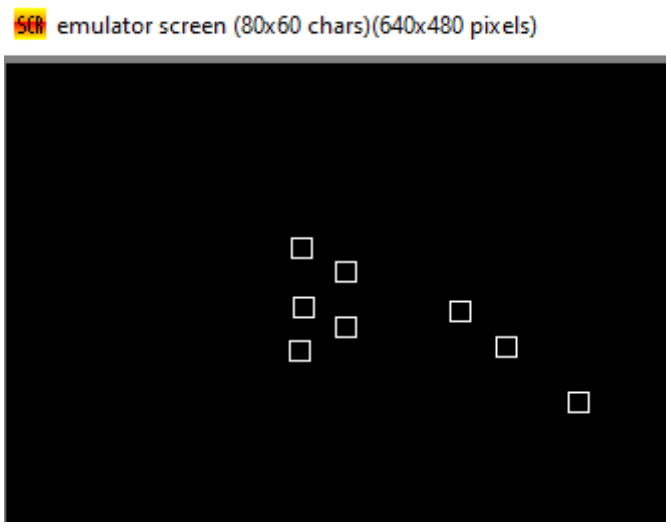
4.Question

EMU8086 Code

```
.Model Small
.Stack 64
.Data
XandY DW 2 dup(?)
.Code

PROC Main
 Mov AX,Data
 Mov DS,AX

 MOV AX, 12H            ; To set 640*480 pixels
 INT 10H
 INT 10H

 Start:
 Mov BX,0000h
 Call Detect            ; Checks if the left mouse button has been pressed.
 DrawS:
 Call DrawSquare        ; If the left button is pressed, it draws a square there.
 Jmp Start

Endp Main

PROC Detect

 Lea BP,XandY

 MOV AX, 01
 INT 33H

 GetXY:
 Mov AX,03
 Int 33H
 Shr CX,1
 MOV [XandY],CX       ; WRITE X COOR. TO MEMORY "X"
 MOV [XandY+2],DX     ; WRITE Y COOR. TO MEMORY "Y"
 Cmp BX,1
 Je DrawS
 JMP GetXY
Endp Detect

PROC DrawSquare          ; TO DRAW SQUARE

Add [XandY],04h
 Sub [XandY+2],04h       ; Starting Points
 Mov CX,[XandY]
 Mov DX,[XandY+2]

Mov BL,10d               ; To keep height
RightS:                  ; THE RIGHT EDGE OF THE SQUARE
    Mov AH,0CH
    Mov AL,0FH
    Int 10H

    Inc DX
    Dec BL
    Cmp BL,00h           ; DX increase until it reaches its height.
    Jne RightS


Mov BL,10d               ; To keep height
BottomS:                 ; THE BOTTOM OF THE SQUARE
    Mov AH,0CH
    Mov AL,0FH
    Int 10H
```

```
    Dec CX
    Dec BL
    Cmp BL,00h            ; CX decrease until it reaches its height.
    Jne BottomS

Mov BL,10d                ; To keep height
LeftS:                    ; THE LEFT EDGE OF THE SQUARE
    Mov AH,0CH
    Mov AL,0FH
    Int 10H

    Dec DX
    Dec BL
    Cmp BL,00h            ; DX decrease until it reaches its height.
    Jne LeftS

Mov BL,10d                ; To keep height
TopS:                     ; THE RIGHT SIDE OF THE SQUARE
    Mov AH,0CH
    Mov AL,0FH
    Int 10H

    Inc CX
    Dec BL
    Cmp BL,00h            ; CX increase until it reaches its height.
    Jne TopS

Ret
ENDP DrawSquare
Ends
```

RESULTS



Comment

I used two procedures in this code and my code works forever. First, I defined 2 16-bit free memories in the .data section. These memories will take the x and y axes where the mouse is on the screen.

My first procedure is to get its position from the screen and it controls my left click. When I left click on the screen, we go to the other procedure. It draws a square, the center of which is the location I clicked on.