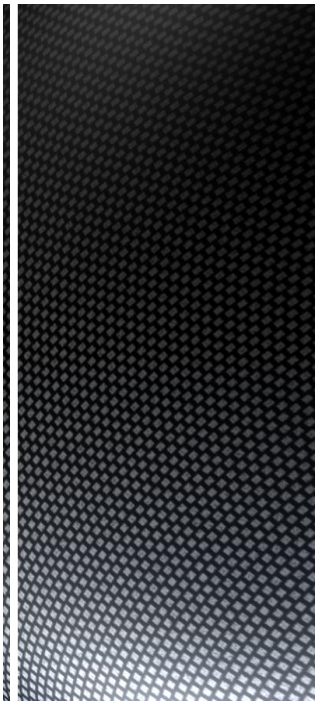
# *Automation (21-541)*

*Advanced Manufacturing Laboratory*
*Department of Industrial Engineering*
*Sharif University of Technology*

*Session # 6*

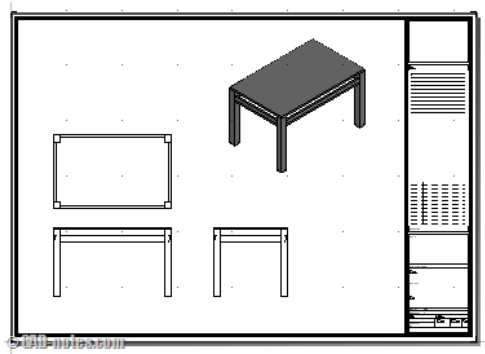


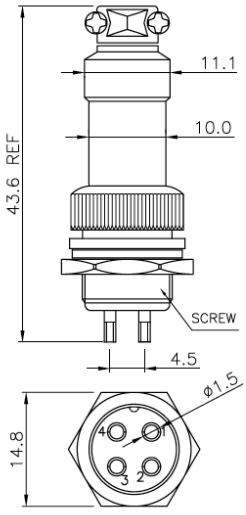
## *Session Schedule*

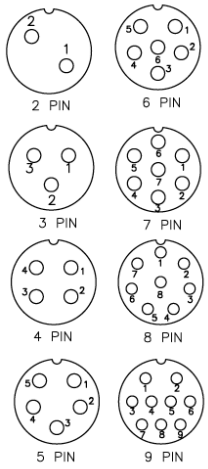
- *Computer-Aided Design (CAD)*
  - *Introduction*
    - *Graphic primitives*

# *Computer-Aided Design (CAD)*

- *Introduction:*
  - *Traditionally drawings are prepared on plane drawing sheets.*





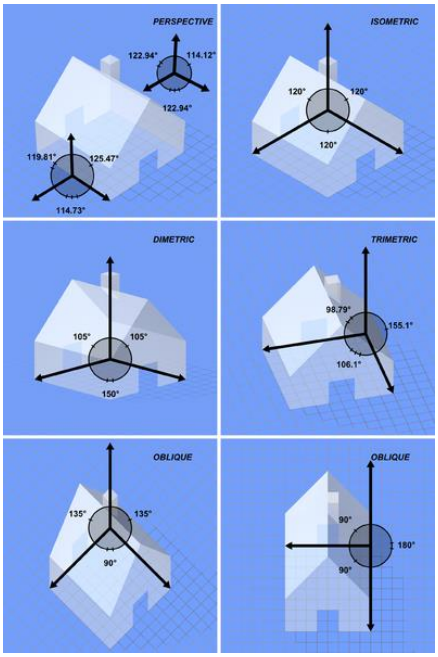



# *Computer-Aided Design (CAD)*

- *Introduction:*
  - *Plane drawing sheets have several limitations:*
    - *The sketches have to be made only in two dimensions*
    - *Though the depth can be represented by*
      - *pictorial projections like:*

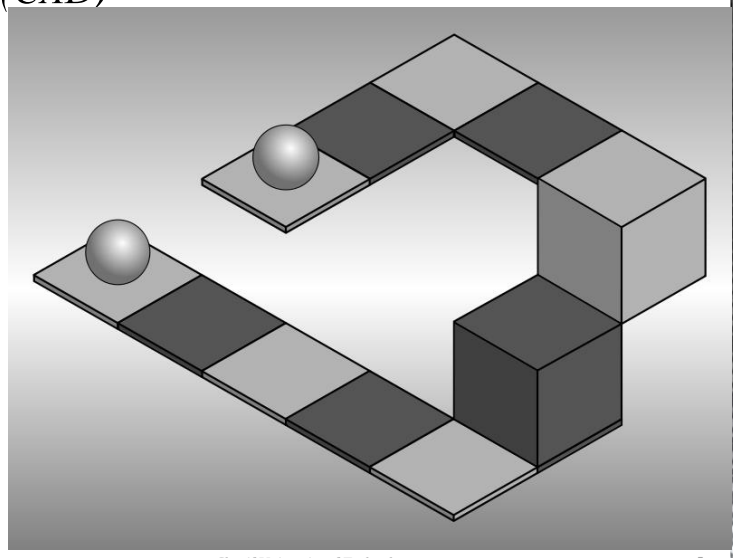
    *isometric and perspective projections,*

    *the projections have to be necessarily reduced to two dimensions.*



## *Computer-Aided Design (CAD)*

- *Introduction:*
  - *Plane drawing sheets have several limitations:*





## *Computer-Aided Design (CAD)*

- *Introduction:*
  - *Use of computer graphics has opened up tremendous possibilities for the designer:*
    - *The object is represented by its geometric model in three dimensions (X, Y and Z)*
    - *The mathematical representation reduces creation of views like orthographic, isometric, axonometric or perspective projections into simple viewing transformations*
    - *Sections can be automatically created.*
    - *Revision and revision control are easy.*
    - *Drawings (geometric models) can be modified easily.*

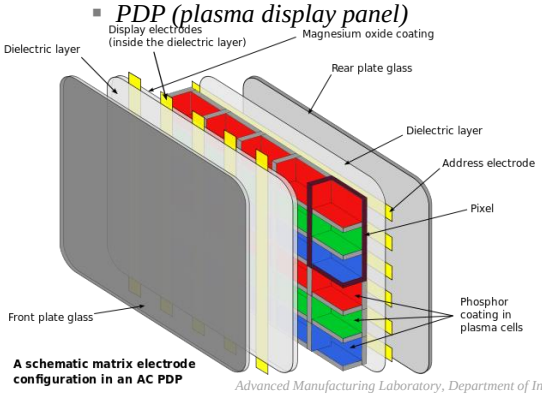
# *Computer-Aided Design (CAD)*

- *Graphic primitives:*
  - *Modern computer graphics displays consist of basically three components.*
    - *Monitor*
    - *Digital Memory or Frame Buffer*
    - *Display Controller*

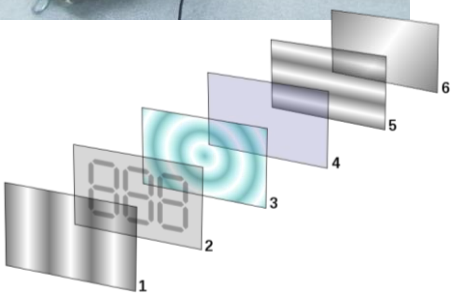



# *Computer-Aided Design (CAD)*

- *Graphic primitives:*
  - *CRT (Cathode ray tube)*
  - *LCD (liquid crystal display )*
  - *PDP (plasma display panel)*

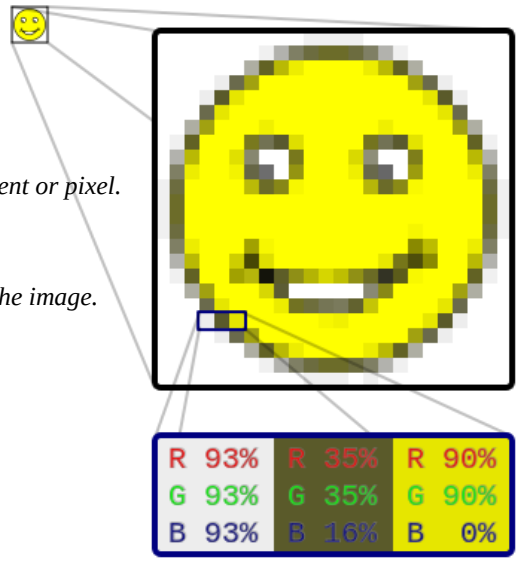



**A schematic matrix electrode configuration in an AC PDP**



## *Computer-Aided Design (CAD)*

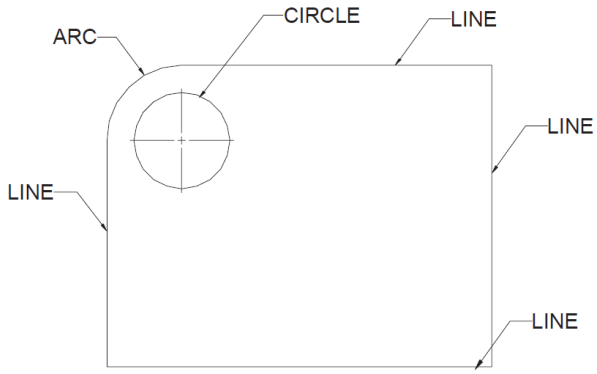
- *Graphic primitives:*
  - *The video display screen is divided into very small rectangular elements called a picture element or pixel.*
  - *Graphic images are formed by setting suitable intensity and color to the pixels which compose the image.*






## *Computer-Aided Design (CAD)*

- *Graphic primitives:*
  - *A drawing is created by an assembly of points, lines, arcs, circles.*
  - *The drawing entities that a user may find in a typical CAD package include :*
    - *point*
    - *line*
    - *construction line, multi-line, polyline*
    - *circle*
    - *spline*
    - *arc*
    - *ellipse*
    - *polygon*
    - *rectangle*



## *Computer-Aided Design (CAD)*

- *Graphic primitives:*
  - *Line*
  - *Straight line segments are used a great deal in computer generated pictures.*
  - *The following criteria have been stipulated for line drawing displays :*
    - *Lines should appear straight*
    - *Lines should terminate accurately*
    - *Lines should have constant density*
    - *Line density should be independent of length and angle*
    - *Line should be drawn rapidly*



## *Computer-Aided Design (CAD)*

- *Graphic primitives:*
  - *DDA algorithm (Digital Differential Analyzer)*
  - *The digital differential analyzer generates lines from their differential equations.*
  - *The DDA works on the principle that X and Y are simultaneously incremented by small steps proportional to the first derivatives of X and Y.*
  - *In the real world of limited precision displays, addressable pixels only must be generated.*

# Computer-Aided Design (CAD)

- *Graphic primitives:*
  - *Procedure DDA (x1, y1, x2, y2 : integer) ;*
  - *As begin:*
  - *STEP=max {abs(x2-x1), abs(y2-y1)}*
  - *Dx=(x2-x1)/STEP; Dy=(y2-y1)/STEP ;*
  - *X=x1; Y=y1;*
  - *For (int i=0; i<=STEP; i++)*

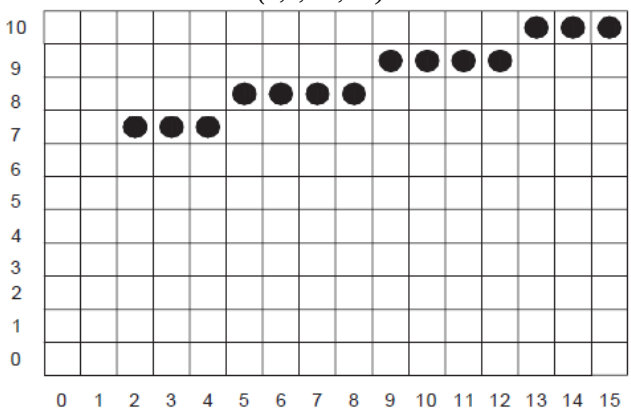
```
{
        plot(truncate(X+0.5),truncate(Y+0.5));
        X= X+Dx;
        Y= Y+Dy;

}
```



# Computer-Aided Design (CAD)

- *Graphic primitives:*
  - *Procedure DDA (2,7, 15, 10)*




| X | Y | trunc (X) | trunc (Y) |
|---|---|---|---|
| 2.5 | 7.50 | 2 | 7 |
| 3.5 | 7.73 | 3 | 7 |
| 4.5 | 7.96 | 4 | 7 |
| 5.5 | 8.19 | 5 | 8 |
| 6.5 | 8.42 | 6 | 8 |
| 7.5 | 8.65 | 7 | 8 |
| 8.5 | 8.88 | 8 | 8 |
| 9.5 | 9.11 | 9 | 9 |
| 10.5 | 9.34 | 10 | 9 |
| 11.5 | 9.57 | 11 | 9 |
| 12.5 | 9.80 | 12 | 9 |
| 13.5 | 10.23 | 13 | 10 |
| 14.5 | 10.46 | 14 | 10 |
| 15.5 | 10.69 | 15 | 10 |

## *Computer-Aided Design (CAD)*

- *Graphic primitives:*
  - $P=(1-t)P_0+(t)P_1 \quad 0 \leq t \leq 1$
  - *Procedure DDA (x1, y1, x2, y2 : integer) ;*
  - *As begin:*
  - *STEP=max {abs(x2-x1), abs(y2-y1)}*
  - *dt=1/STEP;*
  - $(Dx,Dy)=dt(P_1-P_0);$
  - *X=x1; Y=y1;*
  - *For (int i=0; i<=STEP; i++)*

```
{
        plot(truncate(X+0.5),truncate(Y+0.5));
        X= X+Dx;
        Y= Y+Dy;

}
```

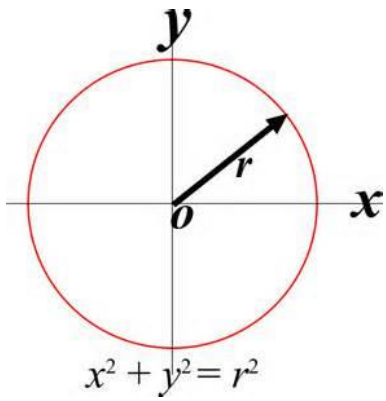


## *Homework: AT:G:02-#*

- *Provide a simple program to plot geometric objects. You should use your CIM data base structure to maintain the geometric data.*
  - *A simple interface can be applied to plot the geometric objects.*
  - *You should provide your first module/procedure to plot a line by getting the required Cartesian locations in a 2D space.*
- *The HW should be sent to Fvalilai@sharif.edu till Tuesday, 6th of Aban (Oct, 28th ,2014)*
- *Email subject: "AT:G:02:#"*

## *Computer-Aided Design (CAD)*

- *Graphic primitives:*
  - *Procedure DDA (X1, Y1, R : integer) ;*

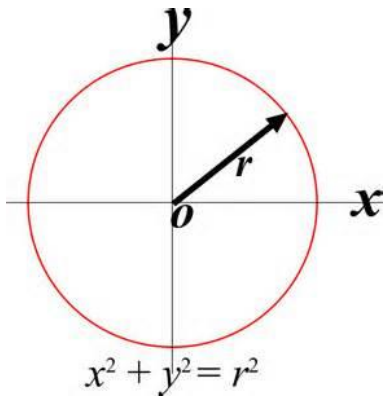





## *Computer-Aided Design (CAD)*

- *Graphic primitives:*
  - *Procedure DDA (X1, Y1, R : integer) ;*
  - *As begin*
  - *For(int tetha=0;tetha<360;thetha++)*

```
{
        Plot(X1+R*cos(theta),Y1+R*sin(theta))
}
```



# *Computer-Aided Design (CAD)*

- *Graphic primitives:*
  - *Procedure DDA (X1, Y1, R : integer) ;*
  - *As begi*
  - *DTetha=*
  - *For(int tetha= π;thetha+=Dtetha)*

*{*

*Plot(X1 os( ),Y1+R*sin(theta))*

*}*