Computer Graphics

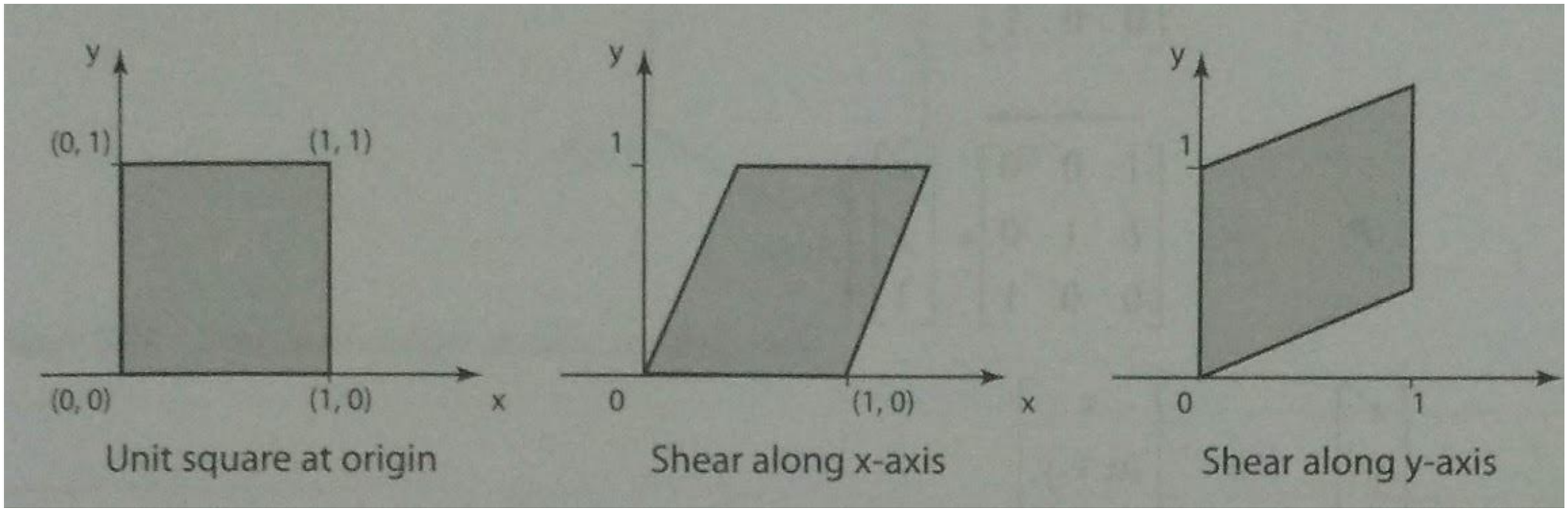
Week 3

Lecture 1

2D Transformations (Part II)

Shear Transform

Distorts the object such that it seems that the object is composed of layers which have been slided over one another.



Shear Equations

Along x-axis:

- Points further from the x-axis slide the most
- Distance from x-axis = y-coordinate
- **x’ = x + ay and y=y**

where a= cot θ
θ = angle transformed shape makes with x-axis

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & a & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Along y-axis:

- Points further from the y-axis slide the most
- Distance from y-axis = x-coordinate
- **x’ = x and y’ = y + bx**

where b= cot θ
θ = angle transformed shape makes with y-axis

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ b & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Example

11. Shear the hexagon in figure 3.23, by an angle $\theta = 30^{o}$.

i) Along x-axis

ii) Along y-axis

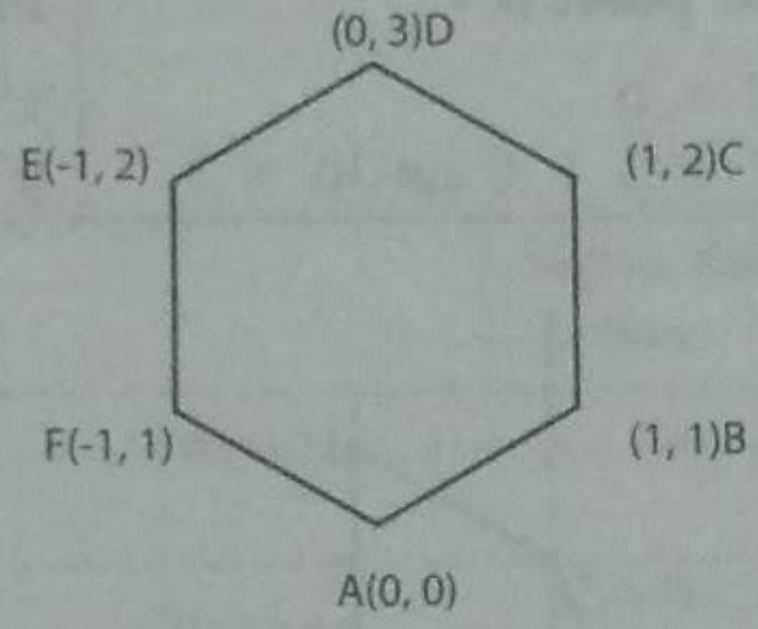
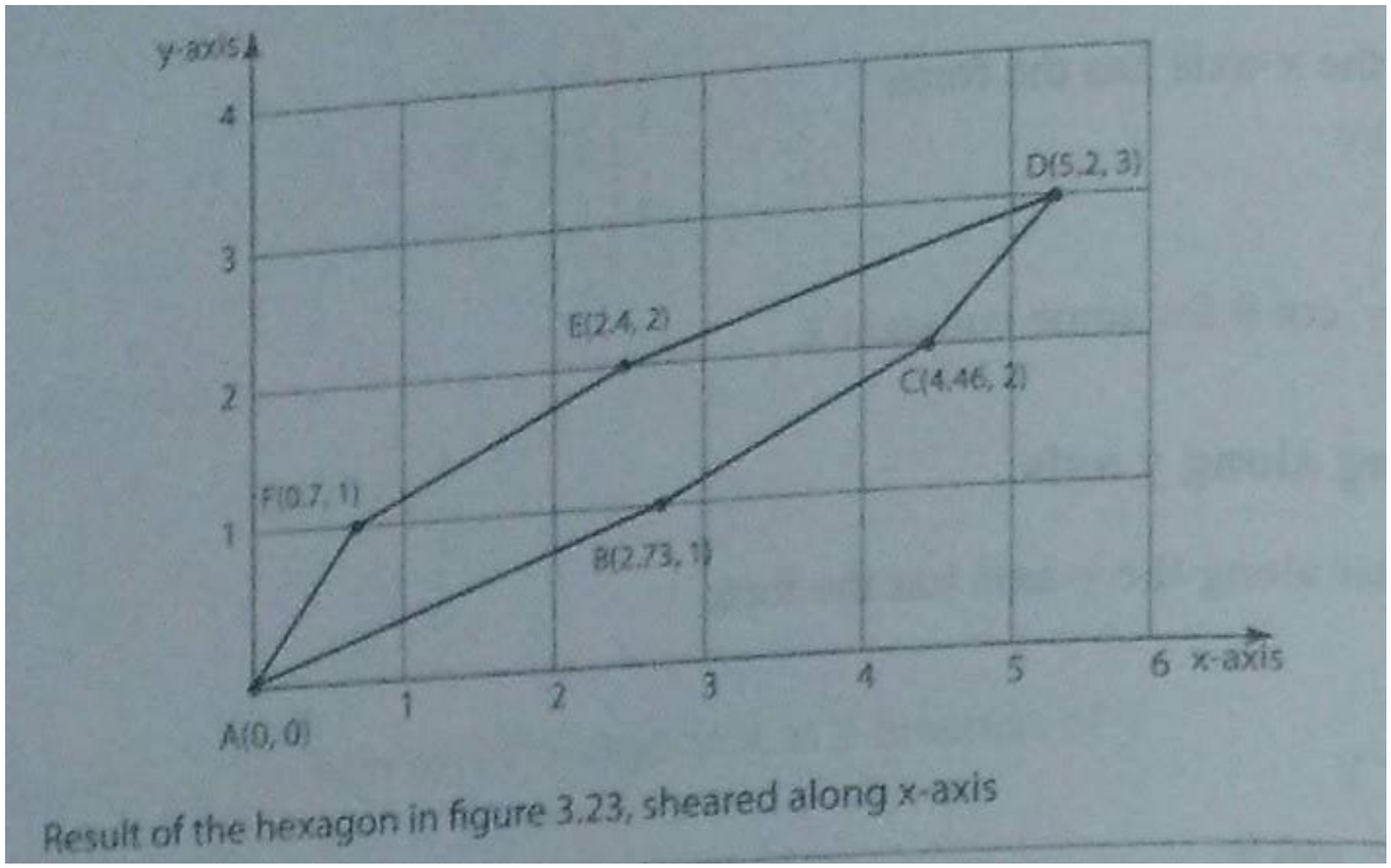


Figure 3.23 Shear the hexagon about x-axis and y-axis

contd

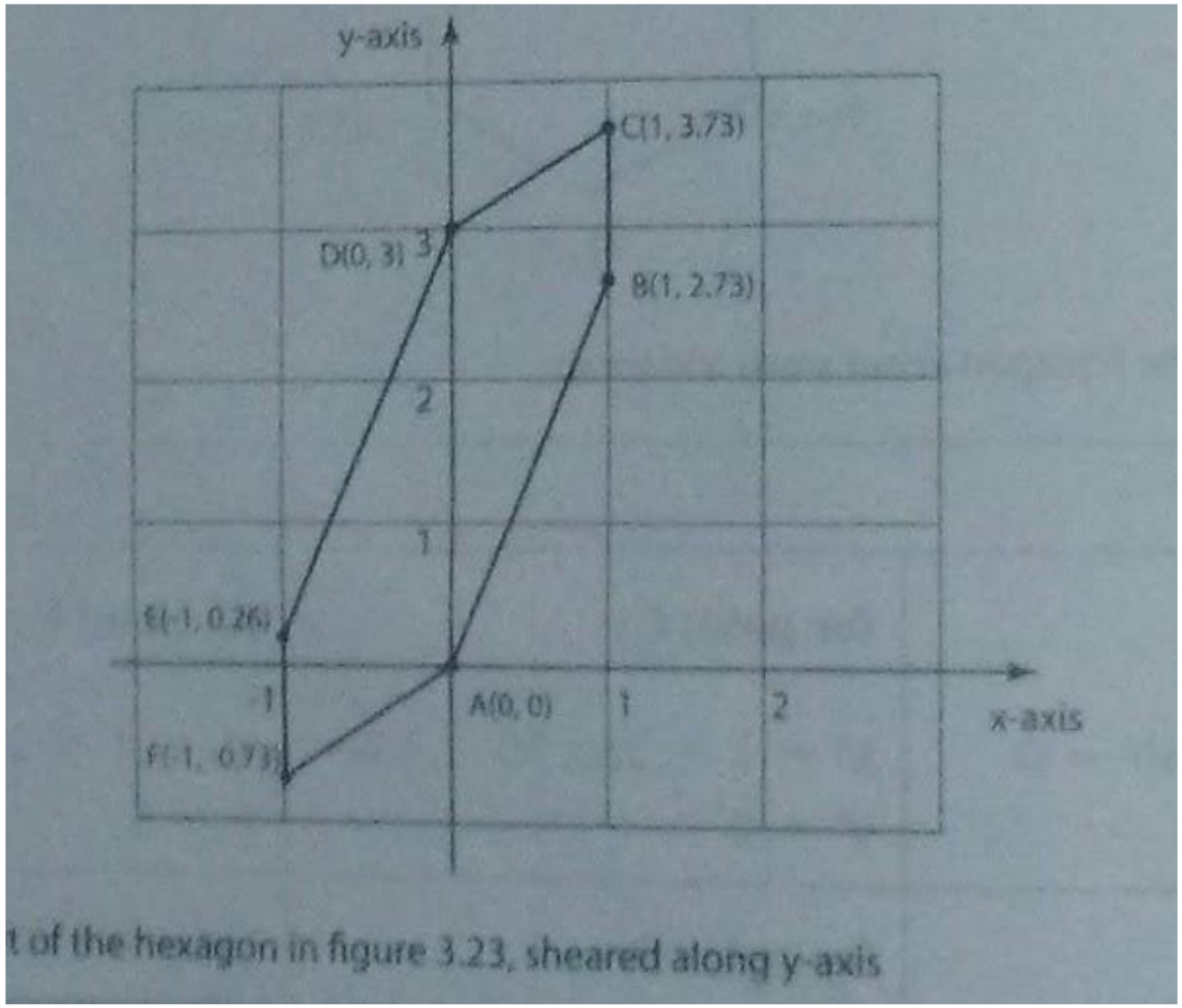


Result of the hexagon in figure 3.23, sheared along x-axis

For every point do $x' = x + y * \cot 30^0$

and $y' = y$

contd

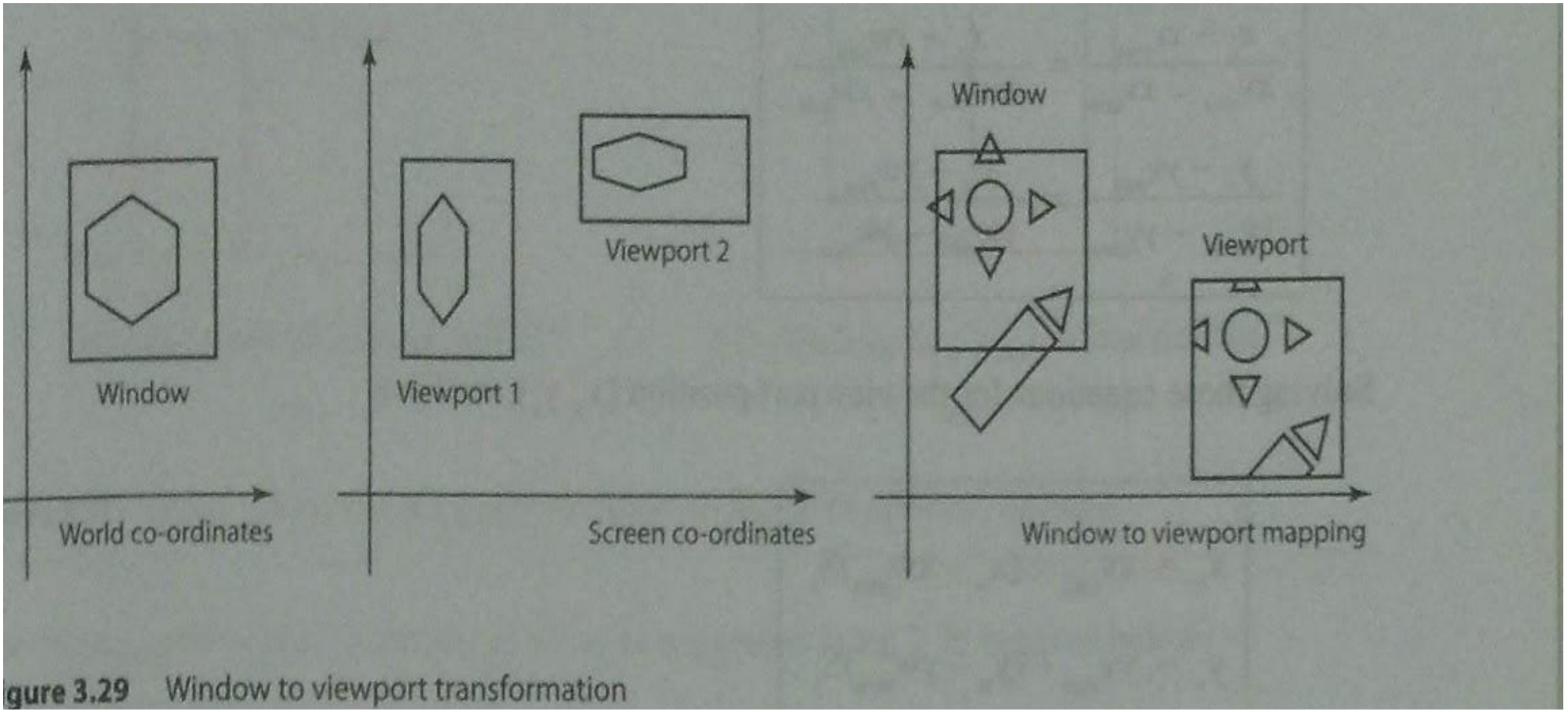


For each point do x'= x

and y' = y + x * cot 30^0

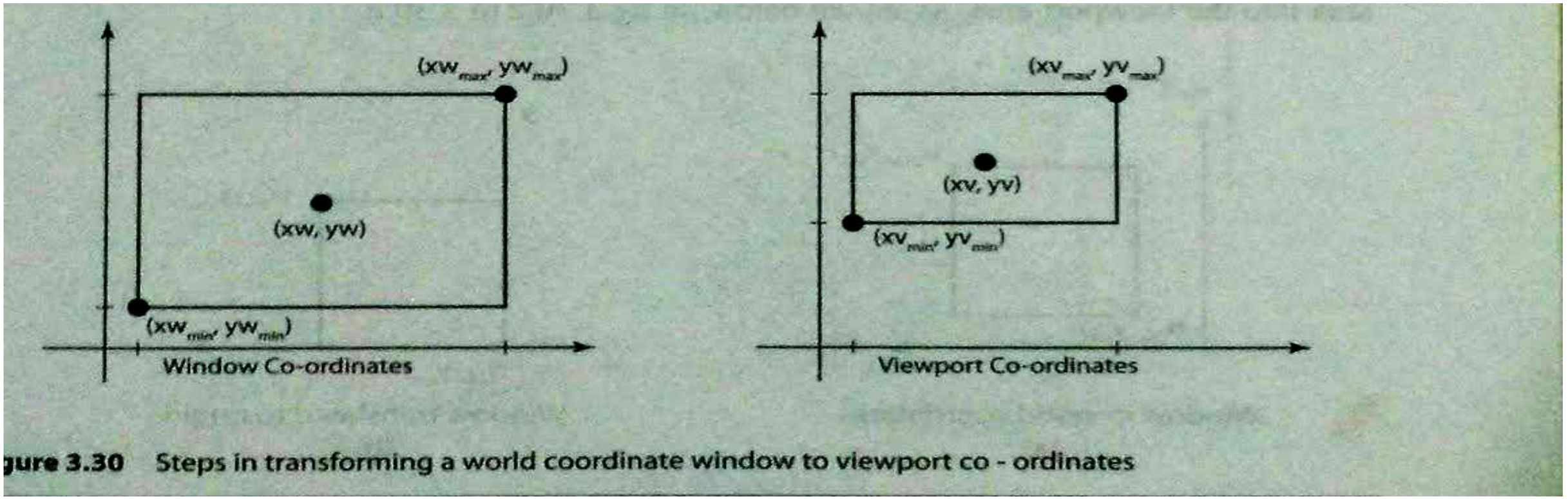
Window to Viewport

i.e. How to convert world coordinates to screen coordinates.



gure 3.29 Window to viewport transformation

Derivation



gure 3.30 Steps in transforming a world coordinate window to viewport co - ordinates

To preserve the relative positions and shapes of the objects we should satisfy the following relationship:

$$\frac{xv - x_{min}}{xv_{min} - xv_{max}} = \frac{xw - xw_{min}}{xw_{min} - xw_{max}}$$

$$\frac{yv - y_{min}}{yv_{min} - yv_{max}} = \frac{yw - yw_{min}}{yw_{min} - yw_{max}}$$

Derivation

$$xv = xv_{min} + (xw - xw_{min}) * \frac{xv_{max} - xv_{min}}{xw_{max} - xw_{min}}$$

$$yv = yv_{min} + (yw - yw_{min}) * \frac{yv_{max} - yv_{min}}{yw_{max} - yw_{min}}$$

Reflection

Matrix form for reflection about x- axis ?
Matrix form for reflection about y- axis ?

Matrix form for reflection about line y=x?

Matrix form for reflection about line y= -x ?

Rigid Body vs Affine Transformations

Rigid Body	**Affine**
Shape of the object does not distort / change	Shape of the object does change / distort

Which transforms are rigid body and which ones are affine ?

The End

Slide 1

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–Johnny Appleseed