CSE 423

Q1. a) 1. Each endpoint is assigned a 4-bit outcode (Left, Right, Bottom, Top) that marks which half-space(s) the point lies in relative to the window.

2. If both endpoints have out code 0000 the line is trivially accepted (completely inside).

3. If the bitwise AND of the two outcodes is non-zero (at least one corresponding bit = 1 in both outcodes), then both endpoints lie outside the window on the same side - the segment cannot cross the window and is trivially rejected. This is the fast trivial reject test.

b) $P_0 = (5, 10)$ $\quad P_1 = (35, 70)$

$$P(t) = P_0 + t(P_1 - P_0)$$
$$= (x_0, y_0) + t(x_1 - x_0, y_1 - y_0)$$
$$= (x_0 + t(x_1 - x_0), y_0 + t(y_1 - y_0))$$
$$= (5 + t(35-5), 10 + t(70-10))$$
$$= (5 + 30t, 10 + 60t)$$

$$x(t) = 5 + 30t$$
$$y(t) = 10 + 60t$$

c) From b, $x(t) = 5 + 30t$
$y(t) = 10 + 60t$

now, $t = \frac{2}{3}$ then

$$x\left(\tfrac{2}{3}\right) = 5 + 20 = 25$$
$$y(t) = 10 + 40 = 50$$

So, the point is $(25, 50)$

d) $(-20, 0)$ to $(40, 80)$ $(5, 10)$ to $(35, 70)$ → path

$x_{min} = -20$ $y_{min} = 0$

$x_{max} = 40$ $y_{max} = 80$

$x_0 = 5, \; y_0 = 10$

$x_1 = 35, \; y_1 = 70$

$D = (x_1 - x_0, \; y_1 - y_0)$

$$t_{left} = \frac{-(x_0 - x_{min})}{(x_1 - x_0)} = \frac{-(5+20)}{35-5} = \frac{-25}{30} = -0.83$$

$$t_{right} = \frac{-(x_0 - x_{max})}{(x_1 - x_0)} = \frac{-(5-40)}{35-5} = \frac{35}{30}$$

$$t_{top} = \frac{-(y_0 - y_{max})}{(y_1 - y_0)} = \frac{-(10-80)}{(70-10)} = \frac{70}{60} = \frac{7}{6}$$

$$t_{bottom} = \frac{-(y_0 - y_{min})}{(y_1 - y_0)} = \frac{-(10-0)}{(70-10)} = \frac{-10}{60} = -1/6$$

Initially, $t_E = 0$, $t_L = 1$

Boundary	N_i	$N_i \cdot D$	t	PE/PL	t_E	t_L
Left	(-1, 0)	-30	-0.833	PE (ignored)	0	1
Right	(1, 0)	30	1.167	PL (ignored)	0	1
Bottom	(0, -1)	-60	-0.167	PE (ignored)	0	1
Top	(0, 1)	60	1.167	PL (ignored)	0	1

No valid intersection parameters fall inside [0, 1], so $t_E = 0$, $t_L = 1$ remain. The segment is fully accepted - no clipping.

Q2. a) Yes we can.

3D out code Bits	Plane	Condition
Bit 1	Left	$x < x_{min}$
Bit 2	Right	$x > x_{max}$
Bit 3	Bottom	$y < y_{min}$
Bit 4	Top	$y > y_{max}$
Bit 5	Near	$z < z_{min}$
Bit 6	Far	$z > z_{max}$

Example: for a 3D window with

$x \in [0, 10]$, $y \in [0, 10]$, $z \in [0, 10]$.

take point $P(12, 5, -3)$

$x = 12 > x_{max} = 10 \rightarrow$ Right

$y = 5 \rightarrow$ inside $\rightarrow$ center $= 0$

$z = -3 < z_{min} = 0 \rightarrow$ Near

So, the 3D outcode $= 010010$

b). $(-10, 60)$ to $(100, 10)$

width 80 height $= 60$

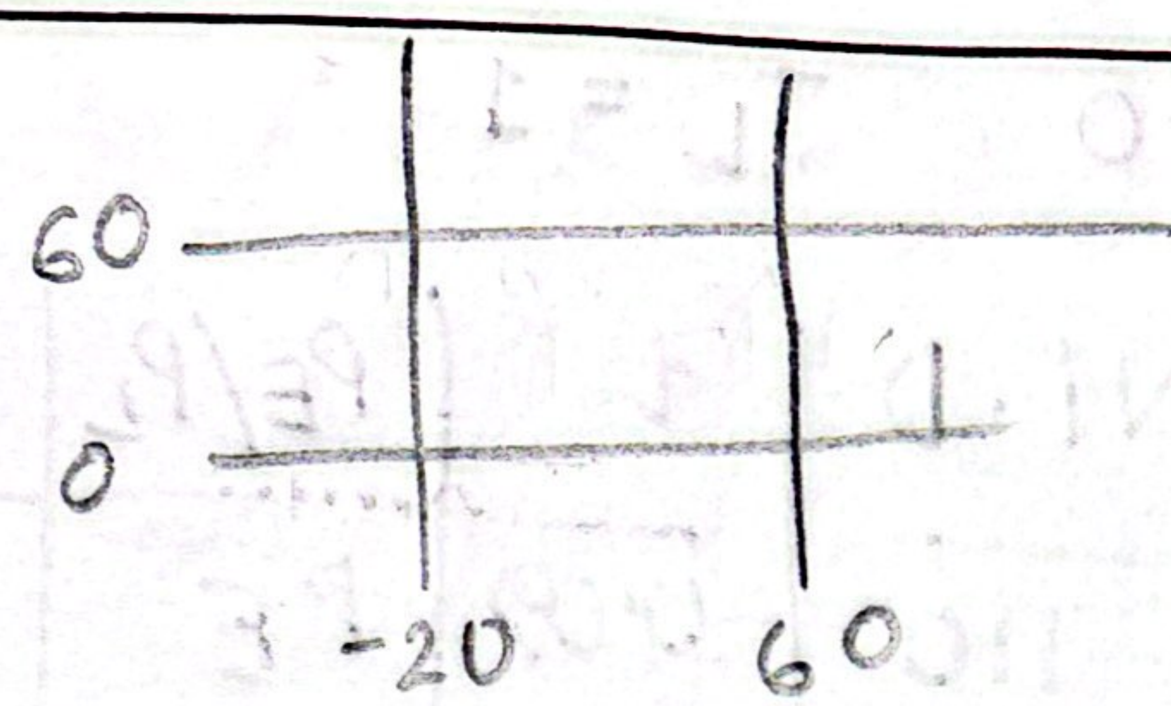
Half " $= 40$ Half " $= 30$

$x_{min} = -20$ $y_{min} = 0$

$x_{max} = 60$ $y_{max} = 60$

$x_0 = -10$ $y_0 = 60$

$x_1 = 100$ $y_1 = 10$



$P_1 = 0000$
$P_2 = 0010$

$$\begin{array}{r} 0000 \\ 0010 \\ \hline 0000 \end{array} \rightarrow \text{partially inside}$$

$P_2 ! = 0000$

$x_1 = x_{max} = 60$

$y - y_1 = m(x - x_1) \Rightarrow y_1 = y - m(x_0 - x_1)$
$= 60 - \left(\frac{-50}{110}\right)(-10 - 60)$
$= 28.18$

$P_1 = 0000$ $\rightarrow$ inside
$P_2 = 0000$
visible part $(-10, 60)$ to $(60, 28.18)$

c) $x_{min} = -20$ $y_{min} = 0$
$x_{max} = 60$ $y_{max} = 60$

$x_0 = -10$ $y_0 = 60$
$x_1 = 100$ $y_1 = 10$

$D = (110, -50)$

Right $= \frac{-(x_0 - x_{max})}{(x_1 - x_0)} = 0.63$

Left $= \frac{-(x_0 - x_{min})}{(x_1 - x_0)} = -0.09$

Top $= 0$

Bottom $\frac{-(y_0 - y_{min})}{(y_1 - y_0)} = 1.2$

Initially $T_E = 0$ $T_L = 1$

Boundary	Ni	Ni·D	t	P_E/P_L	t_E	t_L
Left	(-1,0)	-110	-0.09	P_E	0	1
Right	(1,0)	110	0.63	P_L	0	0.63
Bottom	(0,-1)	50	1.2	P_L	0	0.63
Top	(0, 1)	-50	0	P_E	0	0.63

$t_E < t_L$

P(0) and P(0.63) are true clip intersection

$P(0) = (x_0, y_0) + 0 \times D$

$= (-10, 60)$

$P(0.63) = (-10, 60) + 0.63\,(110, -50)$

$= (59.3\ ,\ 28.5)$

So, same clipped sagment as Cohen-Sutherland.

d) Cyrus-Beck assumes a convex clip polygon and returns a single contiguous $[t_E, t_L]$ interval; for concave clip regions a line may intersect multiple disjoint parts and cyrus Beck can discard segments incorrectly. Cohen Sutherland is tailored to rectangular regions and uses outcodes. both require extra handling to handle concave clipping correctly.