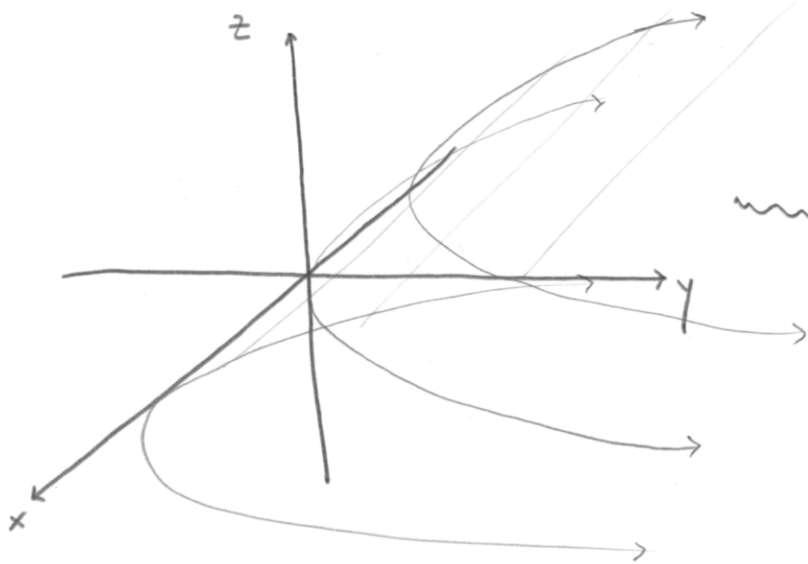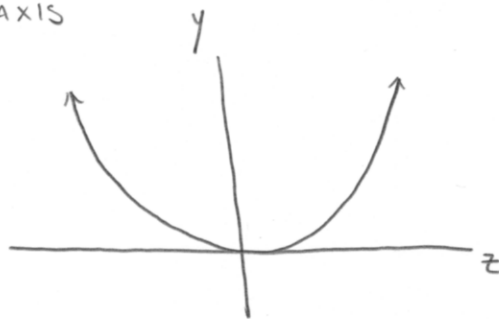4. $4x^2 + y^2 = 4$ — CYLINDER WITH RULINGS $\parallel$ TO Z-AXIS

{ CROSS SECTIONS IN PLANE $z = k$ ARE ELLIPSES: $x^2 + \dfrac{y^2}{2^2} = 1$
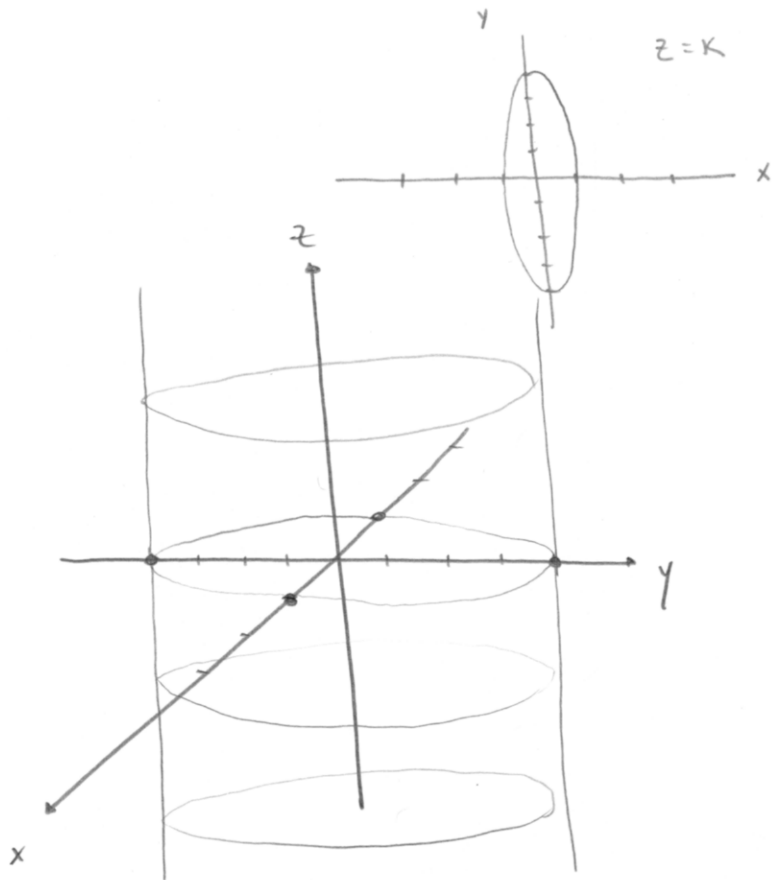
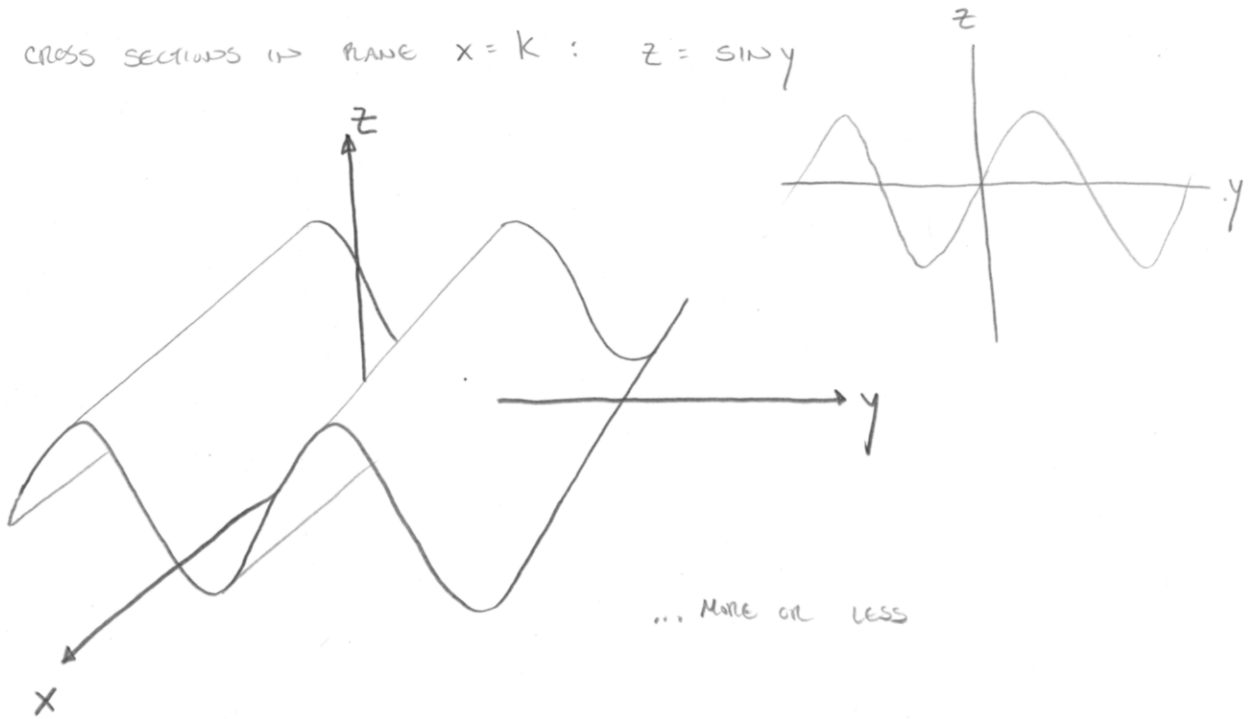6. $y = z^2$ — CYLINDER WITH RULINGS $\parallel$ TO X-AXIS

CROSS SECTIONS IN PLANE $x = k$: PARABOLAS

MORE LIKE THAT :'

8. $z = \sin y$ — CYLINDER WITH RULINGS $\parallel$ TO X-AXIS

CROSS SECTIONS IN PLANE $x = k$: $z = \sin y$

... MORE OR LESS

9. (a) $z = k$: $x^2 + y^2 = 1 + k^2$: CIRCLE OF RADIUS $\sqrt{1 + k^2}$

   $y = k$: $x^2 - z^2 = 1 - k^2$: HYPERBOLA

   $x = k$: $y^2 - z^2 = 1 - k^2$: HYPERBOLA

(b) THE ROLE OF y & z ARE REVERSED, SO NEW EQ DESCRIBES SAME SHAPE, BUT "ON ITS SIDE", WITH HYPERBOLOID 'OPENING UP" ALONG Y-AXIS.
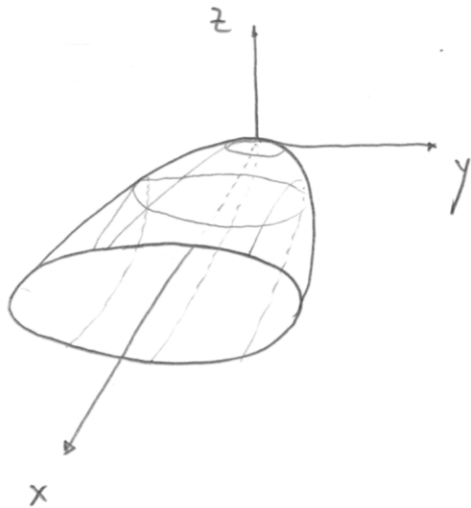
(c) → $x^2 + (y + 1)^2 - z^2 = 1$

   ↑

   SHIFTED 1 UNIT IN NEG. Y-AXIS DIRECTION.

11. $x = k:$ $y^2 + 4z^2 = k$: ELLIPSE , $k \geq 0$

     $y = k:$ $x = 4z^2 + k^2$: PARABOLA , $x \geq 0$

     $z = k:$ $x = y^2 + 4k^2$: PARABOLA , $x \geq 0$

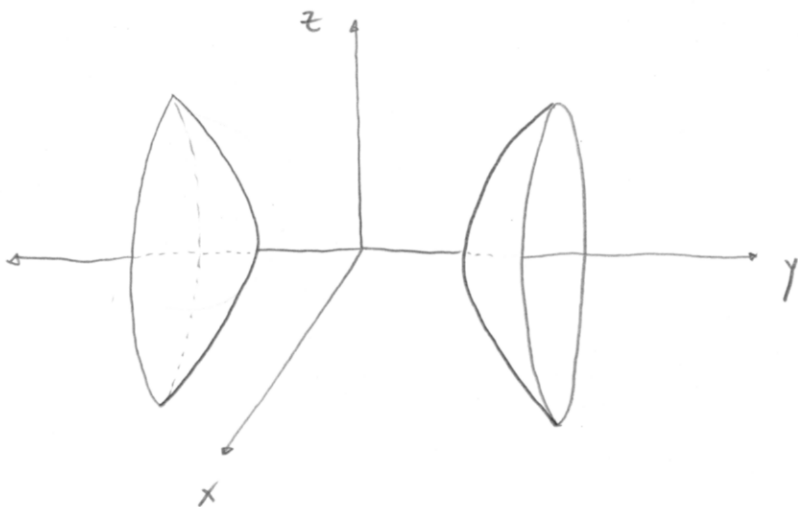ELLIPTIC PARABOLOID

15. $-x^2 + 4y^2 - z^2 = 4$

     $x = k:$ $4y^2 - z^2 = 4 + k^2$: HYPERBOLA

     $y = k:$ $x^2 + z^2 = 4k^2 - 4$: CIRCLE , $|k| \geq 2$
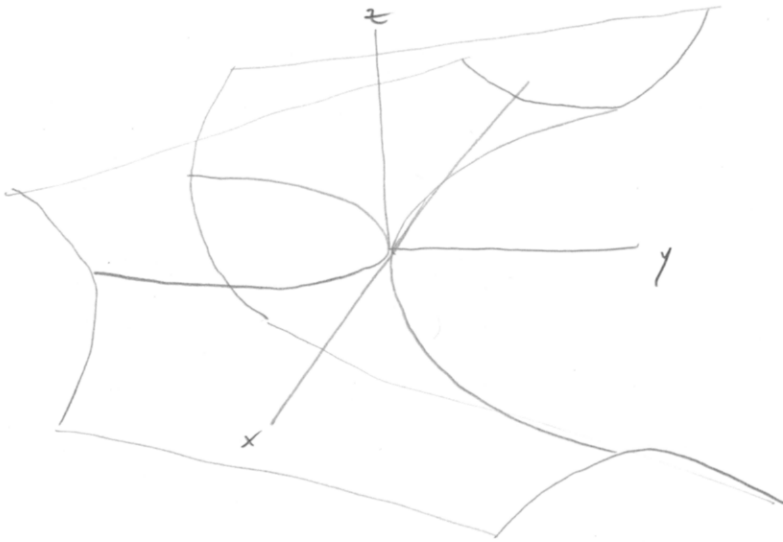
     $z = k:$ $4y^2 - x^2 = 4 + k^2$: HYPERBOLA

HYPERBOLOID OF 2 SHEETS

19. $y = z^2 - x^2$

$x = k :$ $\quad y = z^2 - k$ $\quad :$ PARABOLA $\cup$

$y = k :$ $\quad z^2 - x^2 = k$ $\quad :$ HYPERBOLA $)($

$z = k :$ $\quad y = -x^2 + k^2$ $\quad :$ PARABOLA $\cap$

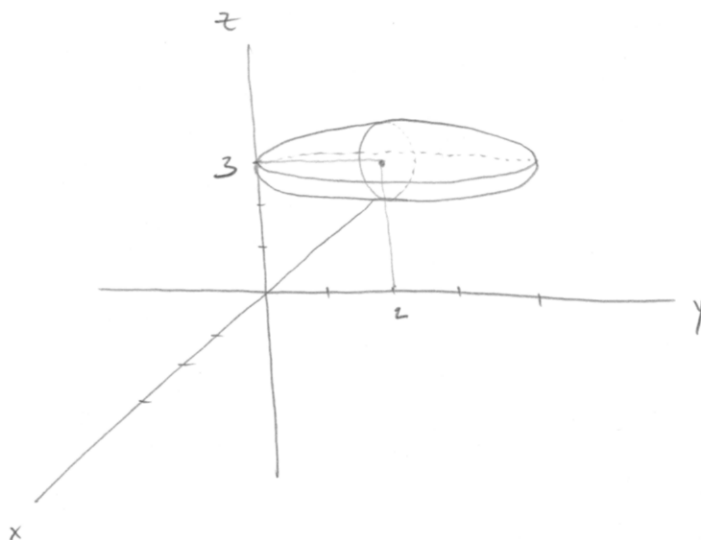HYPERBOLIC PARABOLOID

(HARD TO DRAW !!)

25. $4x^2 + y^2 + 4z^2 - 4y - 24z + 36 = 0$

$4x^2 + (y-2)^2 + 4(z-3)^2 = 4$

$x^2 + \dfrac{(y-2)^2}{4} + (z-3)^2 = 1$
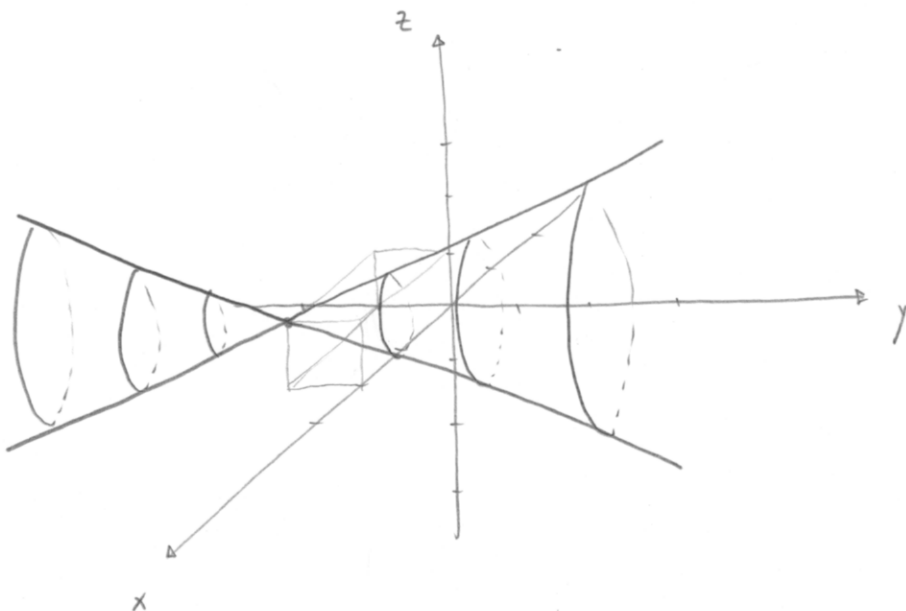
ELLIPSOID WITH CENTER
$(0, 2, 3)$

27. $x^2 - y^2 + z^2 - 4x - 2y - 2z + 4 = 0$

$(x-2)^2 - (y+1)^2 + (z-1)^2 = 0$

CIRCULAR
^ CONE LIKE $\quad y^2 = x^2 + z^2$

BUT WITH CENTER $(2, -1, 1)$

31. DISTANCE FROM PNT $\langle x, y, z \rangle$ TO POINT $(-1, 0, 0)$

$$d_{PNT} = \sqrt{(x+1)^2 + y^2 + z^2}$$

DISTANCE FROM PNT $\langle x, y, z \rangle$ TO PLANE $x = 1$

$$d_{PLANE} = |x - 1| = \sqrt{(x-1)^2}$$

$\Rightarrow d_{PNT} = d_{PLANE}$: $\underbrace{\sqrt{(x+1)^2 + y^2 + z^2}}_{NON-NEG.} = \underbrace{\sqrt{(x-1)^2}}_{NON-NEG.}$

$\Rightarrow (x+1)^2 + y^2 + z^2 = (x-1)^2$

$x^2 + 2x + 1 + y^2 + z^2 = x^2 - 2x + 1$

$y^2 + z^2 = -4x$ $\boxed{\text{ELLIPTIC PARABOLOID}}$

32.

DISTANCE FROM $P\langle x, y, z\rangle$ TO X-AXIS

$$d_x = \sqrt{y^2 + z^2}$$

DISTANCE FROM $P\langle x, y, z\rangle$ TO YZ-PLANE

$$d_{yz} = |x| = \sqrt{x^2}$$

$$\therefore \quad \underbrace{\sqrt{y^2 + z^2}}_{\text{NON-NEG}} = 2\underbrace{\sqrt{x^2}}_{\text{NON-NEG}}$$

$$\rightarrow \quad y^2 + z^2 = 4x^2 \qquad \boxed{\text{CONE}}$$