Obj. Space Coord. System 21-1

Local Cartesian System $\begin{pmatrix} e \\ n \\ u \end{pmatrix}$

Map projection Coordinates $\begin{pmatrix} E \\ N \\ H \end{pmatrix}$

E, N cartesian

H : curved datum surface

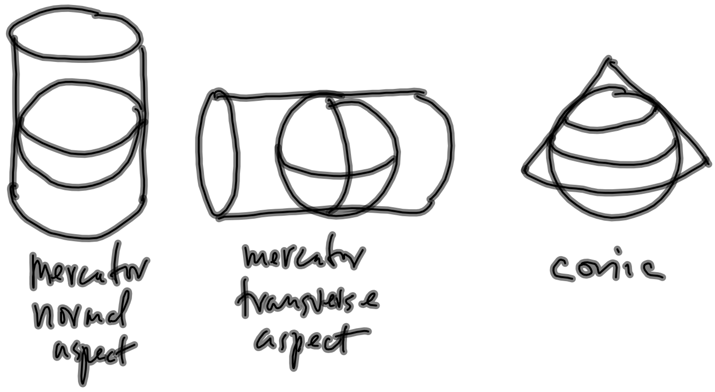
3D not cartesian.

Mercator, Transverse Mercator, Oblique Mercator

Lambert conic, stereographic — conformal

Mar 26-4:25 PM

21-2



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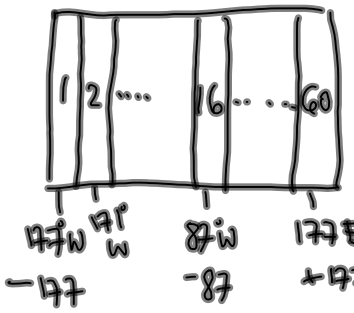
UTM: universal transverse mercator

21-3



60 zones
each one 6° width

FE 500,000 m

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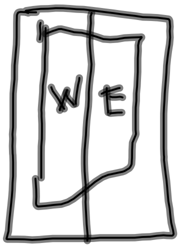
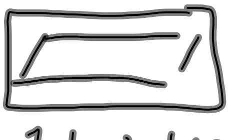
SPC: state plane coord. system

21-4



2 T.M. zones



1 Lambert conic zone

<u>units</u>: meter

foot { US Survey foot / Int'l foot

U.S. Survey Foot
39.37 in/meter
(exact)

Int'l Foot
.3048 m/foot
2.54 cm/inch (exact)

Mar 26-4:25 PM

21-5

s.f. $\frac{1\,m}{39.37\,in} \times \frac{12\,in}{ft} = .304800609601$

i.f. $.3048$

$1/1.6$ million

NAD83 : 31 states with legislation SPCS

11 : us survey foot

6 : int'l foot

14 : meter

units

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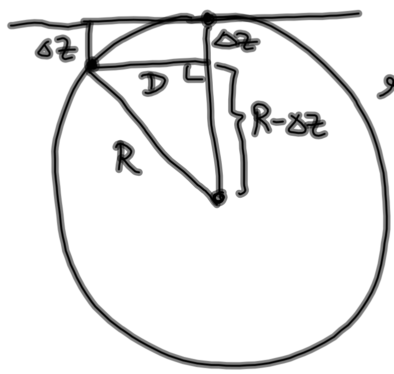
how to adjust H to approximate a Cartesian system

21-6



$R^2 = D^2 + (R - \Delta z)^2$

$R^2 = D^2 + R^2 + \Delta z^2 - 2R\Delta z$

$0 = D^2 + \underbrace{\Delta z^2}_{\approx 0} - 2R\Delta z$

$D^2 = 2R\Delta z$

$\boxed{\Delta z = \frac{D^2}{2R}}$

$R_m = \frac{2a+b}{3} = 6371009.$

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correct H coordinate by substracting Δz from H

21-7

$$H' = H - \Delta z$$

in photogrammetry use $\begin{pmatrix} E \\ N \\ H' \end{pmatrix}$

D (m)	Δz (m)
10	0
100	.0008
500	.02
1000	.08
5000	1.9
10 000	7.8

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Estimation

21-8

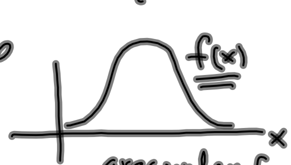
obs → parameters

Error Propagation

result of LS — variance / std. deviation } of parameter

RV random variable

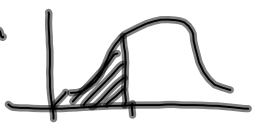
prob. density function



area under fn = 1

cumulative distr. function

F(x)



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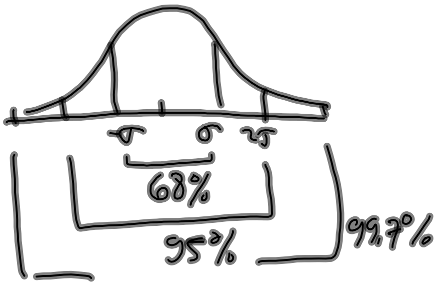
$X, \underline{\underline{\mu}} = E\{x\}$ $\quad E(x) = \int_{-\infty}^{\infty} x \cdot f(x)\,dx$ 21-9

$\sigma^2 = E\{(x-\mu)^2\}$ — variance ✓

$\sigma = \sqrt{\sigma^2}$ — std. deviation



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$\sigma_{xy} = E\{(x-\mu_x)(y-\mu_y)\}$ ← ✓ 21-10

correlation coefficient: $\dfrac{\sigma_{12}}{\sigma_1\sigma_2}$: $-1 \to +1$

R Variable → Random Vector

$$\vec{X} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} \qquad E\{x_1\} = \mu_1, \ \ldots, \ E\{x_n\} = \mu_n \qquad \vec{\mu} = \begin{bmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \mu_n \end{bmatrix}$$

Mar 26-4:25 PM

21-11

$$E\{(\vec{x}-\vec{\mu})(\vec{x}-\vec{\mu})^T\} = \text{covariance matrix } X$$

$$E\left\{\begin{bmatrix} x_1-\mu_1 \\ x_2-\mu_2 \\ \vdots \\ x_n-\mu_n \end{bmatrix}\begin{bmatrix} x_1-\mu_1 & x_2-\mu_2 & \cdots & x_n-\mu_n \end{bmatrix}\right\}$$

$$\Sigma = \begin{bmatrix} E\{(x_1-\mu_1)(x_1-\mu_1)\} & E(x_1-\mu_1)(x_2-\mu_2) & \cdots & E\{(x_1-\mu_1)(x_n-\mu_n)\} \\ E\{(x_2-\mu_2)(x_1-\mu_1)\} & E(x_2-\mu_2)(x_2-\mu_2) & & \\ \vdots & & & \\ E\{(x_n-\mu_n)(x_1-\mu_1)\} & E\{(x_n-\mu_n)(x_2-\mu_2)\} & & E(x_n-\mu_n)(x_n-\mu_n) \end{bmatrix}$$

$n \times n$

Mar 26-4:25 PM

21-12

$$\Sigma = \begin{bmatrix} \sigma^2_{x_1} & \sigma_{x_1x_2} & \cdots & \sigma_{x_1x_n} \\ \sigma_{x_2x_1} & \sigma^2_{x_2} & & \\ \vdots & & \ddots & \\ \sigma_{x_nx_1} & \cdots\cdots & & \sigma^2_{x_n} \end{bmatrix} \text{ symmetric}$$

Σ_x

$\underline{\underline{\Sigma_{xx}}}$

covariance matrix, variance/covariance matrix

$\vec{y} = A\vec{x}$ know Σ_{xx}

$$\boxed{\Sigma_{yy} = A\Sigma_{xx}A^T}$$

Mar 26-4:25 PM