1.2 MÄTFEL

$$M \pm m \; [x]$$

M = MÄTVÄRDE
m = OSÄKERHET/FEL
X = ENHET

TENT
ONS 27.10
KL 13-17
EXACTUM
B123

1.3 FELKÄLLOR

- SYSTEMATISKA FEL
- STATISTISKA FEL (SLUMPFEL)

PRECISION
NOGGRANNHET

1.7 ANALYS AV MÄTDATA

MÄTSERIE: $[X_1, X_2, X_3, \ldots, X_N]$

MEDELVÄRDE: $\bar{X} (= \mu) = \frac{1}{N} \sum_{i=1}^{N} X_i$

VARIANS: $s^2 = \frac{1}{(N-1)} \sum_{i=1}^{N} (X_i - \bar{X})^2$ FÖR ETT SAMPEL

STANDARD AVVIKELSE $\sigma^2 = \frac{1}{N} \sum_{i=1}^{N} (X_i - \bar{X})^2$ DÅ $N \to \infty$

MEDELVÄRDETS MEDELFEL $s_m^2 = \frac{s^2}{N} = \frac{1}{N(N-1)} \sum_{i=1}^{N} (X_i - \bar{X})^2$

HISTOGRAM → DISTRIBUTION

SANNOLIKHETS DISTRIBUTION ~~P(X, ...)~~

$P(X)$ SANNOLIKHETEN FÖR ETT MÄTVÄRDE $[X, X+\Delta X]$

MEDELVÄRDE μ STD. AVVIKELSE σ

$$\sigma^2 = \frac{1}{N} \sum (x-\mu)^2 = \frac{1}{N} \sum (x^2 - 2x\mu + \mu^2)$$

$$= \frac{1}{N} \sum x^2 - \frac{1}{N} \sum (2x\mu - \mu^2)$$

$$= \frac{1}{N} \sum x^2 - \frac{1}{N} \mu \Big[\underbrace{\sum 2x}_{2\mu N} - \sum \mu \Big]$$

$$- \frac{2\mu^2 \cancel{N}}{\cancel{N}} + \frac{1}{\cancel{N}} \cancel{N} \mu^2 = \frac{1}{N} \sum x^2 - \mu^2$$

$\cancel{\sum 2\mu N} - \mu$

$\frac{1}{N} \cancel{\mu \sum \mu (2N - 1)}$

1.7 DISTRIBUTION $P(X)$

$\cancel{n(x)} = N P(X) \qquad \sum n(x) = N \qquad \sum P(x)\Delta X = 1$

1.8 OLIKA DISTRIBUTIONER

BINOMIAL DISTRIBUTIONEN

$$P_B(X, n, P) = \frac{n!}{X!\,(n-X)!}\, P^X (1-P)^{(n-X)}$$

n ST EXP.
X ST ~~[illegible]~~
P SANNOLIKHETEN FÖR X
I ETT EXP.

$$= \binom{n}{X} P^X (1-P)^{(n-X)}$$

$P_B(X, n, P)$ = SL FÖR X ANTAL UTFALL MED SL P DÅ MAN UTFÖR n EXPERIMENT

POISSON DISTRIBUTION

$$P_P(X, \mu) = \frac{\mu^X}{X!} e^{-\mu}$$

BINOMIAL DISTRIB. $\longrightarrow$ POISSON DÅ $n \to \infty$
OCH P 'LITEN'
DVS. $\mu = nP$ ÄR LITEN

GAUSSISK DISTRIBUTION / NORMALDISTRIB.

$$P_G(x, \mu, \sigma) = \frac{1}{\sigma\sqrt{2\pi}} \,\mathrm{EXP}\left[-\frac{(x-\mu)^2}{2\sigma^2}\right]$$

OFTA ANVÄND.

1.9

$$P_B(x,n,p) = \frac{n!}{x!(n-x!)} p^x (1-p)^x$$

$$\frac{n!}{(n-x)!} = \frac{(1\cdot 2\cdot 3\cdot 4\cdot \ldots \cdot n)}{(1\cdot 2\cdot 3\cdot 4\cdot \ldots\ n-x)} = (n-x+1)(n-x+2)\ldots(n-1)\cdot n \rightarrow n^x$$

$$(1-p)^{(n-x)} \rightarrow (1-p)^n$$

$$= \left(1 - \frac{1}{1/p}\right)^{\frac{1}{p} n p} = \left(\frac{1}{e}\right)^{np} = e^{-np}$$

$$\Rightarrow \quad P_p(x,\mu) = \frac{n_p^x e^{-np}}{x!} = \frac{\mu^x e^{-\mu}}{x!}$$

1.9 MEDELVÄRDE OCH VARIANS FÖR P_B, P_P, P_G

P_B: $\quad \mu = np$

$\quad \sigma^2 = np(1-p)$

P_P: $\quad \mu = np$

$\quad \sigma^2 = p = \mu \Rightarrow \sigma = \sqrt{\mu}$

$\Rightarrow$ I EXPERIMENT DÄR P_P KAN ANVÄNDAS ~~KAN SVAR GES SOM~~ ~~$\mu \pm \sigma = \mu \pm \sqrt{\mu}$~~

BLIR

RELATIVA FELET $\frac{\sigma}{\mu} = \frac{\sqrt{\mu}}{\mu}$

$$= \frac{1}{\sqrt{\mu}} \propto \frac{1}{\sqrt{n}} \quad (\mu = np)$$

(1)

1.9 PG

68% AV MÄTVÄRDEN INOM $[\mu-\sigma, \mu+\sigma]$
95% INOM $[\mu-2\sigma, \mu+2\sigma]$
99.5% INOM $[\mu-3\sigma, \mu+3\sigma]$

FWHM $= 2.35\sigma$

50% INOM $[\mu-0{,}675\sigma, \mu+0{,}675\sigma]$
"MOST PROBABLE VALUE"

1.10 FELPROPAGERING

SLUTRESULTATET U BEROR PÅ MÄTTA VÄRDEN $x, y, z, \ldots$ $\quad U = f(x, y, z, \ldots)$

TAYLOR SERIE: $f(x) = f(a) + \frac{f'(a)}{1!}(x-a) + \frac{f''(a)}{2!}(x-a) + \ldots$

$$= \sum \frac{f^{(n)}(a)}{n!}(x-a)^2$$

$$\sigma_u^2 = \frac{1}{N}\sum (u_i - \overline{U})^2$$
$$= \frac{1}{N}\sum \left[\frac{\partial u}{\partial x}(x-\overline{x}) + \frac{\partial u}{\partial y}(y-\overline{y}) + \ldots\right]^2$$
$$\Rightarrow \quad (x-\overline{x})^2\left(\frac{\partial U}{\partial x}\right)^2 = \sigma_x^2\left(\frac{\partial u}{\partial x}\right)^2$$
$$\left\{ 2(x-\overline{x})(y-\overline{y})\frac{\partial u}{\partial x}\frac{\partial U}{\partial y} \right\} \text{ COVARIANS}$$
$$\Rightarrow \quad \sigma_u^2 = \sigma_x^2\left(\frac{\partial u}{\partial x}\right)^2 + \sigma_y^2\left(\frac{\partial u}{\partial y}\right)^2 + \ldots$$

1.11 DATA ANALYS

MINSTA KVADRAT METODEN

3 GIVARE

TEMP. OLIKA OMRÅDEN

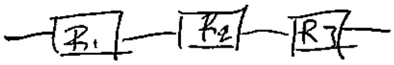
METALLER
TERMISTOR
TERMOPAR

(3) ELEKTRONIK/FILTER

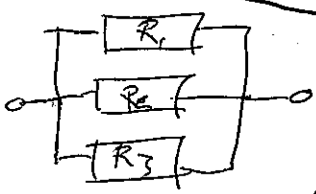
KIRCHOFF I + II

TENT
MÅ 27.10
KL 16–1

$U = RI \qquad P = UI$



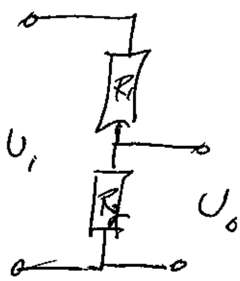
$R_{TOT} = R_1 + R_2 + R_3$



$\frac{1}{R_{TOT}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$R_{TOT} = R_1 \parallel R_2 \parallel R_3$

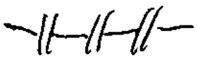
SPÄNNINGSDELN.



DECIBEL

$20 \log \frac{A_1}{A_2} = 10 \log \frac{P_1}{P_2} \quad [dB]$

SPÄNNINGS/STRÖMKÄLLA
IN/UTG IMPEDANS



$Q = CU \quad \Rightarrow \quad I = \frac{dQ}{dt} = C \frac{dU}{dt}$ (s. 18)

$U(t) = L \frac{di}{dt}$

$Z_C = \frac{1}{j\omega C} \qquad Z_L = j\omega L$

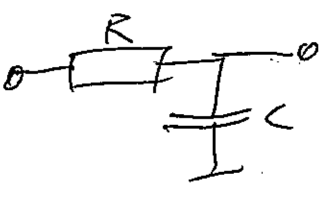
$e^{j\omega t} = \cos(\omega t) + j \sin(\omega t)$

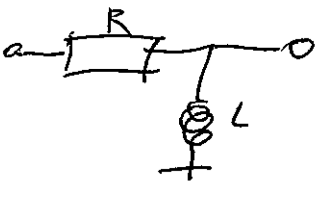
1.14 INTEGR. (26)

DERIV.

$\tau = \frac{1}{RC}$

HI/LO FILTER





$f_{-3dB} = \frac{1}{2\pi RC}$

BODE-PLOT

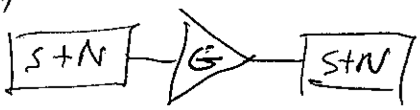
-3dB

$\boxed{2.16\ SM}$

LP
HP
BP
B-STOP

(6)

s24



GIVARE

s 26

LINEARIZATION s27

EGENSKAPER

NOGGRANNHET
RESOLUTION
REPEATAB. / REPRODUCIB.

HYSTERESIS
LINEARITY % OF FULL SCALE

SENSITIVITY
CALIBRATION
NOISE (INTRINSIC, EXTERNAL)
RESPONSE TIME
DEAD TIME (GEIGER)
RISE TIME (10% → 90%)
SETTLING TIME

FIGURES

MODELL FOR GIVARE s 32

(COAX)

RC-FILTERS
DECIBEL

TWO-TERMINAL
FOUR-TERMINAL
BRIDGE