

ข้อ 1: กำหนดหา  $\lambda$  ที่ทำให้ Threshold มี minimum error

เราเห็น  $\lambda$  นี้ **optimum threshold** ให้เขียนว่า  $\lambda_{opt}$

ใช้ **Leibnitz's rule** เพื่อหา  $\lambda_{opt}$

มี  $\int_{a(u)}^{b(u)} f(z, u) dz$  และ ทน (4.29)

$$\text{erfc}(u) = \frac{2}{\sqrt{\pi}} \int_u^{\infty} \exp(-z^2) dz$$

ให้  $a(u) = u$ ,  $b(u) = \infty$  และ  $f(z, u) = \frac{2}{\sqrt{\pi}} \exp(-z^2)$

และ เรายัง

$$\begin{aligned} \frac{d}{du} \text{erfc}(u) &= \frac{d}{du} \int_{a(u)}^{b(u)} f(z, u) dz \\ &\stackrel{\text{Leibnitz's rule}}{=} -\frac{1}{\sqrt{\pi}} \exp(-u^2) \end{aligned} \quad (4.36)$$

ท (4.35)

$$P_e = P_0 P_{10} + P_1 P_{01}$$

$$= \frac{P_0}{2} \text{erfc}\left(\frac{A+\lambda}{\sqrt{N_0/T_b}}\right) + \frac{P_1}{2} \text{erfc}\left(\frac{A-\lambda}{\sqrt{N_0/T_b}}\right) \quad (4.35)$$

diff. (4.35) តើសូល  $\lambda$  គឺជា 1 ឬ 0 ឬ 1/2 ឬ 1/4 ឬ 1/8 ឬ 1/16 ឬ 1/32 ឬ 1/64 ឬ 1/128 ឬ 1/256 ឬ 1/512 ឬ 1/1024 ឬ 1/2048 ឬ 1/4096 ឬ 1/8192 ឬ 1/16384 ឬ 1/32768 ឬ 1/65536 ឬ 1/131072 ឬ 1/262144 ឬ 1/524288 ឬ 1/1048576 ឬ 1/2097152 ឬ 1/4194304 ឬ 1/8388608 ឬ 1/16777216 ឬ 1/33554432 ឬ 1/67108864 ឬ 1/134217728 ឬ 1/268435456 ឬ 1/536870912 ឬ 1/1073741824 ឬ 1/2147483648 ឬ 1/4294967296 ឬ 1/8589934592 ឬ 1/17179869184 ឬ 1/34359738368 ឬ 1/68719476736 ឬ 1/137438953472 ឬ 1/274877906944 ឬ 1/549755813888 ឬ 1/1099511627776 ឬ 1/2199023255552 ឬ 1/4398046511104 ឬ 1/8796093022208 ឬ 1/17592186044416 ឬ 1/35184372088832 ឬ 1/70368744177664 ឬ 1/140737488355328 ឬ 1/281474976710656 ឬ 1/562949953421312 ឬ 1/1125899906842624 ឬ 1/2251799813685248 ឬ 1/4503599627370496 ឬ 1/9007199254740992 ឬ 1/18014398509481984 ឬ 1/36028797018963968 ឬ 1/72057594037927936 ឬ 1/144115188075855872 ឬ 1/288230376151711744 ឬ 1/576460752303423488 ឬ 1/1152921504606846976 ឬ 1/2305843009213693952 ឬ 1/4611686018427387904 ឬ 1/9223372036854775808 ឬ 1/18446744073709551616 ឬ 1/36893488147419103232 ឬ 1/73786976294838206464 ឬ 1/147573952589676412928 ឬ 1/295147905179352825856 ឬ 1/590295810358705651712 ឬ 1/1180591620717411303424 ឬ 1/2361183241434822606848 ឬ 1/4722366482869645213696 ឬ 1/9444732965739290427392 ឬ 1/18889465931478580854784 ឬ 1/37778931862957161709568 ឬ 1/75557863725914323419136 ឬ 1/151115727451828646838272 ឬ 1/302231454903657293676544 ឬ 1/604462909807314587353088 ឬ 1/1208925819614629174706176 ឬ 1/2417851639229258349412352 ឬ 1/4835703278458516698824704 ឬ 1/9671406556917033397649408 ឬ 1/19342813113834066795298816 ឬ 1/38685626227668133590597632 ឬ 1/77371252455336267181195264 ឬ 1/154742504910672534362390528 ឬ 1/309485009821345068724781056 ឬ 1/618970019642690137449562112 ឬ 1/1237940039285380274899124224 ឬ 1/2475880078570760549798248448 ឬ 1/4951760157141521099596496896 ឬ 1/9903520314283042199192993792 ឬ 1/19807040628566084398385987584 ឬ 1/39614081257132168796771975168 ឬ 1/79228162514264337593543950336 ឬ 1/158456325028528675187087900672 ឬ 1/316912650057057350374175801344 ឬ 1/633825300114114700748351602688 ឬ 1/1267650600228229401496703205376 ឬ 1/2535301200456458802993406410752 ឬ 1/5070602400912917605986812821504 ឬ 1/10141204801825835211973625643008 ឬ 1/20282409603651670423947251286016 ឬ 1/40564819207303340847894502572032 ឬ 1/81129638414606681695789005144064 ឬ 1/162259276829213363391578010288128 ឬ 1/324518553658426726783156020576256 ឬ 1/649037107316853453566312041152512 ឬ 1/1298074214633706907132624082305024 ឬ 1/2596148429267413814265248164610048 ឬ 1/5192296858534827628530496329220096 ឬ 1/10384593717069655257060992658440192 ឬ 1/20769187434139310514121985316880384 ឬ 1/41538374868278621028243970633760768 ឬ 1/83076749736557242056487941267521536 ឬ 1/166153499473114484112975882535043072 ឬ 1/332306998946228968225951765070086144 ឬ 1/664613997892457936451903530140172288 ឬ 1/1329227995784915872903807060280344576 ឬ 1/2658455991569831745807614120560689152 ឬ 1/5316911983139663491615228241121378304 ឬ 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1/1809251394333065553493296640760748560207343510400633813116524750123642650624 ឬ 1/3618502788666131106986593281521497120414687020801267626233049500247285301248 ឬ 1/7237005577332262213973186563042994240829374041602535252466099000494570602496 ឬ 1/14474011154664524427946373126085988481658748083205070504932198000989141204992 ឬ 1/28948022309329048855892746252171976963317496166410141009864396001978282409984 ឬ 1/57896044618658097711785492504343953926634992332820282019728792003956564819968 ឬ 1/115792089237316195423570985008687907853269984665640564039457584007913129639936 ឬ 1/231584178474632390847141970017375815706539969331281128078915168015826259279872 ឬ 1/463168356949264781694283940034751631413079938662562256157830336031652518559744 ឬ 1/926336713898529563388567880069503262826159877325124512315660672063305037119488 ឬ 1/1852673427797059126777135760139006525652319754650249024631321344126610074238976 ឬ 1/3705346855594118253554271520278013051304639509300498049262642688253220148477952 ឬ 1/7410693711188236507108543040556026102609279018600996098525285376506440296955904 ឬ 1/14821387422376473014217086081112052205218558037201992197050570753012880593911808 ឬ 1/29642774844752946028434172162224104410437116074403984394101141506025761187823616 ឬ 1/59285549689505892056868344324448208820874232148807968788202283012051522

ឧបសគ្គ **transmitted signal energy per bit** គឺ

$$E_b = A^2 T_b \quad (4.39)$$

ជំនួស (4.38)

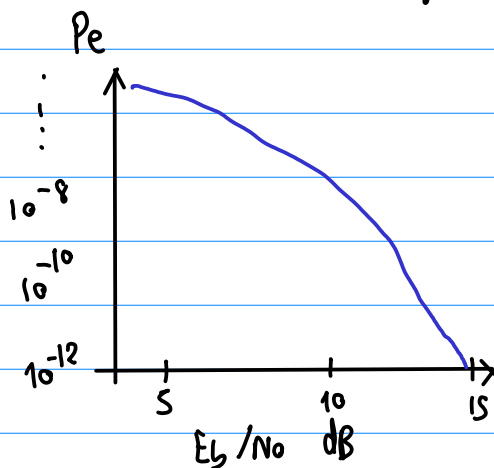
$$P_e = \frac{1}{2} \operatorname{erfc} \left( \sqrt{\frac{E_b}{N_0}} \right) \quad (4.40)$$

ក្រាប

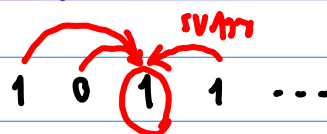
ប្រើប្រាស់រូបមន្ត (4.40) យើងអាច គណនាប្រសិទ្ធភាពប្រព័ន្ធគ្រប់ប្រភេទ (4.39)

ឯង

$$P_e < \frac{\exp(-E_b/N_0)}{2\sqrt{\pi E_b/N_0}} \quad (4.41)$$



#### 4.4 Intersymbol Interference : ISI



ឆ្លងកាត់ គឺ 1 ក្នុង ០ ⇒ error

ហេតុនេះ, ឆ្លងកាត់ ឬ ឧបករណ៍ (ideal channel) ៤៥ អនុញ្ញាតិ Matched  
 filter ដើម្បីកាត់បន្ថយ ISI ហេតុនេះ បង្កើនសមត្ថភាពប្រព័ន្ធគ្រប់គ្រង  
 ប្រព័ន្ធគ្រប់គ្រង ប្រព័ន្ធគ្រប់គ្រង ប្រព័ន្ធគ្រប់គ្រង ប្រព័ន្ធគ្រប់គ្រង

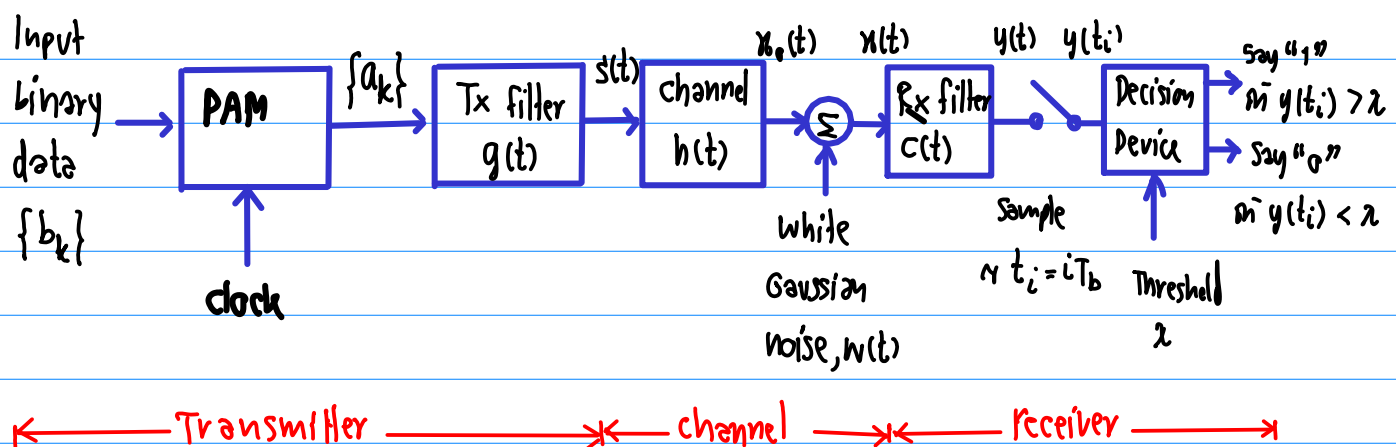
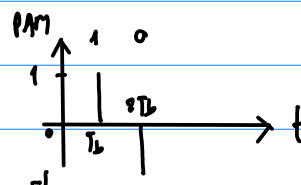


Fig: Baseband binary data Transmission System

ឯកសារ baseband binary PAM system ក្នុង incoming binary  
 sequence  $\{b_k\}$  ប្រើប្រាស់ symbols "1" ឬ "0" ក្នុងរយៈពេល  
 ពេលវេលា  $T_b$

Pulse-amplitude modulator (PAM) ប្រើប្រាស់ binary sequence

ឬ short pulse i.e.



input binary data နှို

$$a_k = \begin{cases} +1, & b_k = 1 \\ -1, & b_k = 0 \end{cases} \quad (4.92)$$

Transmit filter ၏ impulse response  $g(t)$  ၊ producing signal

$$s(t) = \sum_k a_k g(t - kT_b) \quad (4.93)$$

receive filter output :  $\tilde{u}$

$$y(t) = \mu \sum_k a_k p(t - kT_b) + n(t) \quad (4.94)$$

$\mu$  ၏ scaling factor ၏  $p(t)$  သတိပေးချက်

$$\mu p(t) = g(t) * h(t) * c(t) \quad (4.95)$$

$p(t)$  ၏ normalized ၏ ၏

$$p(0) = 1 \quad (4.96)$$

Fourier transform ၏ (4.95) ၏

$$\mu P(f) = G(f) H(f) C(f) \quad (4.97)$$

$w(t)$  ၏ white Gaussian noise ၏ mean ၀

receive filter output  $y(t)$  ၏  $t_i = iT_b$

โจทย์ (9.94) 10/4

$$y(t_i) = \mu \sum_{k=-\infty}^{\infty} a_k p[(i-k)T_b] + n(t_i)$$

$$= \underbrace{\mu a_i}_{\text{ค่าที่คาดหวังของ bit ที่ } i} + \underbrace{\sum_{\substack{k=-\infty \\ k \neq i}}^{\infty} a_k p[(i-k)T_b]}_{\text{ค่าที่คาดหวังของ bit อื่นๆ}} + \underbrace{n(t_i)}_{\text{noise}}$$

ค่าที่คาดหวัง  
ของ bit ที่ i

ค่าที่คาดหวังของ bit อื่นๆ

ในกรณีนี้จะมีค่า 0

ในกรณีนี้

$p(t)$  ที่ให้มา

