21 Jan 2020

* Latency vs rate. Which one is more important?

PSD and Bandwidth

How do you determine bw?

- Deterministic → Fourier Transform
- Random signal → PSD (similar to PDF)

An interpretation of PSD:

Let $X(t)$ be an ensemble of random signals:

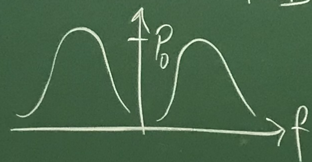
$$\{x_1(t), x_2(t), \dots, x_n(t)\}$$

with $Pr(x_i(t)) = P_i$ and $\sum_i P_i = 1$

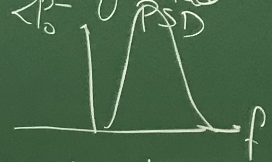
$$S_X(f) = \sum_i P_i |X_i(f)|^2$$

PSD: real, nonnegative, sym, $\int_{-\infty}^{\infty} S_x(f)\,df = P_{Total}$

double-sided PSD



single-sided PSD



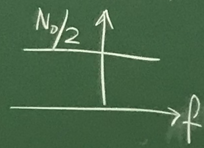
Ex: How much power does $X(t)$ have between 10MHz and 20MHz?

$$P_{10-20} \triangleq \int_{-20MHz}^{-10MHz} S_{x,DS}(f)\,df + \int_{10MHz}^{20MHz} S_{x,DS}(f)\,df$$

$$= \int_{10M}^{20M} \underbrace{2 S_{x,DS}(f)}_{S_{x,SS}(f)}\,df$$

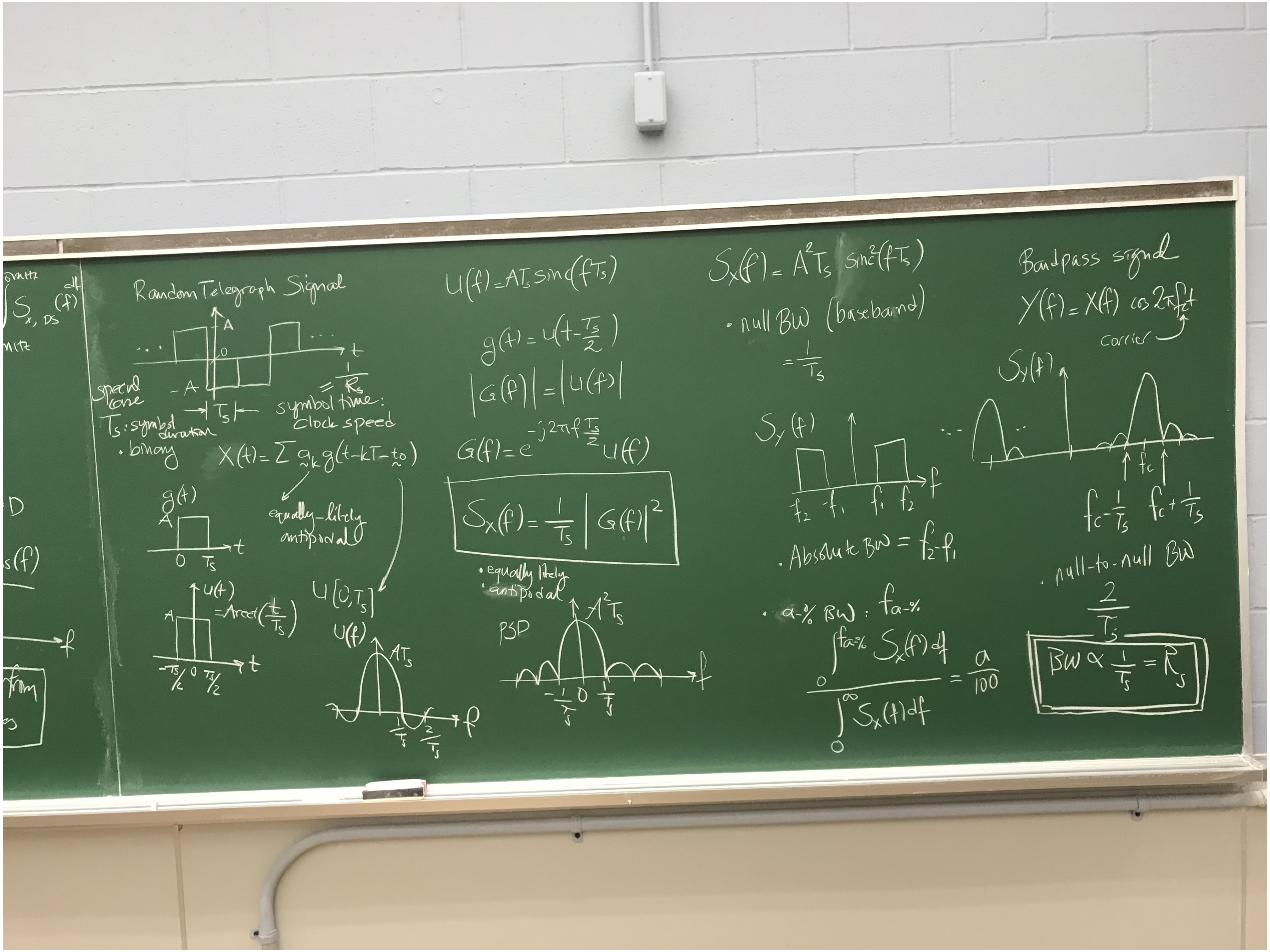
Ex: White noise PSD

$S_{w,DS}(f)$



$S_{w,SS}(f)$

BW determined only from +ve frequencies



Random Telegraph Signal
speed cone
Ts: symbol duration
symbol time: clock speed
= 1/Rs
• binary
X(t) = Σ ak g(t − kT − to)
equally likely antipodal
g(t)
u(t) = A rect(t/Ts)
U[0, Ts]
U(f)
ATs
U(f) = ATs sinc(fTs)
g(t) = u(t − Ts/2)
|G(f)| = |U(f)|
G(f) = e^(−j2πf Ts/2) U(f)
Sx(f) = 1/Ts |G(f)|²
• equally likely
• antipodal
PSD
A²Ts
Sx(f) = A²Ts sinc²(fTs)
• null BW (baseband)
= 1/Ts
Sy(f)
• Absolute BW = f2 − f1
• a-% BW : fa-%
∫0^fa-% Sx(f) df / ∫0^∞ Sx(f) df = a/100
Bandpass signal
Y(f) = X(f) cos 2πfct
carrier
Sy(f)
fc − 1/Ts
fc + 1/Ts
• null-to-null BW
2/Ts
BW ∝ 1/Ts = Rs