

# 1. EQUATIONS

## 1.1. Mathematical Expressions

Mathematical expressions such as equations, formulas, etc. should be typeset in accordance with the following rules:

- Mathematical symbols and expressions within the text should be written with the same font used in the equation or equation array environments in order to separate them from the regular text. Italic font is the typical choice.

### Good Example 1:

“Notice that the spectral efficiency of the system is  $R = n + m = \log_2(NM)$  bits per channel use (bpcu). At each transmission instant, each set of  $n + m$  bits is split into groups of  $n$  and  $m$  bits.” (Because the letters  $N$ ,  $M$ ,  $n$ , and  $m$  are used to denote some mathematical entities they are written in the math environment.)

- Mathematical expressions, equations and equation arrays should be part of the text and should not be treated as images or floating objects. This means that i) they should be placed with one line spacing between the preceding and following text, ii) if they finish the sentence they should be ended with a full stop (.), iii) if the sentence continues after the mathematical expression it should not have a paragraph indentation or it should not start with a capital letter.

**Good Example 2:** The received signal is expressed as

$$\mathbf{y} = \mathbf{H}\Psi\mathbf{x} + \boldsymbol{\nu}, \quad (1.1)$$

where  $\mathbf{H}$  is the  $N_r \times N_t$  dimensional channel matrix and  $\mathbf{y}$  and  $\boldsymbol{\nu}$  are the  $N_r \times 1$  dimensional received signal and channel noise vectors, respectively.

**Good Example 3:** The received signal is expressed as

$$\mathbf{y} = \mathbf{H}\Psi\mathbf{x} + \boldsymbol{\nu}. \quad (1.2)$$

In this expression,  $\mathbf{H}$  is the  $N_r \times N_t$  dimensional channel matrix and  $\mathbf{y}$  and  $\boldsymbol{\nu}$  are the  $N_r \times 1$  dimensional received signal and channel noise vectors, respectively.

**Good Example 4 (Equation Group):** Notice that under the signal model presented in the previous section,  $\mathbf{z}$  forms a zero-mean proper complex Gaussian random vector with the mean vector,  $\mathbf{m}_z$ , that can be written as

$$\begin{aligned} \mathbf{m}_z &= \mathbb{E}[\mathbf{z}] = \sqrt{\frac{\rho K}{K+1}} (\bar{\mathbf{h}}_u \psi_u X_v - \bar{\mathbf{h}}_{\hat{u}} \psi_{\hat{u}} X_{\hat{v}}) \\ &= \sqrt{\frac{\rho K}{K+1}} (\bar{\mathbf{h}}_u a_u X_v e^{j\theta_u} - \bar{\mathbf{h}}_{\hat{u}} a_{\hat{u}} X_{\hat{v}} e^{j\theta_{\hat{u}}}), \end{aligned} \quad (1.3)$$

and the covariance matrix,  $\boldsymbol{\Sigma}_z$ , that can be computed as

$$\boldsymbol{\Sigma}_z = \frac{\rho \gamma(u, \hat{u}, v, \hat{v}, \psi_u, \psi_{\hat{u}}) \boldsymbol{\Sigma}_r}{K+1}, \quad (1.4)$$

where  $\rho$  and  $\boldsymbol{\Sigma}_r$  are as defined before.

On the other hand, writing of mathematical expressions as in the following are examples of bad practice and is not advised.

**Bad Example 1:** (Extra space between the text and the mathematical expressions.)

The received signal is expressed as

$$\mathbf{y} = \mathbf{H}\Psi\mathbf{x} + \boldsymbol{\nu}, \quad (1.5)$$

where  $\mathbf{H}$  is the  $N_r \times N_t$  dimensional channel matrix and  $\mathbf{y}$  and  $\boldsymbol{\nu}$  are the  $N_r \times 1$  dimensional received signal and channel noise vectors, respectively.

**Bad Example 2:** (Paragraph indent and/or capital letter use after an equation)

despite the fact that the sentence is continued.)

The received signal is expressed as

$$\mathbf{y} = \mathbf{H}\Psi\mathbf{x} + \boldsymbol{\nu} \quad (1.6)$$

Where  $\mathbf{H}$  is the  $N_r \times N_t$  dimensional channel matrix and  $\mathbf{y}$  and  $\boldsymbol{\nu}$  are the  $N_r \times 1$  dimensional received signal and channel noise vectors, respectively.

**Bad Example 3:** (Equation appearing as a floating object instead being attached to a sentence.)

The received signal is expressed as follows:

$$\mathbf{y} = \mathbf{H}\Psi\mathbf{x} + \boldsymbol{\nu} \quad (1.7)$$

In this expression,  $\mathbf{H}$  is the  $N_r \times N_t$  dimensional channel matrix and  $\mathbf{y}$  and  $\boldsymbol{\nu}$  are the  $N_r \times 1$  dimensional received signal and channel noise vectors, respectively.

- Multiple equations or mathematical expressions should be written in an equation array environment. This guarantees the single line spacing between these expressions. In equation arrays, the individual lines should be aligned such that the first equality (or inequality or similarity) signs are in line with each other.

**Good Example 5:**

The SINR for the users in  $\hat{U}_1$ , the SNR for the users in  $U_2$  on each subcarrier  $n$  and the SNR for the remaining users in  $\tilde{U}_1$  on each subcarrier  $k$  can be written as

$$\Gamma_{\hat{U}_1}^{(n)} = \frac{P_n|h_n|^2}{P_{N+n}|h_{N+n}|^2 + \sigma^2} = \frac{P_t|g_n|^2}{\epsilon P_t|g_{N+n}|^2 + \sigma^2}, \quad (1.8)$$

$$\begin{aligned} \Gamma_{U_2}^{(n)} &= \frac{P_{N+n}|h_{N+n}|^2}{P_n|a_n - \hat{a}_n|^2|h_n|^2 + \sigma^2} \\ &= \frac{\epsilon P_t|g_{N+n}|^2}{P_t|a_n - \hat{a}_n|^2|g_n|^2 + \sigma^2}, \end{aligned} \quad (1.9)$$

$$\Gamma_{\hat{U}_1}^{(k)} = \frac{P_k|h_k|^2}{\sigma^2} = \frac{P_t|g_k|^2}{\sigma^2}, \quad (1.10)$$

respectively, where  $n \in \{1, \dots, M\}$ ,  $k \in \{M+1, \dots, N\}$ .

Try to avoid writing mathematical expression groups as given in the example below.

**Bad Example 4:**

The SINR for the users in  $\hat{U}_1$ , the SNR for the users in  $U_2$  on each subcarrier  $n$  and the SNR for the remaining users in  $\tilde{U}_1$  on each subcarrier  $k$  can be written as

$$\Gamma_{\hat{U}_1}^{(n)} = \frac{P_n|h_n|^2}{P_{N+n}|h_{N+n}|^2 + \sigma^2} = \frac{P_t|g_n|^2}{\epsilon P_t|g_{N+n}|^2 + \sigma^2} \quad (1.11)$$

$$\Gamma_{U_2}^{(n)} = \frac{P_{N+n}|h_{N+n}|^2}{P_n|a_n - \hat{a}_n|^2|h_n|^2 + \sigma^2} = \frac{\epsilon P_t|g_{N+n}|^2}{P_t|a_n - \hat{a}_n|^2|g_n|^2 + \sigma^2} \quad (1.12)$$

$$\Gamma_{\tilde{U}_1}^{(k)} = \frac{P_k|h_k|^2}{\sigma^2} = \frac{P_t|g_k|^2}{\sigma^2} \quad (1.13)$$

respectively, where  $n \in \{1, \dots, M\}$ ,  $k \in \{M+1, \dots, N\}$ .

- Mathematical expressions should be referred to after they appear first and not before. Try to avoid from forward referencing.

**Bad Example 5:**

The received signal is expressed as in Equation (1.14) given below:

$$\mathbf{y} = \mathbf{H}\Psi\mathbf{x} + \boldsymbol{\nu}. \quad (1.14)$$

$\mathbf{H}$  is the  $N_r \times N_t$  dimensional channel matrix and  $\mathbf{y}$  and  $\boldsymbol{\nu}$  are the  $N_r \times 1$  dimen-

sional received signal and channel noise vectors, respectively.

**Bad Example 6:**

The received signal is expressed as

$$\mathbf{y} = \mathbf{H}\Psi\mathbf{x} + \boldsymbol{\nu}. \quad (1.15)$$

In Equation (1.15),  $\mathbf{H}$  is the  $N_r \times N_t$  dimensional channel matrix and  $\mathbf{y}$  and  $\boldsymbol{\nu}$  are the  $N_r \times 1$  dimensional received signal and channel noise vectors, respectively.

This equation template should be followed strictly.