

# Reducing the numbers of delays and their affection to the numerical solution to coupled-DDAEs ??

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**Abstract:** In this short note we examine a newly proposed method, namely "reducing the number of delays in a network" for DDAEs, and study the effectiveness as well as drawbacks of this approach to the numerical solution procedure of DDAEs. Such networks can arise while a feedback controllers is applied to a multi-physical systems described by coupled subsystems, and each subsystem is described by a DAE. The time-delays are resulted from the fact that a controller requires some time to measure the state and to compute the feedback before applying it. We study the index of the network of coupled DAEs, and illustrate the effectiveness of a method while applying to a network of mechanical systems.

**Keywords:** Descriptor systems; delay; delay differential-algebraic equations; mechanical systems.

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## 1. INTRODUCTION

This document is a template for L<sup>A</sup>T<sub>E</sub>X 2<sub>&</sub>. If you are reading a paper or PDF version of this document, please download the electronic file **ifacconf.tex**. You will also need the class file **ifacconf.cls**. Both files are available on the IFAC web site.

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## 2. PROCEDURE FOR PAPER SUBMISSION

Next we see a few subsections.

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For submission guidelines, follow instructions on paper submission system as well as the event website.

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\* Sponsor and financial support acknowledgment goes here.

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### 2.2 Equations

Some words might be appropriate describing equation (1), if we had but time and space enough.

$$\frac{\partial F}{\partial t} = D \frac{\partial^2 F}{\partial x^2}. \quad (1)$$

See Able (1956), Able et al. (1954), Keohane (1958) and Powers (1985).

*Example.* This equation goes far beyond the celebrated theorem ascribed to the great Pythagoras by his followers.

*Theorem 1.* The square of the length of the hypotenuse of a right triangle equals the sum of the squares of the lengths of the other two sides.

**Proof.** The square of the length of the hypotenuse of a right triangle equals the sum of the squares of the lengths of the other two sides.

Of course L<sup>A</sup>T<sub>E</sub>X manages equations through built-in macros. You may wish to use the **amstex** package for enhanced math capabilities.

### 2.3 Figures

To insert figures, use the **graphicx** package. Although other graphics packages can also be used, **graphicx** is simpler to use. See Fig. 1 for an example.

Figures must be centered, and have a caption at the bottom.

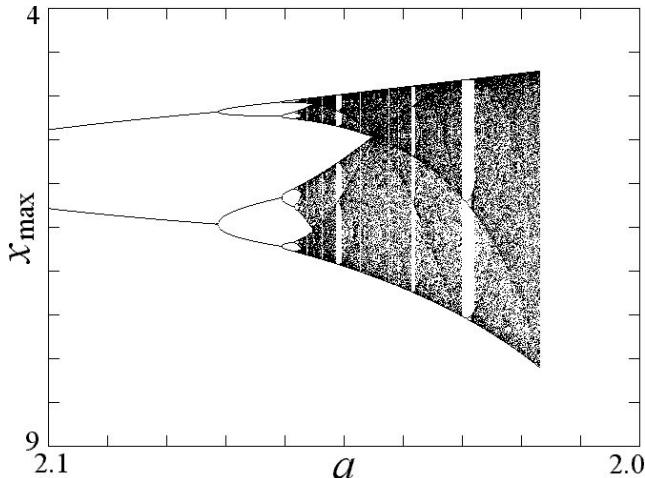


Fig. 1. Bifurcation: Plot of local maxima of  $x$  with damping  $a$  decreasing

#### 2.4 Tables

Tables must be centered and have a caption above them, numbered with Arabic numerals. See table 1 for an example.

Table 1. Margin settings

Page	Top	Bottom	Left/Right
First	3.5	2.5	1.5
Rest	2.5	2.5	1.5

#### 2.5 Final Stage

Authors are expected to mind the margins diligently. Papers need to be stamped with event data and paginated for inclusion in the proceedings. If your manuscript bleeds into margins, you will be required to resubmit and delay the proceedings preparation in the process.

*Page margins.* See table 1 for the page margins specification. All dimensions are in *centimeters*.

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*PDFLaTeX* is a special version of LaTeX by Han The Thanh which produces PDF output directly using Type-1 fonts instead of the standard *dvi* file. It accepts figures in JPEG, PNG, and PDF formats, but not PostScript. Encapsulated PostScript figures can be converted to PDF with the *epstopdf* tool or with Adobe Acrobat Distiller.

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- (1) Produce a *dvi* file by running *latex* twice.
- (2) Produce a PostScript (*ps*) file with *dvips*.
- (3) Produce a PDF file with *ps2pdf* or Adobe Acrobat Distiller.

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Use SI as primary units. Other units may be used as secondary units (in parentheses). This applies to papers in data storage. For example, write “15 Gb/cm<sup>2</sup> (100 Gb/in<sup>2</sup>)”. An exception is when English units are used as identifiers in trade, such as “3.5 in disk drive”. Avoid combining SI and other units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity in an equation. The SI unit for magnetic field strength **H** is A/m. However, if you wish to use units of T, either refer to magnetic flux density **B** or magnetic field strength symbolized as  $\mu_0 \mathbf{H}$ . Use the center dot to separate compound units, e.g., “A · m<sup>2</sup>”.

### 4. HELPFUL HINTS

#### 4.1 Figures and Tables

Figure axis labels are often a source of confusion. Use words rather than symbols. As an example, write the quantity “Magnetization”, or “Magnetization M”, not just “M”. Put units in parentheses. Do not label axes only with units. For example, write “Magnetization (A/m)” or “Magnetization (Am<sup>-1</sup>)”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K”.

Multipliers can be especially confusing. Write “Magnetization (kA/m)” or “Magnetization (10<sup>3</sup>A/m)”. Do not write “Magnetization (A/m) × 1000” because the reader would not know whether the axis label means 16000 A/m or 0.016 A/m.

#### 4.2 References

Use Harvard style references (see at the end of this document). With L<sup>A</sup>T<sub>E</sub>X, you can process an external bibliography database using *bibtex*,<sup>2</sup> or insert it directly into the reference section. Footnotes should be avoided as far as possible. Please note that the references at the end of this document are in the preferred referencing style. Papers that have not been published should be cited as “unpublished”. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

#### 4.3 Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have already been defined in the abstract. Abbreviations such as IFAC, SI, ac, and dc do not have to be defined. Abbreviations that incorporate

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periods should not have spaces: write “C.N.R.S.”, not “C. N. R. S.” Do not use abbreviations in the title unless they are unavoidable (for example, “IFAC” in the title of this article).

#### 4.4 Equations

Number equations consecutively with equation numbers in parentheses flush with the right margin, as in (1). To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Use parentheses to avoid ambiguities in denominators. Punctuate equations when they are part of a sentence, as in

$$\int_0^{r_2} F(r, \varphi) dr d\varphi = [\sigma r_2 / (2\mu_0)] \cdot \int_0^{\inf} \exp(-\lambda|z_j - z_i|) \lambda^{-1} J_1(\lambda r_2) J_0(\lambda r_i) d\lambda \quad (2)$$

Be sure that the symbols in your equation have been defined before the equation appears or immediately following. Italicize symbols (*T* might refer to temperature, but *T* is the unit tesla). Refer to “(1)”, not “Eq. (1)” or “equation (1)”, except at the beginning of a sentence: “Equation (1) is ...”.

#### 4.5 Other Recommendations

Use one space after periods and colons. Hyphenate complex modifiers: “zero-field-cooled magnetization”. Avoid dangling participles, such as, “Using (1), the potential was calculated” (it is not clear who or what used (1)). Write instead: “The potential was calculated by using (1)”, or “Using (1), we calculated the potential”.

A parenthetical statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.) Avoid contractions; for example, write “do not” instead of “don’ t”. The serial comma is preferred: “A, B, and C” instead of “A, B and C”.

## 5. CONCLUSION

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

## ACKNOWLEDGEMENTS

Place acknowledgments here.

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## Appendix A. A SUMMARY OF LATIN GRAMMAR

## Appendix B. SOME LATIN VOCABULARY