DEPARTMENT OF MECHANICAL & AEROSPACE ENGINEERING

University of Strathclyde Engineering

Title

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Word Count: XXXX

A thesis submitted in partial fulfilment for the requirement of degree of NAME of THE COURSE/DEGREE

October 2020

Abstract

Abstract should be on one page. It should summarise the project objectives, the work carried out, methods used, the main research findings arising from the work and conclusions reached.

Acknowledgements

This thesis is the result of the author's original research. However if any external support, help or contributions were received, it must be acknowledged here.

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Nomenclature

Constants

c	Speed of light in a vacuum, $299\,792\,458\,\mathrm{m/s}$
h	Plank's constant, $6.626\,070\,04 \times 10^{-34}\,\mathrm{m^2\,kg/s}$

Variables

$\mathbf{q}$	Quaternions
ρ	Density, kg/m^3
g	Gravitational acceleration, m/s^2
V	Volume, m^3

1 Introduction

1.1 Format of Tables, Figures and Equations

Each item must have a numerical label and title (a caption). Figure captions must appear below the figure, see Fig. 1.1. Table captions must appear above the table, see Table 1.1. Equation captions appear to the right of the equation (or below if space does not permit), see Eq. (1.1).

A decaying harmonic is given as,

$$y(t) = ae^{-b\omega t}\sin(\omega t + \phi) \tag{1.1}$$

where a is the sine wave amplitude, frequency ω, phase offset ϕ, and the exponential coefficient $b > 0$. An example is shown in Figure 1.1.

This is generally an infinite dimensional optimisation problem of the form

$$\min_{u,x} \ \phi\left(x(t_f)\right) \ + \int_{t_0}^{t_f} f_0\left(x(t), u(t)\right) \ dt \tag{1.2}$$

subject to

$$\dot{x}(t) = f\left(x(t), u(t)\right) \tag{1.3}$$

$$c\left(x(t), u(t)\right) \leq 0, \quad t \in [t_0, t_f] \tag{1.4}$$

$$\omega\left(x(t_0), x(t_f)\right) = 0 \tag{1.5}$$

where $f(x(t), u(t))$ describes the dynamic of the system, the function $\omega(x(t_0), x(t_f))$ the equal-

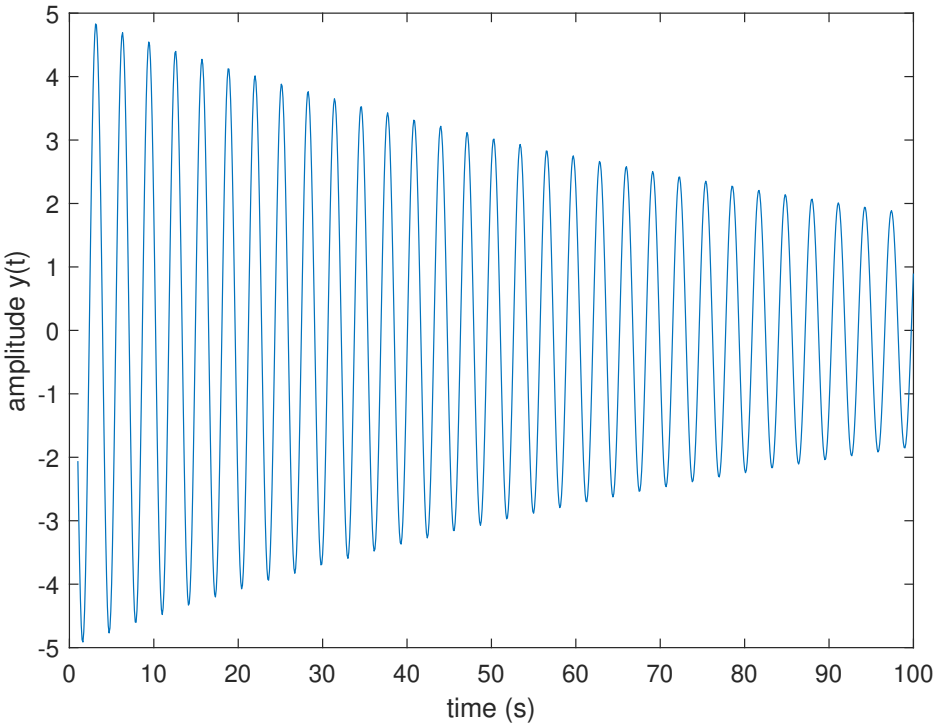

Figure 1.1: Exponentially decaying sine wave from Eq. (1.1)

ity constraints on initial and final states and $c(x(t), u(t))$ the path constraints. The solution of an optimal control problem is the pair $[x^*(t), u^*(t)]$ which minimise the objective function defined by $\phi(x(t_f))$ and $f_0(x(t), u(t))$.

Tables, Figures and Equations must have separate numbering. Each item should appear in sequential order and be mentioned explicitly in the body of text, and be mentioned prior to appearing in the report. If you are using a figure or table from a third party (book, paper, website etc.) then it must be referenced in the caption, as in Tables 1.1–1.2. If data has been extracted from several sources and compiled into a table, this can be referenced in the table itself.

Each item should be centralised in the body of text. No text wrapping should be employed around figures, tables, or equations. All text in the figure should be legible. There is no limitation of figure size, it is better to show a figure larger and legible, than smaller and indecipherable.

Day	Min Temp	Max Temp	Summary
Monday	11 °C	22 °C	A clear day with lots of sunshine. However, the strong breeze will bring down the temperatures.
Tuesday	9 °C	19 °C	Cloudy with rain, across many northern regions. Clear spells across most of Scotland and Northern Ireland, but rain reaching the far northwest.
Wednesday	10 °C	21 °C	Rain will still linger for the morning. Conditions will improve by early afternoon and continue throughout the evening.

*Table 1.1: Table caption (*WikiBooks: LaTeX/Tables *2020)*

1.2 Nomenclature

All variables and symbols used should be given in the text, and summarised in List of Symbols, or Nomenclature at the start. The nomenclature should include all the variables, their descriptions and if applicable, the values (in the case of constants) and units. It does not usually include acronyms.

The symbols can be grouped, or not, to help with clarity depending on the number of vari-

Item		
Animal	Description	Price ($)
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.50
Emu	stuffed	33.33
Armadillo	frozen	8.99

Table 1.2: Caption for table taken from WikiBooks: LaTeX/Tables *(2020)*

ables.

1.3 Referencing

Referencing should preferably follow the Harvard system, although a numeric style such as Vancouver system is also acceptable. It is important that attention is paid to proper referencing of others' work (including figures), both to avoid plagiarism and to allow others to find the source document (Klein 2010), e.g., web links should contain the URL and the date that the web link was sourced. If necessary, Turnitin will be used to check for plagiarism.

A bibliography can be used to reference different reference sources including books (Goossens et al. 1993), and articles (Abedon et al. 2003, Greenwade 1993). Abedon (1994) wrote an interesting paper in the field of molecular biology, which has a slightly different citation format.

2 Literature Review

2.1 Section 1

2.2 Section 2

2.2.1 Sub-section

2.3 Section 3

3 Method

4 Results

5 Discussion

6 Conclusion

This section should summarise the information presented in the report. No new information regarding the work should be included here. It will often include a further or future work section, discussing what would be useful going forward.

References

Abedon, S. T. (1994), Lysis and the interaction between free phages and infected cells, *in* J. D. K. Karam, J. W. Drake, K. N. Kreuzer, G. Mosig, D. Hall, F. A. Eiserling, L. W. Black, E. Kutter, K. Carlson, E. S. Miller & E. Spicer, eds, 'Molecular biology of bacteriophage T4', ASM Press, Washington DC, pp. 397–405.

Abedon, S. T., Hyman, P. & Thomas, C. (2003), 'Experimental examination of bacteriophage latent-period evolution as a response to bacterial availability', *Applied and Environmental Microbiology* **69**, 7499–7506.

Goossens, M., Mittelbach, F. & Samarin, A. (1993), *The LaTeX Companion*, Addison-Wesley, Reading, Massachusetts.

Greenwade, G. D. (1993), 'The Comprehensive Tex Archive Network (CTAN)', *TUGBoat* **14**(3), 342–351.

Klein, R. (2010), 'Black holes and their relation to hiding eggs', *Theoretical Easter Physics* .

WikiBooks: LaTeX/Tables (2020).
URL: *https://en.wikibooks.org/wiki/LaTeX/Tables*

A Additional material

Appendices give the chance to include supplementary information which is useful but not pertinent to the understanding of the report. Appendices should be referred to explicitly in the main text, or should not be included. The appendices shall not be used as a means to include additional word count.