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Instrumentation for Engineers

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For Caroline and Jack

Contents

<i>Preface</i>	xi
<i>Acknowledgements</i>	xiii
1 The Performance of Instrumentation Systems	1
Introduction	1
Generalised instrumentation design	3
The performance of instrumentation systems	6
Error analysis	6
2 Sensors and Transducers	13
Introduction	13
Displacement sensing	13
Velocity sensing	21
Acceleration sensing	24
Strain measurement	25
Flow sensors	29
Temperature sensors	32
Optical sensors	35
Acoustic sensors	38
Hall effect sensors	39
3 Signal Conditioning	41
Introduction	41
Bridge circuits	42
Operational amplifier signal conditioning circuits	55
Analysing op-amp circuits	62

4	Analogue Filters	79
	Introduction	79
	Filter order	81
	Filter class	82
	Operational-amplifier filters	84
	Special-purpose filter devices	95
5	Signal Conversion	102
	Introduction	102
	Digital and analogue conversion fundamentals	103
	Digital-to-analogue converters	105
	Frequency-to-voltage converters	109
	Sample-and-hold devices	109
	Analogue-to-digital converters	110
	Analogue multiplexers	115
	Example design	116
6	Digital Circuits and Microprocessor Interfacing	118
	Introduction	118
	Digital device families	118
	Combinational logic, gates and Boolean algebra	121
	Sequential logic circuits	125
	Digital systems interfacing	130
	Number codes	135
	Microprocessors	138
	Example interface designs	144
	Communication standards	157
7	Frequency Domain Analysis	159
	Introduction	159
	The modal domain	164
	Waterfall diagrams	167
	Vector response diagrams	168
	Fourier analysis	170
	Fourier series	170
	The Fourier Transform	177
8	Practical Spectrum Analysis	180
	Introduction	180
	Analogue analysers	180
	Digital analysers	182
	The Fast Fourier Transform	184
	Aliasing and Shannon's Sampling Theorem	188

Windowing	190
Choice of window	195
Glossary of FFT analyser terminology	199
9 Correlation and Spectral Analysis	203
Introduction	203
Signal classification	203
Autocorrelation	205
Interpreting autocorrelation diagrams	208
Cross-correlation	213
Interpreting cross-correlation functions	215
<i>Bibliography and Further Reading</i>	217
<i>Index</i>	219

Preface

The science (or even the art!) of instrumentation is of fundamental importance to engineers, scientists and medical workers. Instruments are the eyes and ears of the technologist. (His nose is reserved for detecting the effects of excess current.) Without sensors and their associated signal processing systems there would be no modern transport, no National Grid distributing electricity, and anyone unlucky enough to fall ill would be offered only the most primitive medical treatment. The progress that has been made in almost all areas of technology can be seen in terms of the rate at which the necessary instrumentation has been developed. For example, in recent years many improvements have been made to the performance of the internal combustion engine. More and more power has been squeezed out of smaller and more economic engines. One of the reasons is that in the last few years sensors have been developed which allow investigations to be made of the way in which the flame front spreads inside a cylinder after ignition. This work has led to a redesign of the geometry of the inlet valves and the piston, and more efficient engines are the result.

The process of instrumentation is often considered solely in terms of the sensors used and their associated electronics. However, there are two steps involved in making any measurement. These are, first, getting the data, which is where sensors and electronics are used, and second, analysing it. The analysis may simply consist of an assessment of the errors, or may involve the application of some more complicated technique such as Fourier or correlation analysis. The important point is that some form of signal analysis is almost always necessary. The type of analysis to be applied may well have implications for the kind of sensors used, or vice versa. Thus, an instrumentation system should be designed or used with due regard to the expectations that the user has of the results.

In view of the importance of instrumentation, it is vital that engineers and scientists have a good working knowledge of the principles involved in measurement and analysis. If the best possible performance is to be had from a measurement system then its weaknesses must be thoroughly understood, as well as its strong points. It is often said of electronic systems and devices that the most important features to look out for are the ones that the manufacturer has NOT included on the data sheet!

The basis of this book is a course in instrumentation which I give to final year mechanical engineering undergraduates. This course presents instrumentation from the viewpoints of both electronics and signal analysis. The sensors and electronic circuits likely to be needed by a final year student project and for postgraduate research are comprehensively covered. Three chapters are devoted to methods of time and frequency domain analysis, and suggestions for further reading on some of the more specialised techniques are given in the bibliography. It is therefore a suitable university text for students of engineering, science or medicine who are seeking a practical guide to instrumentation. It is also hoped that the book will be of use to practising engineers in general.

Finally, some words of thanks. I would like to record my gratitude to my friend and colleague Tony Pretlove, who first showed me the fascination of engineering, and turned a reluctant physicist into a happy engineer. Thanks are also due to Martyn Ramsden, who read the manuscript and offered many helpful suggestions, and to Professor Roy Farrar of Southampton University who encouraged the work. The text was typed and corrected by myself on that wonderful thing, a word-processor program on a microcomputer. Without the aid of this software it would have been impossible to keep the end result in View.

Hear ye not the hum of mighty workings?

Keats: to Haydon

Southampton University

J. D. TURNER

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