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Sensors and Transducers

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Preface

Most quantities that we need to measure are inherently analogue. There is nothing very digital about a length or a temperature and, even though light may be considered to consist of photons, most measurements involve such large numbers that the process is effectively analogue. Our own senses are analogue, so it is hardly surprising that the vast majority of physical sensors are analogue as well. It is only since the developments in microprocessor technology that digital transducers have become important; however, they still have to measure analogue quantities, and most digital transducers therefore employ exactly the same physical principles as their analogue counterparts.

The words ‘sensor’ and ‘transducer’ are widely used in referring to sensing devices, the former having gained in popularity over the latter in recent years. This is a pity because ‘transducer’ stresses the change of form of energy basic to the sensing process and leads to an elegant and powerful classification of devices. The word ‘transducer’ is used here when considering a complete sensing device, in which a change of form of energy *always* occurs, the word ‘sensor’ being reserved for devices that are not energy-converting, such as a thermistor which simply changes its resistance in response to temperature.

The aim of the book is to provide an integrated account of the principles and properties of the most important types of physical transducer. The first chapter discusses the types of physical energy and the corresponding signals, and identifies three basic types of transducer. A synthesis of the subject is attempted in chapter 2, by describing the analogies that exist between different physical systems. Chapter 3 starts with a three-dimensional representation of all possible transducers and goes on to consider the basic physical mechanisms available for transduction. Chapter 4 develops the relevant expressions for amplifiers and transducer bridges that are required before the detailed descriptions of the basic transducers for length, temperature and radiation can be given in chapters 5, 6 and 7. For each of these quantities the physical background and

standards are explained, followed by both a theoretical treatment of the basic transducers and a description of their practical design and application. Chapter 8 includes a description of the application of the basic transducers to several fields of measurement such as acceleration, force, pressure and flow, and the final chapter reviews some of the most recent developments in the transducer field, such as optical-fibre sensors, resonator sensors, solid-state devices, and smart sensors.

The book is specifically about transducers rather than measurement systems, and provides an integrated and comprehensive coverage of presently available transducers and recent developments. The classification of transducers, based on energy conversion, automatically encompasses both 'analogue' and 'digital' devices, which are seen to be simply different ways of using a particular physical principle. The book is intended as an undergraduate text for first year students in engineering, physics and information technology.

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*Guinea-pigs are nocturnal animals that mostly sleep during the day.