Section 15 delves into the aspects of electrical engineering that a mechanical engineer should comprehend. The initial topic defines electrical and magnetic terms (volts, current, resistance, conductivity, impedence, susceptance). We enter the realm of circuits, i.e., electrical, magnetic and various types of batteries. The author explains the study of alternating circuits and its components and follows with electrical instruments. The most important a-c instruments revolve about electrodynamometer, thermocouple, rectifier, ironvane and electronics. Additional instruments are induction and induction watthour meter, instrument transformers, voltmeter, anometer, wheatstone bridge, Kelvin double bridge, various types of d-c generators and motors. The author covers additional important transformers and electrical functions.

Next, we study a-c motors (polyphase induction, squirrel cage and synchronous). The synchronous generators are the only type of a-c generator employed in power stations. The book furnishes ratings of electrical apparatus, their efficiency plus due consideration to electrical drives and types of switchboards. With this information provided, the book stresses the different procedures involved in power transmission and systems. This follows with the various methods in power distribution and efficient methods of interior wiring. The next subsections expound upon magnets, ignition systems in automobiles, and unveils the mysteries of electronics, their components and circuits. The section concludes with a brief consideration of computer-aided design and manufacture (CAD/CAM).

Section 16 continues with instruments and controls. The mechanical engineer must possess an understanding of the good and bad parts of measurement pertaining to (*a*) mass and weight measurement, (*b*) time and frequency measurement, (*c*) linear and angular displacement, (*d*) area measurement, (*e*) fluid volume and pressure measurements, (*f*) force and torque measurements. Additional important measurements are (*g*) temperature, (*h*) liquid-level, (*i*) flow rate, and (*j*) power. We must understand important sensing devices, i.e., galvanometers, voltmeters, potentiometers, impedance bridge, velocity-acceleration measurement plus the measurement of physical and chemical properties. Beginning with the various terms of feedback systems, we study the basic automatic control system, its process plus the transient analysis of a control system. Other important features are signal flow representation and controller. This leads to hydraulic control systems, its frequency response, Bode diagram, sampled data control system and state space concepts. The subsection concludes with computer control employing digital computers, programmed controller and distributed control systems. We close this section by acknowledging the various instruments with special emphasis on specific problems in surveying and automation.

Section 17 focuses on industrial engineering. Beginning with the basic industrial economics and arrangements (plant organization, process planning, production control, etc.), it follows through with the various components of cost accounting. This encompasses budgets, types of cost systems, cost analysis, capital expenditure, etc. The next subsection involves engineering statistics and quality control. Methods engineering implies process analysis elements and principles of motion study, job standardization, performance rating and employment of time standards. The cost of electrical power is surveyed as to fixed charges, transmission costs, power prices, and operating charges. The section concludes with an abbreviated version of human factors engineering.

Section 18 reports on environmental control. This concerns itself with the national policy, control of thermal discharges, wastewater controls, atmospheric pollution and means of controlling it. Proceeding, we meet radioactive waste management, solid and hazardous waste management, occupational safety and health.

The concluding section is a "catchall." It explains various aspects of mechanical refrigeration, cryogenics (gas liquidification, properties of cryogenic fluids, instrumentation and safety). The book explains optics (index of refraction, dispersion, refraction and aperture) in too abbreviated a fashion. The important concepts of patents, trademarks, and copyrights are explained.

In summary, this is a very valuable book. The reviewer feels that a number of topics should be expanded, i.e., finite elements, acoustics incorporating acoustic intensity, increase in tables for beams, vibration including that of solids and axisymmetric structures. In addition, the newer boundary element method should be included, as well as Routh-Harwitz stability criterion, transfer matrix of beams and acoustic systems (pipe flow) and turbine blade vibrations. This added information would make it a most indispensable tool for the mechanical engineer. The reviewer recommends this book to mechanical and other engineers needing information on this subject.

Variational Methods in Mechanics, by Toshio Mura and Tatsuhito Koya, Oxford University Press, Inc., New York, N.Y., 1992, 244 pp.

REVIEWED BY S. M. HEINRICH[2]

This book stems from Professor Mura's lectures on variational principles in mechanics, a course he has taught at Northwestern University for approximately 25 years, with coauthor Toya providing input related to computer implementation. The authors state in the preface that their intention is to explain the essence of Courant and Hilbert's *Methoden der Mathematischen Physik* "in practical, commonsense terms" by emphasizing science and engineering applications, while minimizing mathematical arguments associated with existence theorems, continuity conditions, convergence, etc. Indeed, the reviewer found the book to be a rather nonrigorous treatment of variational methods, which for the most part drew upon numerous example problems from mechanics to illustrate the application of the methods. Well over half of the text is devoted to example problems and problem sets for the reader. This is done at the expense of presenting the theoretical underpinnings of both the variational principles and the approximate solution techniques. Although the authors state in the preface that alternative titles for the book could have been "Variational Principles" or "Calculus of Variations," the reviewer feels that these would have been misnomers. Very few principles or theorems are presented in the book. In most of the examples, the solution begins with the relevant functional without much regard for its origin. Thus, the book does not appear to be aimed at students receiving an initial exposure to variational mechanics, i.e., those interested in learning the general principles and how to use these to mathematically formulate a physical problem as a variational problem. For this reason, the reviewer believes the text would be more suitable as a supplementary text in a course on variational mechanics or as the primary text in a second course on the subject dealing with applications.

The organization of the book is rather "segmented," having no apparent chapter/section/subsection heirarchy. Chapter topics include the Euler equation, Ritz's method, Galerkin's method, elasticity, Castigliano's theorem, plasticity, eigenvalue problems, finite element method. Lagrange multipliers, and bounds for the overall properties of anisotropic composites. A unique aspect of the book is that the use of symbolic manipulation is discussed as it relates to variational problems, and a 23-page appendix is devoted to the use of the code *Mathematica*.

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Most treatments of variational methods will generally first define fundamental concepts and terms, state and prove general theorems, and then apply these theorems to the solution of specific examples. In this book, the approach is essentially reversed: the mathematical formulation of a specific problem is first presented, and then the equations are formally manipulated using variational calculus, resulting in certain quantities or relations that are defined a posteriori. The reader might feel uncomfortable with this approach, unless he is already familiar with the topic. For instance, if the reader has not been exposed to, say, the term "natural boundary condition," then a statement such as "the boundary conditions (5.4) are called the natural boundary conditions" does little to define the term. It only indicates that Eq. (5.4) is an *example* of a natural boundary condition. This method of "defining" terms is used throughout the book. An exception is the final chapter, "Bounds for the Overall Properties of Anisotropic Composites," contributed by Professor J. R. Willis, in which the basic theory is first laid out, followed by derivations of general results and the solution of a specific example.

In summary, the reviewer feels that the book is best suited for the reader who is already familiar with the calculus of variations and the variational principles of mechanics. Its content provides a valuable library of example problems that illustrate the application of the underlying theory in a practical way and for a wide variety of mechanics problems.