MECHANICAL AND ELECTRICAL SYSTEMS IN BUILDINGS

Sixth Edition

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This book on mechanical and electrical systems covers five major disciplines: HVAC, plumbing and fire protection, electrical power and telecommunications, illumination, and noise and vibration control.

Coauthors Richard R. Janis and William K.Y. Tao have both taught university courses on mechanical and electrical systems for more than 30 years while working as consulting engineers. Their various courses have emphasized the roles of participants in the building process as well as the theories and technologies of system design. In 1989, they finished the first edition of this text in response to the need for a text that was up to date with current practice, emphasizing the Why? and the How? as energy and well as the What?

The topics covered in this book are in a state of continuous advancement, triggering the need for substantial updating every few years. This sixth edition incorporates new developments in all the major disciplines, with updates on electrical, lighting, telecom, plumbing, and HVAC.

New items in the sixth edition include:

- Life-cycle cost analyses including societal cost of pollution and economic benefits of indoor environmental quality (IEQ)
- An entire chapter exploring energy impact and economics of various generic architectural and systems options
- VRF heat pump and heat recovery operations using three pipe technology
- Operation of condensing boilers and furnaces and direct fired heating
- Energy and comfort advantages of high-volume, low-speed (HVLS) fans
- EPA WaterSense, the latest development in water conserving fixtures
- Economics of solar photovoltaic systems

The U.S. building industry is embracing sustainable design principles, which were part of the authors’ practice and course offerings long before the concept was accepted. Sustainable design means that engineers, architects, owners, contractors, and facility managers must interact in a team effort to provide high-quality, productive environments for people while considering the impact of their decisions on the environment. This book is a text and reference for students and professionals interested in an interactive, multidisciplinary approach to the building process.

ORGANIZATION OF SIXTH EDITION

In prior editions, Chapters 1 and 2 grew and became unwieldy with the addition of topics. In this sixth edition, even more materials are added to account for advancements in energy and sustainable design. Accordingly, we have reorganized and expanded these new and existing materials into four chapters instead of two. The book is now organized as follows:

Chapter 1, Introduction to Mechanical and Electrical Systems, Sustainable Design, and Evaluating Options, includes new life-cycle cost examples which consider the off-site cost of pollution and the economic effects of indoor environmental quality.

Chapter 2, HVAC Fundamentals, covers the engineering basics required to understand systems.

Chapter 3, HVAC Load Estimating, includes an updated detailed example of heating and cooling load calculations using a building example consistent with current energy codes.

Chapter 4, HVAC Load Management, contains the analysis of various architectural, ventilation, lighting, and appliance options on a hypothetical 30,000 ft² building. Analysis includes the effect on load, initial building cost, energy cost, and life-cycle cost for alternative designs involving the following factors:

- Building geometry and form
- Wall orientation
- Altering glass orientation
- Window-to-wall area ratio
- Control solar loads through windows
- Thermal properties of walls and roof
- Infiltration load control potential
- Ventilation criteria and controls
- Task lighting
- Daylighting
- Appliances load control

Chapters 5 through 9 cover HVAC systems and equipment. These chapters are updated to include new technologies to save energy and in some instances reduce the cost of systems. New, enhanced, and expanded topics include condensing boilers and furnaces, direct fired heating, ground source heat pumps, VRF heat pumps and heat recovery, and high-volume, low-speed fans.
Chapter 10 covers plumbing. Updates include condensing water heaters, instantaneous water heaters, and the EPA WaterSense program.

Chapter 11 covers fire protection with general updates for improved clarity.

Chapters 12 through 15 cover electrical systems with general updates including current economics of solar PV systems.

Chapters 16 through 19 cover lighting, including general updates, strategies for high performance, and enhanced coverage of newly dominant LED light sources.

Chapter 20 on noise and vibration takes on a higher level of importance as sound is increasingly recognized for its effect on indoor environmental comfort.

Chapter 21 on architectural accommodation covers system coordination, space planning options, and has many images to convey the visual impact of design.

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Organizations

Special thanks go to the following organizations for providing valuable design data:

ASHRAE American Society for Heating Refrigeration and Air Conditioning Engineers
IESNA Illuminating Engineering Society of North America
ASPE American Society for Plumbing Engineers
NCAC National Council of Acoustical Consultants
NEC National Electrical Code
NFPA National Fire Protection Association
TIA/EIA Telecommunication Industry Association

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