

**Philip Kosky
Robert Balmer
William Keat
George Wise**

Exploring Engineering

**An Introduction to
Engineering and Design**



* S K N 0 0 8 3 3 0 *

Fourth Edition



Physical Constants and Unit Conversion Factors*

PHYSICAL CONSTANTS
Avogadro's Number, $N_A = 6.023 \times 10^{26}$ molecules/kgmole Standard Gravitational Acceleration $g = 32.174 \text{ ft/s}^2 = 9.807 \text{ m/s}^2$ Newton's Second law Constant, $g_c = 32.174 \text{ lbf}\cdot\text{ft}/(\text{lbf}\cdot\text{s}^2)$ (English units) $= 1$ (integer) [0] (MKS units) Universal Gas Constant, $R = 1545.35 \text{ ft}\cdot\text{lbf}/(\text{lbfmole}\cdot\text{R})$ $= 8314.3 \text{ J}/(\text{kgmole}\cdot\text{K})$
LENGTH
$1 \text{ m} = 3.2808 \text{ ft} = 39.37 \text{ in} = 100 \text{ cm}$ $1 \text{ cm} = 0.0328 \text{ ft} = 0.394 \text{ in} = 10^{-2} \text{ m}$ $1 \text{ km} = 1000 \text{ m} = 0.6215 \text{ miles} = 3281 \text{ ft}$ $1 \text{ in} = 2.540 \text{ cm} = 0.0254 \text{ m}$ $1 \text{ ft} = 12 \text{ in} = 0.3048 \text{ m}$
AREA
$1 \text{ m}^2 = 10^4 \text{ cm}^2 = 10.76 \text{ ft}^2 = 1550 \text{ in}^2$ $1 \text{ ft}^2 = 144 \text{ in}^2 = 0.0929 \text{ m}^2 = 929.05 \text{ cm}^2$ $1 \text{ cm}^2 = 10^{-4} \text{ m}^2 = 1.0764 \times 10^{-3} \text{ ft}^2 = 0.155 \text{ in}^2$ $1 \text{ in}^2 = 6.94 \times 10^{-3} \text{ ft}^2 = 6.452 \times 10^{-4} \text{ m}^2 = 6.452 \text{ cm}^2$
VOLUME
$1 \text{ m}^3 = 35.313 \text{ ft}^3 = 6.1023 \times 10^4 \text{ in}^3 = 264.171 \text{ gallon}$ $1 \text{ liter (L)} = 10^{-3} \text{ m}^3 = 0.0353 \text{ ft}^3 = 61.03 \text{ in}^3$ $1 \text{ gallon} = 231 \text{ in}^3 = 0.13368 \text{ ft}^3 = 3.785 \times 10^{-3} \text{ m}^3$ $1 \text{ ft}^3 = 1728 \text{ in}^3 = 0.02832 \text{ m}^3 = 7.4805 \text{ gallon}$ $1 \text{ in}^3 = 16.387 \text{ cm}^3 = 1.6387 \times 10^{-5} \text{ m}^3$

MASS
$1 \text{ kg} = 1000 \text{ g} = 2.2046 \text{ lbfm} = 0.0685 \text{ slug}$ $1 \text{ lbfm} = 453.6 \text{ gram} = 0.4536 \text{ kg} = 3.108 \times 10^{-2} \text{ slug}$ $1 \text{ slug} = 32.174 \text{ lbfm} = 1.459 \times 10^4 \text{ gram} = 14.594 \text{ kg}$
MASS DENSITY
$1 \text{ lbfm}/\text{ft}^3 = 16.0187 \text{ kg}/\text{m}^3$ $1 \text{ kg}/\text{m}^3 = 0.062427 \text{ lbfm}/\text{ft}^3 = 10^{-3} \text{ g}/\text{cm}^3$ $1 \text{ g}/\text{cm}^3 = 1 \text{ kg}/\text{liter} = 62.4 \text{ lbfm}/\text{ft}^3 = 10^3 \text{ kg}/\text{m}^3$
FORCE
$1 \text{ newton} = 10^5 \text{ dyne} = 1 \text{ kg}\cdot\text{m}/\text{s}^2 = 0.225 \text{ lbf}$ $1 \text{ lbf} = 4.448 \text{ newton}$ $1 \text{ poundal} = 1 \text{ lbfm ft}/\text{s}^2 = 0.031081 \text{ lbf}$
ENERGY
$1 \text{ joule} = 1 \text{ newton}\cdot\text{m} = 1 \text{ kg}\cdot\text{m}^2/\text{s}^2 = 9.479 \times 10^{-4} \text{ Btu}$ $1 \text{ kJ} = 1000 \text{ joule} = 0.9479 \text{ Btu}$ $1 \text{ Btu} = 1055.0 \text{ joule} = 1.055 \text{ kJ} = 778.16 \text{ ft}\cdot\text{lbf}$
POWER
$1 \text{ watt} = 1 \text{ joule}/\text{s} = 1 \text{ kg}\cdot\text{m}^2/\text{s}^3 = 1.3405 \times 10^{-3} \text{ hp}$ $1 \text{ kW} = 1000 \text{ watt} = 73.73 \text{ ft}\cdot\text{lbf}/\text{s} = 1.3405 \text{ hp}$ $1 \text{ Btu}/\text{hr} = 0.293 \text{ watt} = 0.2161 \text{ ft}\cdot\text{lbf}/\text{s} = 3.93 \times 10^{-4} \text{ hp}$ $1 \text{ hp} = 550 \text{ ft}\cdot\text{lbf}/\text{s} = 33,000 \text{ ft}\cdot\text{lbf}/\text{min} = 746 \text{ watt}$
ELECTRICAL UNITS
$1 \text{ watt} = \text{J}/\text{s} = 1 \text{ V}\cdot\text{A} = 621 \text{ lumens at } 5500 \text{ A}$ $1 \text{ kilowatt hour} = 3412 \text{ Btu} = 1.341 \text{ horsepower hour}$ $1 \text{ volt} = 1 \text{ joule}/\text{coulomb} = 1 \text{ watt}/\text{amp} = 1 \text{ ohm}\cdot\text{amp}$ $1 \text{ amp} = 1 \text{ coulomb}/\text{second}$

*This table follows the conventional conversion table format that emphasizes its readability and may not accurately represent the appropriate number of significant figures (as explained in the text).

The Engineering Ethics Decision Matrix

This is an example of one particular Engineering Ethics Decision Matrix

Options → NSPE Canons ↓	Go along with the decision	Appeal to higher management	Quit your job	Write your state representative	Call a newspaper reporter
Hold paramount the safety, health and welfare of the public.					
Perform services only in the area of your competence					
Issue public statements only in an objective and truthful manner					
Act for each employer or client as faithful agents or trustees					
Avoid deceptive acts					
Conduct themselves honorably . . .					

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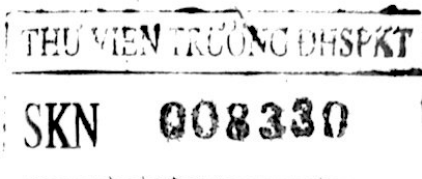
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William Keat

George Wise



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This new edition of *Exploring Engineering: An Introduction to Engineering and Design* has been expanded and reorganized to cover industrial engineering and aeronautical engineering, and now includes a deeper discussion of nuclear engineering. With its broad coverage of today's many engineering specialties, *Exploring Engineering* provides students with an opportunity to explore the fundamental principles that form the basis of the engineering profession, and to understand how these principles apply within a structured design process.

KEY FEATURES

- NEW: Chapters on Industrial Engineering and Aeronautical Engineering
- NEW: Chapter on engineering design team building in the "Hands-On" design section
- NEW: Content on engineering drawing and sketching and sustainable engineering
- NEW: Expanded content in the Nuclear Energy, Defining the Problem, Generation of Alternative Concepts, and Detailed Design chapters
- An Engineering Ethics Decision Matrix is introduced in Chapter 1 and used throughout the book to pose ethical challenges and explore ethical decision-making in an engineering context
- Lists of "Top Engineering Achievements" and "Top Engineering Challenges" help put the material in context and show engineering as a vibrant discipline involved in solving societal problems

ABOUT THE AUTHORS

Philip Kosky, PhD – University of California at Berkeley. Formerly a scientist and engineer at the GE Research Center, Niskayuna, NY. Research Professor of Engineering at Union College.

Robert Balmer, ScD – University of Virginia. Formerly an engineer at Bettis Atomic Power Laboratory and at various DuPont facilities. Currently serves as Dean Emeritus of Engineering and Computer Science at Union College, and Professor Emeritus in the Mechanical Engineering Department at the University of Wisconsin-Milwaukee.

William Keat, PhD – Massachusetts Institute of Technology. Currently serving as Professor of Mechanical Engineering at Union College.

George Wise, PhD – Boston University. Formerly a communications specialist and historian at General Electric's Global Research Center in Niskayuna, NY and Deputy Director of the Dudley Observatory, Schenectady, NY. Served as Adjunct Professor of Mechanical Engineering at Union College.

CONTENTS: Part 1: Lead-On; What Engineers Do; Elements of Engineering Analysis; Force and Motion; Energy; Engineering Economics; Part 2: Minds-On; Aeronautical Engineering; Chemical Engineering; Civil Engineering; Computer Engineering; Electrical Engineering; Industrial Engineering; Manufacturing Engineering; Materials Engineering; Mechanical Engineering; Nuclear Engineering; Part 2.1: Emerging Engineering Fields; Bioengineering; Electrochemical Engineering; Green Energy Engineering; Part 3: Hands-On; Introduction to Engineering Design; Design Teams; Design Step 1: Defining the Problem; Design Step 2: Generation of Alternative Concepts; Design Step 3: Evaluation of Alternatives and Selection of a Concept; Design Step 4: Detailed Design; Design Step 5: Design Defense; Design Step 6: Manufacturing and Testing; Design Step 7: Performance Evaluation; Design Step 8: Design Report; Examples of Design Competitions; Closing Remarks on the Important Role of Design Projects; Index



ACADEMIC PRESS

An imprint of Elsevier
store.elsevier.com

ISBN 978-0-12-801242-0



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