


COMPUTATIONAL MECHANICS

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There are two primary ways in which the computer can be of valuable assistance to you as you study the topics in this *Mechanics of Materials* text. First, you can use math application software or a spreadsheet program or a programming language of your own choice to write a computer program to solve a mechanics of materials problem. There are twenty such exercises in the book. For example, there are three computer-based design problems (Probs. 2.8-19 through 2.8-21) that ask you to use the computer to obtain a plot that will enable you to select the best design for a simple truss structure. By writing your own computer programs for several of these exercises, you will not only gain experience in programming, but you should also gain valuable experience in organizing efficient, systematic solutions of mechanics of materials problems.

Use of one of the two computer programs that is supplied for use with the book is another way in which the computer can be of valuable assistance to you. The more powerful of these two computer programs is the award-winning **MDSolids** educational software, which is described in Appendix G.1.¹ Since MDSolids is written in Visual Basic, it is only available for use on computers running a Windows operating system (95, 98, NT).² For Macintosh users, the **MechSOLID** software, described in Appendix G.2, is available.³

G.1 MDSolids



The **MDSolids** software package and ninety special MDSolids-based example problems that are provided with *Mechanics of Materials, 2nd edition* will enable you to use the computer for solving problems in axial deformation, torsion, bending, combined-loading, and buckling of the type treated in Chapters 2 through 12 of the book. MDSolids provides both systematic problem-solving procedures and a user-friendly graphical interface, and through its use you can gain valuable insight

¹The MDSolids educational software package is copyrighted by its author, Dr. Timothy A. Philpot. It was a winner of the 1998 Premier Award for Excellence in Engineering Education Courseware. The MDSolids website is (www.mdsolids.com).

²Windows is a registered trademark of the Microsoft Corporation.

³Macintosh is a registered trademark of Apple Computer, Inc.

into the behavior of structural members and systems under various loading conditions.

MDSolids Modules. MDSolids consists of *modules*, which are similar to book chapters in that each module focuses on specific mechanics of materials concepts and problem-solving methods. There are currently twelve MDSolids modules:

- Basic Stress and Strain Problems
- Beam and Strut Axial Structures
- Truss Analysis and Stresses
- Statically Indeterminate Axial Structures
- Torsion Members
- Determinate Beams
- Flexure
- Section Properties
- Column Buckling
- Mohr's Circle Analysis
- General Analysis of Axial, Torsion, and Beam Structures
- Pressure Vessels

The modules can be accessed in any sequence. MDSolids is powerful enough so that many different structural configurations and loadings can be analyzed with each separate module, but the modules are also coordinated so that results from one module are available for use in related modules.

MDSolids Features. MDSolids is an educational software package developed specifically for the introductory mechanics of materials course. The version of MDSolids that is provided with this *Mechanics of Materials* textbook consists of two closely integrated parts: (1) the basic MDSolids educational software, and (2) a special supplement of ninety example problems.

Features of the MDSolids Software: Some of the key features of the basic MDSolids software are:

- *Versatility:* As indicated above, MDSolids has computational modules pertaining to all of the topics taught in a typical mechanics of materials course. The scope of MDSolids offers routines to help students at all levels of understanding.
- *Ease of Input:* Graphic cues are provided to guide users in entering data, so that the student is able to define a problem intuitively and directly without the need for a user's manual.
- *Visual Communication:* Each MDSolids routine features a picture, sketch, or plot that graphically depicts important aspects of the problem. For a number of topics, including stresses in beams, deflection of beams, Mohr's Circle for stress and strain, and others, plots that show the results are generated.
- *Correct Solution and Intermediate Results:* MDSolids is an "electronic solutions manual," giving not only the correct solution for each problem but

also providing intermediate steps that can be used to confirm the problem-solving approach.

- *Text-based Explanations:* Many of the MDSolids modules provide extra explanations to describe in words how the calculations are performed.
- *Help Files:* The MDSolids Help Files contain instructions for using the software, but, more importantly, they contain theoretical background and practical suggestions for solving various types of problems.

Features of the Special MDSolids-based Example Problems: To accompany this *Mechanics of Materials* textbook, the author of MDSolids has created ninety (90) additional special example problems. The key features of these special example problems are:

- *Close Ties with the Textbook:* At the point in the book where one of these example problems can serve to supplement the text discussion and the text example(s), there is an MDS icon that “points” to one or more of these special MDS example problems. In the homework problem sections, an MDS icon precedes the group of homework problems of the type that is covered by the identified special MDS example problem(s).
- *Complete, Textbook-style Format:* The special example problems are written in the same style and with the same nomenclature, sign conventions, etc. as the example problems in the book. They are not just computer-generated numerical solutions.
- *Broad Range of Topics and Level of Difficulty:* There are special MDSolids examples for Chapters 2 through 12. Many of these are illustration-of-concept type examples that will be of special help to those students who need a “tutor” to supplement the book and the instructor’s lectures. There are also “end-to-end” type examples that illustrate the power of the linking of MDSolids modules (e.g., section properties, shear-force and bending-moment in beams, flexural and shear stresses in beams, and Mohr’s circle).
- *Close Ties with the MDSolids Modules:* The special example problems are treated as help files of the basic MDSolids software. For example, the user can close an example problem and immediately be in the appropriate MDSolids module(s) with the data of the example problem already entered into the correct MDSolids input boxes. See “Suggestions on How to Use MDSolids” below.

Suggestions on How to Use MDSolids. Installation instructions are provided with the CD-ROM. Ideally, the MDSolids software modules and the special example problems will initially be used in the following manner. After reading the text material on a topic and studying the example problem(s) in the book, look at the problem statement of a relevant special MDS example; next, attempt to work the example by hand; then, consult the complete, textbook-style solution; and, finally, move directly to the relevant MDSolids module(s) and enter different input to see how the different input affects the solution. At each step you will get accurate, immediate, and often pictorial feedback. Then, you can move on to the assigned homework or to related homework-type problems, working them by hand and using MDSolids as an “electronic solutions manual” to provide feedback. Once you are familiar with how MDSolids works, you will be able to go directly to the MDSolids modules and obtain solutions to a broad range of mechanics of materials problems, including complex design-type problems.



G.2 MechSOLID

Macintosh users will find some of the MDSolids capability in *MechSOLID*, computer software available as a free download from the author's or publisher's website (see below).

The seven modules that comprise the MechSOLID suite of programs are:⁴

AREAPROP—Computation of Geometric Properties of Plane Areas (Appendix C and Chapter 6)

LINSOLVE—Solution of Simultaneous Linear Algebraic Equations (General)

AXIALDEF—Solution of Axial Deformation Problems (Section 3.8)

TORSDEF—Solution of Torsional Deformation Problems (Section 4.7)

V/M-DIAG—Plotting of Shear and Moment Diagrams (Section 5.5)

BEAMDEF—Solution of Beam Deflection Problems (Section 7.7)

MOHR—Plotting of Mohr's Circles for Stress and Strain (Chapters 8 and 9)

For each of the topics listed above there is an associated computer program in the MechSOLID suite of programs. However, it should be noted that MechSOLID is much more limited in scope than the MDSolids suite of programs, it lacks the powerful MDSolids graphical user interface, and there are no special example problems like the ninety MDSolids special example problems.

The *User's Guide* describes the function of each of the seven MechSOLID modules and shows how they are related to material in the book. The V/M-DIAG module is based on the discontinuity-function method for constructing shear-force and bending-moment diagrams. The AXIALDEF module, the TORSDEF module, and the BEAMDEF module are all based on Displacement-Method solution procedures. The *User's Guide* illustrates how hand solution of an axial deformation problem by the Displacement Method is related to the corresponding AXIALDEF solution.

The Macintosh version of the MechSOLID software, the *User's Guide*, and sets of MechSOLID-related homework exercises are available from the following website: <http://www.ae.utexas.edu/~craig>, or through the publisher at www.wiley.com/college.

⁴The numbers in parentheses are for the 2nd edition of *Mechanics of Materials*.