PART 1: HOW TO USE THIS BOOK

This book, *SE Structural Engineering Reference Manual*, is designed to help you prepare for the 16-hour Structural Engineering (SE) exam administered by the National Council of Examiners for Engineering and Surveying (NCEES). The NCEES SE exam will test your knowledge of structural principles by presenting problems that cover the design of an entire structure or a portion of a structure.

The exam is given in four modules—two concerning vertical forces and two concerning lateral forces. Chapter 1 covers vertical forces, incidental lateral forces, and other variable forces. Chapter 2 through Chap. 8 are organized around the eight areas in which these forces are applied, which are:

- reinforced concrete design
- foundations and retaining structures
- prestressed concrete design
- structural steel design
- timber design
- reinforced masonry design
- lateral forces (wind and seismic)
- bridge design

The structural design principles presented in each chapter build on those in earlier chapters, so you should read the chapters in the order in which they are presented. The examples within each chapter should also be read in sequence. Taken together in this way, they constitute the solution to a complete design problem similar to that on the exam.

Your solutions to the SE exam problems must be based on the NCEES-adopted codes and design standards. Therefore, you should carefully review the appropriate sections of the exam-adopted design standards and codes that are presented, analyzed, and explained in each chapter of this book. Each example in this book focuses on one specific code principle and offers a clear interpretation of that principle.

The Codes and References section lists the SE design standards that code-based problems on the exam will reference. You will not receive credit for solutions based on other editions or standards. All problems are in customary U.S. (English) units, and you will not receive credit for solutions using SI units.

Abbreviations are used throughout this book to refer to the design standards and codes referenced by the SE exam. This book’s “Codes and References” section lists these abbreviations, each followed by the full name of its appropriate design standard or code. This book also cites other publications that discuss pertinent structural design procedures, and these publications are also listed in the “Codes and References” section. Text references to all other publications are numbered as endnotes in each chapter, and the publications are cited in the “References” section that precedes each chapter’s practice problems. These references are provided for your additional review.

As you prepare for the SE exam, the following suggestions may also help.

- Become intimately familiar with this book. This means knowing the order of the chapters, the approximate locations of important figures and tables, and so on.
- Use the subject title tabs along the side of each page.
- Skim through a chapter to familiarize yourself with the subjects before starting the practice problems.
- To minimize time spent searching for often-used formulas and data, prepare a one-page summary of all the important formulas and information in each subject area. You can then refer to this summary during the exam instead of searching in this book.
- Use the index extensively. Every significant term, law, theorem, concept, and code (including sections, equations, and tables) has been indexed. If you don’t recognize a term used, look for it in the index. Some subjects appear in more than one chapter. Use the index to learn all there is to know about a particular subject.
PART 2: EVERYTHING YOU EVER WANTED TO KNOW ABOUT THE SE EXAM

ABOUT THE EXAM

The SE exam is offered in two components. The first component—vertical forces (gravity/other) and incidental lateral forces—takes place on a Friday. The second component—lateral forces (wind/earthquake)—takes place on a Saturday. Each component comprises a morning breadth module and an afternoon depth module, as outlined in Table 1.

Each morning breadth module lasts four hours and contains 40 multiple-choice problems that cover a range of structural engineering topics specific to vertical and lateral forces. Each afternoon depth module also lasts four hours, but instead of multiple-choice problems, each module contains constructed-response (essay) problems. You may choose either the bridges or the buildings module within both exam components. That is, if you choose to work buildings for the vertical forces component, you must also work buildings for the vertical forces component.

According to NCEES, the vertical forces (gravity/other) and incidental lateral force module in buildings covers loads, lateral earth pressures, analysis methods, general structural considerations (e.g., element design), structural systems integration (e.g., connections), and foundations and retaining structures. The same depth module in bridges covers gravity loads, superstructures, substructures, and lateral loads other than wind and seismic. It may also require pedestrian bridge and/or vehicular bridge knowledge.

The lateral forces (wind/earthquake) depth module in buildings covers lateral forces, lateral force distribution, analysis methods, general structural considerations (e.g., element design), structural systems integration (e.g., connections), and foundations and retaining structures. The same depth module in bridges covers gravity loads, superstructures, substructures, and lateral forces. It may also require pedestrian bridge and/or vehicular bridge knowledge.

WHAT DOES “MOST NEARLY” REALLY MEAN?

One of the more disquieting aspects of the exam’s multiple-choice questions is that the available answer choices are seldom exact. Answer choices generally have only two or three significant digits. Exam questions ask, “Which answer choice is most nearly the correct value?” or they instruct you to complete the sentence, “The value is approximately …” A lot of self-confidence is required to move on to the next question when you don’t find an exact match for the answer you calculated, or if you have had to split the difference because no available answer choice is close.

NCEES has described it like this.

Many of the questions on NCEES exams require calculations to arrive at a numerical answer. Depending on the method of calculation used, it is very possible that examinees working correctly will arrive at a range of answers. The phrase “most nearly” is used to accommodate answers that have been derived correctly but that may be slightly different from the correct answer choice given on the exam. You should use good engineering judgment when selecting your choice of answer. For example, if the question asks you to determine the load on a beam, you should literally select the answer option that is most nearly what you calculated, regardless of whether it is more or less than your calculated value. However, if the question asks you to size a beam to carry a load, you should select an answer option that will safely carry the load. Typically, this requires selecting a value that is closest to but larger than the load.

The difference is significant. Suppose you were asked to calculate “most nearly” the volumetric pure water flow required to dilute a contaminated stream to an acceptable concentration. Suppose, also, that you calculated 823 gpm. If the answer choices were (A) 600 gpm, (B) 800 gpm, (C) 1000 gpm, and (D) 1200 gpm, you would go with answer choice (B), because it is most nearly what you calculated. If, however, you were asked to select a pump or pipe with the same rated capacities, you would have to go with choice (C). Got it?

HOW MUCH MATHEMATICS IS NEEDED FOR THE EXAM?

There are no pure mathematics questions (algebra, geometry, trigonometry, etc.) on the SE exam. However, you will need to apply your knowledge of these subjects to the exam questions.

Generally, only simple algebra, trigonometry, and geometry are needed on the SE exam. You will need to use trigonometric, logarithm, square root, exponentiation, and similar buttons on your calculator. There is no need to use any other method for these functions.

Except for simple quadratic equations, you will probably not need to find the roots of higher-order equations. Occasionally, it will be convenient to use the equation-solving capability of an advanced calculator. However, other solution methods will always exist. For second-order (quadratic) equations, it does not matter if you find roots by factoring, completing the square, using the quadratic equation, or using your calculator’s root finder.
### Table 1  NCEES SE Exam Component/Module Specifications

#### Friday: vertical forces (gravity/other) and incidental lateral forces

<table>
<thead>
<tr>
<th>Morning Breadth Module</th>
<th>Analysis of Structures (13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 hours</td>
<td>Generation of Loads (5)</td>
</tr>
<tr>
<td>40 multiple-choice problems</td>
<td>Load Distribution and Analysis Methods (8)</td>
</tr>
</tbody>
</table>

- Design and details of structures (27)
- General structural considerations (3)
- Structural systems integration (2)
- Structural steel (5)
- Cold-formed steel (1)
- Concrete (5)
- Wood (4)
- Masonry (3)
- Foundations and retaining structures (4)

#### Afternoon Depth Module^b^ | Buildings^c^

<table>
<thead>
<tr>
<th>4 hours</th>
<th>Steel Structure (25% of your score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essay Problems</td>
<td>Concrete Structure (25% of your score)</td>
</tr>
<tr>
<td></td>
<td>Wood Structure (25% of your score)</td>
</tr>
<tr>
<td></td>
<td>Masonry Structure (25% of your score)</td>
</tr>
</tbody>
</table>

- Bridges
- Concrete Superstructure (25% of your score)
- Other elements of bridges (e.g., culverts, abutments, and retaining walls) (25% of your score)
- Steel superstructure (50% of your score)

#### Saturday: lateral forces (wind/earthquake)

<table>
<thead>
<tr>
<th>Morning Breadth Module</th>
<th>Analysis of Structures (15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 hours</td>
<td>Generation of Loads (7)</td>
</tr>
<tr>
<td>40 multiple-choice problems</td>
<td>Load Distribution and Analysis Methods (8)</td>
</tr>
</tbody>
</table>

- Design and detailing of structures (25)
- General structural considerations (3)
- Structural systems integration (2)
- Structural steel (5)
- Cold-formed steel (1)
- Concrete (5)
- Wood (3)
- Masonry (3)
- Foundations and retaining structures (3)

#### Afternoon Depth Module^a^ | Buildings^c^

<table>
<thead>
<tr>
<th>4 hours</th>
<th>Steel Structure (25% of your score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essay Problems</td>
<td>Concrete Structure (25% of your score)</td>
</tr>
<tr>
<td></td>
<td>Wood and/or Masonry Structure (25% of your score)</td>
</tr>
<tr>
<td></td>
<td>General Analysis (e.g., existing structures, secondary structures, nonbuilding structures, and/or computer verification) (25% of your score)</td>
</tr>
</tbody>
</table>

- Bridges
- Piers or Abutments (25% of your score)
- Foundations (25% of your score)
- General analysis of seismic forces (50% of your score)

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^a^Afternoon sessions focus on a single area of practice. You must choose either the buildings or bridges depth module, and you must work the same depth module across both exam components.

^b^At least one problem will contain a multistory building, and at least one problem will contain a foundation.

^c^At least two problems will include seismic content with a seismic design category of D or above. At least one problem will include wind content with a base wind speed of at least 110 mph. Problems may include a multistory building and/or a foundation.
There is little or no use of calculus on the exam. Rarely, you may need to take a simple derivative to find a maximum or minimum of some function. Even rarer is the need to integrate to find an average, moment of inertia, statical moment, or shear flow.

Basic statistical analysis of observed data may be necessary. Statistical calculations are generally limited to finding means, medians, standard deviations, variances, percentiles, and confidence limits. Usually, the only population distribution you need to be familiar with is the normal curve. Probability, reliability, hypothesis testing, and statistical quality control are not explicit exam subjects, though their concepts may appear peripherally in some problems.

The SE exam is concerned with numerical answers, not with proofs or derivations. You will not be asked to prove or derive formulas.

Occasionally, a calculation may require an iterative solution method. Generally, there is no need to complete more than two iterations. You will not need to program your calculator to obtain an “exact” answer. Nor will you generally need to use complex numerical methods.

IS THE EXAM TRICKY?

Other than providing superfluous data, the SE exam is not a “tricky exam.” The exam questions are difficult in their own right. NCEES does not provide misleading or conflicting statements to try to get you to fail. However, commonly made mistakes are represented in the available answer choices. Thus, the alternative answers (known as distractors) will be logical.

Questions are generally practical, dealing with common and plausible situations that you might experience in your job. You will not be asked to design a structure for reduced gravity on the moon, to design a mud-brick road, to analyze the effects of a nuclear bomb blast on a structure, or to use bamboo for tension reinforcement.

WHAT MAKES THE QUESTIONS DIFFICULT?

Some questions are difficult because they defy the imagination. Three-dimensional structural questions fit this description. If you cannot visualize the question, you probably cannot solve it.

Some questions are difficult because the computational burden is high, and they just take a long time.

Some questions are difficult because the terminology is obscure, and you may not know what the terms mean. This can happen in almost any subject.

WHAT REFERENCE MATERIAL IS PERMITTED IN THE EXAM?

The SE exam is an open-book exam. Check your state’s exam requirements and restrictions, as some states restrict which books and materials can be used for the exam. (The PPI website has a listing of state boards at ppi2pass.com/stateboards.)

Personal notes in a three-ring binder and other semipermanent covers can usually be used. Some states use a “shake test” to eliminate loose papers from binders. Make sure that nothing escapes from your binders when they are inverted and shaken.

The references you bring into the exam room in the morning do not have to be the same as the references you use in the afternoon. However, you cannot share books with other examinees during the exam.

A few states do not permit collections of solved problems such as Schaum’s Outline Series, sample exams, and solutions manuals. A few states maintain a formal list of banned books.

Strictly speaking, loose paper and scratch pads are not permitted in the exam. Certain types of preprinted graphs and logarithmically scaled graph papers (which are almost never needed) should be three-hole punched and brought in a three-ring binder. An exception to this restriction may be made for laminated and oversize charts, graphs, and tables that are commonly needed for particular types of questions. However, there probably aren’t any such items for the SE exam.

MAY TABS BE PLACED ON PAGES?

It is common to tab pages in your books in an effort to reduce the time required to locate useful sections. Inasmuch as some states consider Post-it notes to be “loose paper,” your tabs should be of the more permanent variety. Although you can purchase tabs with gummed attachment points, it is also possible to use transparent tape to attach the Post-its you have already placed in your books.
CAN YOU WRITE AND MARK IN YOUR BOOKS?

During your preparation, you may write anything you want, anywhere in your books, including this one. You can use pencil, pen, or highlighter in order to further your understanding of the content. However, during the exam, you must avoid the appearance of taking notes about the exam. This means that you should write only on the scratch paper that is provided. During the exam, other than drawing a line across a wide table of numbers, you should not write in your books.

WHAT ABOUT CALCULATORS?

The SE exam requires the use of a scientific calculator. It is a good idea to bring a spare calculator with you to the exam.

NCEES has banned communicating and text-editing calculators from the exam site. Only select types of calculators are permitted. Check the current list of permissible devices at the PPI website (ppi2pass.com/calculators). Contact your state board to determine if non-graphing and specialty slide rules are permitted.

The exam has not been optimized for any particular brand or type of calculator. In fact, for most calculations, a $15 scientific calculator will produce results as satisfactory as those from a $200 calculator. There are definite benefits to having built-in statistical functions, graphing, unit-conversion, and equation-solving capabilities. However, these benefits are not so great as to give anyone an unfair advantage.

It is essential that a calculator used for the SE exam have the following functions:

- trigonometric and inverse trigonometric functions
- hyperbolic and inverse hyperbolic functions
- \( \pi \)
- \( \sqrt{x} \) and \( x^2 \)
- both common and natural logarithms
- \( y^x \) and \( e^x \)

You may not share calculators with other examinees.

Laptops, tablet computers, and electronic readers are not permitted in the exam. Their use has been considered, but no states actually permit them.

You may not use a walkie-talkie, cell phone, or other communications or text-messaging device during the exam.

Be sure to take your calculator with you whenever you leave the exam room for any length of time.

HOW ARE THE EXAM COMPONENTS GRADED AND SCORED?

For the morning multiple-choice problems, answers are recorded on an answer sheet that is machine graded. The minimum number of points for passing (referred to by NCEES as the “cut score”) varies from administration to administration. The cut score is determined through a rational procedure, without the benefit of knowing examinees’ performance on the exam. That is, the exam is not graded on a curve. The cut score is selected based on what you are expected to know, not on allowing a certain percentage of engineers “through.”

The grading of multiple-choice problems is straightforward, since a computer grades your score sheet. Either you get the problem right or you don’t. There is no deduction for incorrect answers, so guessing is encouraged. However, if you mark two or more answers, no credit is given for the problem.

Solutions for the afternoon essay problems are evaluated for overall compliance with established scoring criteria and for general quality. The scores from each of the morning and afternoon modules are combined for a component’s final score.

Exam results are given a pass/fail grade approximately 10–12 weeks after the exam date. You will receive the results of your exam from either your state board by mail or online through your MyNCEES account. You will receive a pass or fail notice only and will not receive a numerical score. Diagnostic reports that outline areas of strength and weakness are provided to those who do not pass.

HOW YOU SHOULD GUESS

NCEES produces defensible licensing exams. As a result, there is no pattern to the placement of correct responses. Therefore, it most likely will not help you to guess all “A,” “B,” “C,” or “D.”

The proper way to guess is as an engineer. You should use your knowledge of the subject to eliminate illogical answer choices. Illogical answer choices are those that violate good engineering principles, that are outside normal operating ranges, or that require extraordinary assumptions. Of course, this requires you to have some basic understanding of the subject in the first place. Otherwise, it’s back to random guessing. That’s the reason that the minimum passing score is higher than 25%.

You won’t get any points using the “test-taking skills” that helped with tests prepared by amateurs. You won’t be able to eliminate any [verb] answer choices from “Which [noun] …” questions. You won’t find
problems with options of the “more than 50” and “less than 50” variety. You won’t find one answer choice among the four that has a different number of significant digits, or has a verb in a different tense, or has some singular/plural discrepancy with the stem. The distractors will always match the stem, and they will be logical.

**CHEATING AND EXAM SUBVERSION**

There aren’t very many ways to cheat on an open-book exam. The proctors are well trained in spotting the few ways that do exist. It goes without saying that you should not talk to other examinees in the room, nor should you pass notes back and forth. You should not write anything into your books or take notes on the contents of the exam. The number of people who are released to use the restroom may be limited to prevent discussions.

NCEES regularly reuses good problems that have appeared on previous exams. Therefore, exam integrity is a serious issue with NCEES, which goes to great lengths to make sure nobody copies the questions. You may not keep your exam booklet, enter text from questions into your calculator, or copy problems into your own material.

The proctors are concerned about exam subversion, which generally means activity that might invalidate the exam or the exam process. The most common form of exam subversion involves trying to copy exam problems for future use.

NCEES has become increasingly unforgiving about the loss of its intellectual property. NCEES routinely prosecutes violators and seeks financial redress for loss of its exam problems, as well as invalidating any engineering license you may have earned by taking one of its exams while engaging in prohibited activities. Your state board may impose additional restrictions on your right to retake any exam if you are convicted of such activities. In addition to tracking down the sources of any exam problem compilations that it becomes aware of, NCEES is also aggressive in pursuing and prosecuting examinees who disclose the contents of the exam in internet forum and “chat” environments. Your constitutional rights to free speech and expression will not protect you from civil prosecution for violating the nondisclosure agreement that NCEES requires you to sign before taking the exam. If you wish to participate in a dialogue about a particular exam subject, you must do so in such a manner that does not violate the essence of your nondisclosure agreement. This requires decoupling your discussion from the exam and reframing the question to avoid any exam particulars.

**PART 3: HOW TO PREPARE FOR AND PASS THE SE EXAM**

**WHAT SHOULD YOU STUDY?**

The exam covers many diverse subjects. Strictly speaking, you don’t have to study every subject on the exam in order to pass. However, the more subjects you study, the more you’ll improve your chances of passing. You should decide early in the preparation process which subjects you are going to study. The strategy you select will depend on your background. The four most common strategies are as follows.

- A broad approach is the key to success for examinees who have recently completed their academic studies. This strategy is to review the fundamentals of a broad range of undergraduate subjects (which means studying all or most of the chapters in this book). The exam includes enough fundamental problems to make this strategy worthwhile. Overall, it’s the best approach.

- Engineers who have little time for preparation tend to concentrate on the subject areas in which they hope to find the most problems. By studying the list of exam subjects, some have been able to focus on those subjects that will give them the highest probability of finding enough problems that they can answer. This strategy works as long as the exam has enough of the types of questions they need. Too often, though, examinees who pick and choose subjects to review can’t find enough problems to complete the exam.

- Engineers who have been away from classroom work for a long time tend to concentrate on the subjects in which they have had extensive experience, in the hope that the exam will feature lots of problems in those subjects. This method is seldom successful.

- Some engineers plan on modeling their solutions from similar problems they have found in textbooks, collections of solutions, and old exams. These engineers often spend a lot of time compiling and indexing the example and sample problem types in all of their books. This is not a legitimate preparation method, and it is almost never successful.

**HOW LONG SHOULD YOU STUDY?**

We’ve all heard stories of the person who didn’t crack a book until the week before the exam and still passed it with flying colors. Yes, these people really exist. However, I’m not one of them, and you probably aren’t either. In fact, I’m convinced that these people are as rare as the ones who have taken the exam five times and still can’t pass it.
A thorough review takes approximately 300 hours. Most of this time is spent solving problems. Some of it may be spent in class; some is spent at home. Some examinees spread this time over a year. Others cram it all into two months. Most classroom review courses last for three or four months. The best time to start studying will depend on how much time you can spend per week.

**DO YOU NEED A REVIEW SCHEDULE?**

It is important that you develop and adhere to a review outline and schedule. Once you have decided which subjects you are going to study, you can allocate the available time to those subjects in a manner that makes sense to you. If you are not taking a classroom review course (where the order of preparation is determined by the lectures), you should make an outline of subjects for self-study to use for scheduling your preparation. A fill-in-the-dates schedule is provided in Table 2 at the end of this introduction.

**A SIMPLE PLANNING SUGGESTION**

Designate some location (a drawer, a corner, a cardboard box, or even a paper shopping bag left on the floor) as your “exam catch-all.” Use your catch-all during the months before the exam when you have revelations about things you should bring with you. For example, you might realize that the plastic ruler marked off in tenths of an inch that is normally kept in the kitchen junk drawer can help you with some soil pressure questions. Or you might decide that a certain book is particularly valuable, or that it would be nice to have dental floss after lunch, or that large rubber bands and clips are useful for holding books open.

It isn’t actually necessary to put these treasured items in the catch-all during your preparation. You can, of course, if it’s convenient. But if these items will have other functions during the time before the exam, at least write yourself a note and put the note into the catch-all. When you go to pack your exam kit a few days before the exam, you can transfer some items immediately, and the notes will be your reminders for the other items that are back in the kitchen drawer.

**HOW YOU CAN MAKE YOUR REVIEW REALISTIC**

During the exam, you must be able to recall solution procedures, formulas, and important data quickly. You must remain sharp for eight hours or more. If you played a sport back in school, your coach tried to put you in game-related situations. Preparing for the SE exam isn’t much different than preparing for a big game. Some part of your preparation should be realistic and representative of the exam environment.

There are several things you can do to make your review more representative. For example, if you gather most of your review resources (i.e., books) in advance and try to use them exclusively during your review, you will become more familiar with them. (Of course, you can also add to or change your references if you find inadequacies.)

Learning to use your time wisely is one of the most important lessons you can learn during your review. You will undoubtedly encounter questions that end up taking much longer than you expected. In some instances, you will cause your own delays by spending too much time looking through books for things you need (or just by looking for the books themselves!). Other times, the questions will entail too much work. It is important that a portion of your review involves solving problems so that you learn to recognize these situations and so that you can make intelligent decisions about skipping such questions during the exam.

Two realistic review books that you can use during your exam preparation to practice solving problems include *Structural Engineering Solved Problems for the SE Exam* (published by PPI), and *SE Structural Engineering Buildings Practice Exam* (published by PPI).

**WHAT TO DO A FEW DAYS BEFORE THE EXAM**

There are a few things you should do a week or so before the exam.

You should arrange for childcare and transportation. Since the exam does not always start or end at the designated time, make sure that your childcare and transportation arrangements are flexible.

Check PPI’s website for last-minute updates and errata to any PPI books you might have and are bringing to the exam.

Obtain a separate copy of this book’s index. You can photocopy the actual index; alternatively, the index is available as a download on PPI’s website, ppi2pass.com/strmindex.

If it’s convenient, visit the exam location in order to find the building, parking areas, exam room, and restrooms. If it’s not convenient, you can find driving directions and/or site maps online.

Take the battery cover off your calculator and check to make sure you are bringing the correct size replacement batteries. Some calculators require a different kind of battery for their “permanent” memories. Put the cover back on and secure it with a piece of masking tape. Write your name on the tape to identify your calculator.

If your spare calculator is not the same as your primary calculator, spend a few minutes familiarizing yourself with how it works. In particular, you should verify that your spare calculator is functional.
PREPARE YOUR CAR

[ ] Gather snow chains, shovel, and tarp to kneel on while installing chains.
[ ] Check tire pressures.
[ ] Check your car’s spare tire.
[ ] Check for tire installation tools.
[ ] Verify that you have the vehicle manual.
[ ] Check fluid levels (oil, gas, water, brake fluid, transmission fluid, window-washing solution).
[ ] Fill up car with gas.
[ ] Check battery and charge if necessary.
[ ] Know something about your fuse system (where they are, how to replace them, etc.).
[ ] Assemble all required maps.
[ ] Fix anything that might slow you down (missing wiper blades, etc.).
[ ] Check your car’s taillights.
[ ] Affix the current DMV registration sticker.
[ ] Fix anything that might get you pulled over on the way to the exam (burned-out taillight or headlight, broken lenses, bald tires, missing license plate, noisy muffler, etc.).
[ ] Treat the inside windows with anti-fog solution.
[ ] Put a roll of paper towels in the back seat.
[ ] Gather exact change for any bridge tolls or toll roads.
[ ] Put $20 in your car’s glove box.
[ ] Check for current registration and proof of insurance.
[ ] Locate a spare door and ignition key.
[ ] Find your roadside-assistance cards and phone numbers.
[ ] Plan alternate routes.

PREPARE YOUR EXAM KITS

Second in importance to your scholastic preparation is the preparation of your two exam kits. The first kit consists of a bag, box (plastic milk crates hold up better than cardboard in the rain), or wheeled travel suitcase containing items to be brought with you into the exam room.

[ ] your exam authorization notice
[ ] government-issued photo identification (e.g., driver’s license)
[ ] this book
[ ] other textbooks and reference books
[ ] regular dictionary
[ ] scientific/engineering dictionary
[ ] review course notes in a three-ring binder
[ ] cardboard boxes or plastic milk crates to use as bookcases
[ ] primary calculator
[ ] spare calculator
[ ] instruction booklets for your calculators
[ ] extra calculator batteries
[ ] straightedge and rulers
[ ] compass
[ ] protractor
[ ] scissors
[ ] stapler
[ ] transparent tape
[ ] magnifying glass
[ ] small (jeweler’s) screwdriver for fixing your glasses or for removing batteries from your calculator
[ ] unobtrusive (quiet) snacks or candies, already unwrapped
[ ] two small plastic bottles of water
[ ] travel pack of tissue (keep in your pocket)
[ ] handkerchief
[ ] headache remedy
[ ] personal medication
[ ] $5.00 in miscellaneous change
[ ] back-up reading glasses
[ ] light, comfortable sweater
[ ] loose shoes or slippers
[ ] cushion for your chair
[ ] earplugs
[ ] wristwatch
[ ] several large trash bags (“raincoats” for your boxes of books)
[ ] roll of paper towels
[ ] wire coat hanger (to hang up your jacket)
[ ] extra set of car keys

The second kit consists of the following items and should be left in a separate bag or box in your car in case they are needed.

[ ] copy of your application
[ ] proof of delivery
[ ] light lunch
[ ] beverage in thermos or cans
[ ] sunglasses
[ ] extra pair of prescription glasses
[ ] raincoat, boots, gloves, hat, and umbrella
[ ] street map of the exam area
[ ] parking permit
[ ] battery-powered desk lamp
[ ] your cell phone
[ ] piece of rope

**PREPARE FOR THE WORST**

All of the occurrences listed in this section have happened to examinees. Granted, you cannot prepare for every eventuality. But even though each occurrence is a low-probability event, taken together these occurrences are worth considering in advance.

- Imagine getting a flat tire, getting stuck in traffic, or running out of gas on the way to the exam.
- Imagine rain and snow as you are carrying your cardboard boxes into the exam room. Would plastic trash bags be helpful?
- Imagine arriving late. Can you get into the exam without having to make two trips from your car?
- Imagine having to park two blocks from the exam site. How are you going to get everything to the exam room? Can you actually carry everything that far? Could you use a furniture dolly, a supermarket basket, or perhaps a helpmate?
- Imagine a Star Trek convention, a square-dancing contest, construction, or an auction taking place in the next room.
- Imagine a site without any heat, with poor lighting, or with sunlight streaming directly into your eyes.
- Imagine a hard folding chair and a table with one short leg.
- Imagine a site next to an airport with frequent take-offs, or next to a construction site with a pile driver, or next to the NHRA State Championship.
- Imagine a seat where someone nearby chews gum with an open mouth; taps his pencil or drums her fingers; or wheezes, coughs, and sneezes for eight hours.
- Imagine the distraction of someone crying or of proctors evicting yelling and screaming examinees who have been found cheating. Imagine the tragedy of another examinee’s serious medical emergency.
- Imagine a delay of an hour while they find someone to unlock the building, turn on the heat, or wait for the head proctor to bring instructions.
- Imagine a power outage occurring sometime during the exam.
- Imagine a proctor who (a) tells you that one of your favorite books can’t be used during the exam, (b) accuses you of cheating, or (c) calls “time’s up” without giving you any warning.
- Imagine not being able to get your lunch out of your car or find a restaurant.
- Imagine getting sick or nervous during the exam.
- Imagine someone stealing your calculator during lunch.

**WHAT TO DO THE DAY BEFORE THE EXAM**

Take the day before the exam off from work to relax. Do not cram. A good night’s sleep is the best way to start the exam. If you live a considerable distance from the exam site, consider getting a hotel room in which to spend the night.

Practice setting up your exam work environment. Carry your boxes to the kitchen table. Arrange your “bookcases” and supplies. Decide what stays on the floor in boxes and what gets an “honored position” on the tabletop.

Use your checklist to make sure you have everything. Make sure your exam kits are packed and ready to go. Wrap your boxes in plastic bags in case it’s raining when you carry them from the car to the exam room.

Calculate your wake-up time and set the alarms on two bedroom clocks. Select and lay out your clothing items. (Dress in layers.) Select and lay out your breakfast items.

If it’s going to be hot on exam day, put your (plastic) bottles of water in the freezer.

Make sure you have gas in your car and money in your wallet.

**WHAT TO DO THE DAY OF THE EXAM**

Turn off the quarterly and hourly alerts on your wrist-watch. Leave your cell phone in your car. If you must bring it, set it on silent mode. Bring a morning newspaper.

You should arrive at least 30 minutes before the exam starts. This will allow time for finding a convenient parking place, bringing your materials to the exam room, adjusting to room and seating changes, and calming down. Be prepared, though, to find that the exam room is not open or ready at the designated time.

**WHAT TO DO DURING THE EXAM**

All of the procedures typically associated with timed, proctored, computer-graded assessment tests will be in effect when you take the SE exam.
The proctors will distribute the exam booklets and answer sheets if they are not already on your tables. You should not open the booklets until instructed to do so. You may read the information on the front and back covers, and you should write your name in the appropriate blank spaces.

Listen carefully to everything the proctors say. Do not ask your proctors any engineering questions. Even if they are knowledgeable in engineering, they will not be permitted to answer your questions.

Answers to questions are recorded on an answer sheet contained in the test booklet. The proctors will guide you through the process of putting your name and other biographical information on this sheet when the time comes, which will take approximately 15 minutes. You will be given the full four hours to answer questions. Time to initialize the answer sheet is not part of your four hours.

The common suggestions to “completely fill the bubbles, and erase completely” apply here. NCEES provides each examinee with a mechanical pencil with HB lead. Use of ballpoint pens and felt-tip markers is prohibited.

If you finish the exam early and there are still more than 30 minutes remaining, you will be permitted to leave the room. If you finish less than 30 minutes before the end of the exam, you may be required to remain until the end. This is done to be considerate of the people who are still working.

When you leave, you must return your exam booklet. You may not keep the exam booklet for later review.

If there are any questions that you think were flawed, in error, or unsolvable, ask a proctor for a “reporting form” on which you can submit your comments. Follow your proctor’s advice in preparing this document.

**HOW TO SOLVE MULTIPLE-CHOICE QUESTIONS**

When you begin each session of the exam, observe the following suggestions.

- Use only the pencil provided.
- Do not spend an inordinate amount of time on any single question. If you have not answered a question in a reasonable amount of time, make a note of it and move on.
- Set your wristwatch alarm for five minutes before the end of each four-hour session, and use that remaining time to guess at all of the remaining questions. Odds are that you will be successful with about 25% of your guesses, and these points will more than make up for the few points that you might earn by working during the last five minutes.
- Make mental notes about any questions for which you cannot find a correct response, that appear to have two correct responses, or that you believe have some technical flaw. Errors in the exam are rare, but they do occur. Such errors are usually discovered during the scoring process and discounted from the exam, so it is not necessary to tell your proctor, but be sure to mark the one best answer before moving on.
- Make sure all of your responses on the answer sheet are dark. Completely fill the bubbles.

**SOLVE QUESTIONS CAREFULLY**

Many points are lost to carelessness. Keep the following items in mind when you are solving the end-of-chapter questions. Hopefully, these suggestions will be automatic during the exam.

- Did you recheck your mathematical equations?
- Do the units cancel out in your calculations?
- Did you convert between radius and diameter?
- Did you convert between feet and inches?
- Did you convert from gage to absolute pressures?
- Did you convert between kPa and Pa?
- Did you recheck all data obtained from other sources, tables, and figures?

**SHOULD YOU TALK TO OTHER EXAMINEES AFTER THE EXAM?**

The jury is out on this question. People react quite differently to the exam experience. Some people are energized. Most are exhausted. Some people need to unwind by talking with other examinees, describing every detail of their experience, and dissecting every exam question. Other people need lots of quiet space. Most engineers are in this latter category.

Since everyone who took the exam has seen it, you will not be violating your “oath of silence” if you talk about the details with other examinees immediately after the exam. It’s difficult not to ask how someone else approached a question that had you completely stumped. However, keep in mind that it is very disquieting to think you answered a question correctly, only to have someone tell you where you went wrong.

To ensure you do not violate the nondisclosure agreement you signed before taking the exam, make sure you do not discuss any exam particulars with people who have not also taken the exam.
AFTER THE EXAM

Yes, there is something to do after the exam. Most people go home, throw their exam “kits” into the corner, and collapse. A week later, when they can bear to think about the experience again, they start integrating their exam kits back into their normal lives. The calculators go back into the drawer, the books go back on the shelves, the $5.00 in change goes back into the piggy bank, and all of the miscellaneous stuff brought to the exam is put back wherever it came.

Here’s what I suggest you do as soon as you get home.

[ ] Thank your partner and children for helping you during your preparation.
[ ] Take any paperwork you received on exam day out of your pocket, purse, or wallet. Put this inside your SE Structural Engineering Reference Manual.
[ ] Reflect on any statements regarding exam secrecy to which you signed your agreement.
[ ] Call your employer and tell him/her that you need to take a mental health day on Monday.

A few days later, when you can face the world again, do the following.

[ ] Make notes about anything you would do differently if you had to take the exam over again.
[ ] Consolidate all of your application paperwork, correspondence to/from your state, and any paperwork that you received on exam day.
[ ] If you took a live prep course, call or email the instructor (or write a note) to say, “Thanks.”
[ ] Return any books you borrowed.
[ ] Write thank-you notes to all of the people who wrote letters of recommendation or reference for you.
[ ] Find and read the chapter in this book that covers ethics. There were no ethics questions on your SE exam, but it doesn’t make any difference. Ethical behavior is expected of an SE in any case. Spend a few minutes reflecting on how your performance (obligations, attitude, presentation, behavior, appearance, etc.) might be about to change once you are licensed. Consider how you are going to be a role model for others around you.
[ ] Put all of your review books, binders, and notes someplace where they will be out of sight.

FINALLY

By the time you’ve “undone” all of your preparations, you might have thought of a few things that could help future examinees. If you have any sage comments about how to prepare, any suggestions about what to do during or bring to the exam, any comments on how to improve this book, or any funny anecdotes about your experience, I hope you will share these with me.

AND THEN, THERE’S THE WAIT …

Waiting for the exam results is its own form of mental torture.

Although the actual machine grading “only takes seconds,” consider the following facts: (a) NCEES prepares multiple exams for each administration, in case one becomes unusable (i.e., is inappropriately released) before the exam date. (b) Since the actual version of the exam used is not known until after it is finally given, the cut score determination occurs after the exam date.

I wouldn’t be surprised to hear that NCEES receives dozens, if not hundreds, of claims from well-meaning examinees who were 100% certain that the exams they took were fatally flawed to some degree—that there wasn’t a correct answer for such-and-such question—that there were two answers for such-and-such question—or even, perhaps, that such-and-such question was missing from their exam booklet altogether. Each of these claims must be considered as a potential adjustment to the cut score.

Then the exams must actually be graded. Since grading nearly 50,000 exams (counting all the FE and PE exams) requires specialized equipment, software, and training not normally possessed by the average employee, as well as time to do the work (also not normally possessed by the average employee), grading is invariably outsourced.

Outsourced grading cannot begin until all of the states have returned their score sheets to NCEES and NCEES has sorted, separated, organized, and consolidated the score sheets into whatever sequence is best. During grading, some of the score sheets “pop out” with any number of abnormalities that demand manual scoring.

After the individual exams are scored, the results are analyzed in a variety of ways. Some of the analysis looks at passing rates by such delineators as degree, major, university, site, and state. Part of the analysis looks for similarities between physically adjacent examinees (to look for cheating). Part of the analysis looks for exam sites that have statistically abnormal group performance. And some of the analysis looks for exam questions that have a disproportionate fraction of successful or unsuccessful examinees. Anyway, you get the idea: Grading is not merely putting your exam sheet in an
electronic reader. All of these steps have to be completed for 100% of the examinees before any results can go out.

Once NCEES has graded your test and notified your state, when you hear about it depends on when the work is done by your state. Some states have to approve the results at a board meeting; others prepare the certificates before sending out notifications. Some states are more computerized than others. Some states have 50 examinees, while others have 10,000. Some states are shut down by blizzards and hurricanes; others are administratively challenged—understaffed, inadequately trained, or over budget.

There is no pattern to the public release of results. None. The exam results are not released to all states simultaneously. (The states with the fewest examinees often receive their results soonest.) They are not released alphabetically by state or examinee name. The people who failed are not notified first (or last). Your coworker might receive his or her notification today, and you might be waiting another three weeks for yours.

Some states post the names of the successful examinees, unsuccessful examinees, or both on their official state websites before the results go out. Others update their websites after the results go out. Some states don’t list much of anything on their websites.

Remember, too, that the size or thickness of the envelope you receive from your state does not mean anything. Some states send a big congratulations package and certificate. Others send a big package with a new application to repeat the exam. Some states send a postcard. Some send a one-page letter. Some states send you an invoice for your license fees. (Ahh, what a welcome bill!) You just have to open it to find out.

AND WHEN YOU PASS ...

[ ] Celebrate.
[ ] Notify the people who wrote letters of recommendation or reference for you.
[ ] Ask your employer for a raise.
[ ] Tell the folks at PPI (who have been rootin’ for you all along) the good news.
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