Contemporary Mathematics

CREDIT HOURS 3

LEVEL LOWER

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Before You Choose This UExcel Exam

Uses for the Examination

- Excelsior College, the test developer, recommends granting three (3) semester hours of lower-level undergraduate credit to students who receive a letter grade of C or higher on this examination. The examination may be used to help fulfill the quantitative requirement for all Excelsior College degree programs that do not specify a higher level of math.

- Other colleges and universities also recognize this exam as a basis for granting credit or advanced standing.

- Individual institutions set their own policies for the amount of credit awarded and the minimum acceptable score.

Exam-takers enrolled in an Excelsior College degree program should ask their academic advisor where this exam fits within their degree program.

Exam-takers not enrolled in an Excelsior College degree program should check with the institution from which they wish to receive credit to determine whether credit will be granted and/or to find out the minimum grade required for credit. Those who intend to enroll in an Excelsior College degree program should ask an admissions counselor where this exam fits within their intended degree program.

For more information on exam availability and actual testing information, see the Exam Registration and Information Guide.

Examination Length and Scoring

The exam consists of approximately 60 questions. Most are single-answer, multiple-choice questions; one is a multiple-answer, multiple-choice question; see the sample questions at the back of this guide. You will have two (2) hours to complete the exam. Your score will be reported as a letter grade. Questions are scored either correct (1) or incorrect (0). There is no partial credit. Each credit-bearing exam contains pretest questions, which are embedded throughout the exam. They are indistinguishable from the scored questions. It is to your advantage to do your best on all the questions. Pretest questions are being tried out for use in future versions of the exam.

The UExcel exams do not have a fixed grading scale such as A = 90–100%, B = 80–90%, and so forth, as you might have seen on some exams in college courses. Each UExcel test has a scale that is set by a faculty committee and is different for each exam. The process, called standard setting, is described in more detail in the Technical Handbook. Excelsior puts each exam through a standard setting because different test questions have different levels of difficulty. To explain further, getting 70% of the questions right on the exam when the questions are easy does not show the same level of proficiency as getting 70% of questions correct when the questions are hard. Every form of a test (a form contains the test questions) has its own specific grading scale tailored to the particular questions on each exam form.

Please also note that on each form, some of the questions count toward the score and some do not; the grading scale applies only to those questions that count toward the score. The area with percentage ratings on the second page of your score report is intended to help identify relative strengths and weaknesses and which
content areas to emphasize, should you decide to take the examination again. Your grade is **based on both scored and pretest questions—pretest questions which are not scored**. Therefore, the percentage ratings do not necessarily reflect the total percentage that counted toward your grade.

For the best view of the types of questions on this exam, see the sample questions in the back of this guide. Practice, practice, practice!

### Score Reporting

For most of our examinations, based on performance, an examinee is awarded a letter grade of A, B, C, or F along with diagnostic information describing examinee performance in each of the major content areas in any given exam. A letter grade of D can be given, but credit is awarded for A, B, and C letter grades only. The letter grades reported to examinees indicate that their performance was equivalent to the performance of students who received the same letter grade in a comparable, on-campus course.

More specifically, the letter grade indicates the examinee’s proficiency relative to the learning outcomes specified in the exam content guide. Following are general descriptions of examinee performance at each level:

### Letter Grade Description

**A**  Highly Competent: Examinee’s performance demonstrates an advanced level of knowledge and skill, relative to the learning outcomes.

**B**  Competent: Examinee’s performance demonstrates a good level of knowledge and skill, relative to the learning outcomes.

**C**  Marginally Competent: Examinee’s performance demonstrates a satisfactory level of knowledge and skill relative to the learning outcomes.

**D**  Not Competent (no credit recommended): Examinee’s performance demonstrates weak knowledge of the content and minimal skill relative to the learning outcomes.\(^1\)

**F**  Fail (no credit recommended): Examinee’s performance demonstrates no knowledge of the content and no skill in the subject relative to the learning outcomes.

Credit is transcribed by Excelsior College for examinees who achieve letter grades of C or higher.

We encourage colleges and universities to use the Excelsior College letter grades of A, B, and C as acceptable standards for awarding credit.

See page 21 for a sample UExcel Grade Report for Examinations, at the back of this content guide.

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### UExcel Exam Resources

#### Excelsior College Bookstore

The Excelsior College Bookstore offers recommended textbooks and other resources to help you prepare for UExcel exams.

The bookstore is available online at (login required): [www.excelsior.edu/bookstore](http://www.excelsior.edu/bookstore)

#### Excelsior College Library

Enrolled Excelsior College students can access millions of authoritative resources online through the Excelsior College Library. Created through our partnership with the Sheridan Libraries of The Johns Hopkins University, the library provides access to journal articles, books, websites, databases, reference services, and many other resources. Special library pages relate to the nursing degree exams and other selected exams. To access it, visit [www.excelsior.edu/library](http://www.excelsior.edu/library) (login is required).

Our library provides:

- 24/7 availability
- The world’s most current authoritative resources
- Help and support from staff librarians

#### Online Tutoring

Excelsior College offers online tutoring through SMARTTHINKING™ to connect with tutors who have been trained in a variety of academic subjects. To access SMARTTHINKING, go to [www.excelsior.edu/smarthinking](http://www.excelsior.edu/smarthinking). Once there, you may download a copy of the SMARTTHINKING Student Handbook as a PDF.

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\(^1\) In general, two hour exams do not award a D letter grade.
Preparing for UExcel Exams

Take Charge of Your Own Learning

At Excelsior College, independent, self-directed study supported by resources we help you find is not a new concept. We have always stressed to exam takers that they are acting as their own teacher, and that they should spend as much time studying for an exam as they would spend in a classroom and on homework for a corresponding college course in the same subject area.

Begin by studying the content outline contained in this content guide, at its most detailed level. You will see exactly which topics are covered, and where chapters on those topics can be found in the Recommended Resources. You will see exactly where you might need to augment your knowledge or change your approach.

The content outline, along with the Learning Outcomes for this exam and recommended textbooks, will serve as your primary resources.

How Long Will It Take Me to Study?

Study for a UExcel exam is comparable to an equivalent college-level course. As an independent learner, you should study and review as much as you would for the same subject in a campus-based college course. If you already have a background in the subject, you may be able to pass the exam successfully with fewer hours of study. It depends upon the learner as well as the subject, the number of credits (for example, a 6- or 8-credit exam will require more hours of study than a 3-credit exam), and the length of the exam. We strongly encourage you to create a long-term action, or study plan, so that you have a systematic approach to prepare for the exam. We’ve included guidelines for creating such a plan.

How Can I Create an Effective Long-Term Study Plan?

1. Determine the time you will require to complete your preparation for this exam. As a rule, you should plan to budget approximately 150 hours of study time for this exam. About 135 of those hours should be spent on studying the content alone. Aside from the content review, you should then factor in time to search for and use other resources, and to complete any projects and assignments in the study materials that will clarify your understanding of the topics in the content outline (that part in the content guide where the specific areas of study are spelled out). Spend more time on concepts and areas in which you feel you are weak. Totaled, this is approximately the amount of time you should expect to devote to a three-credit, campus-based course. The actual amount of time you require depends on many factors, and will be approximate. If your background is weak, you may need to set aside substantially more than 135–150 hours. If your background is strong, you may budget less time.

   Take a few minutes to review the content outline to assess your familiarity with the content. Then, in the space below, write the number of hours you will allocate to complete preparing for the exam.

   Hours Required = [ ]

2. Determine the time you will have available for study.

   In self-study, you need structure, as well as motivation and persistence, and a methodical approach to preparation. There is no set class to keep you on task. You have to do that yourself. Construct a time-use chart to record your daily activities over a one-week period. The most accurate way to do this is to complete the chart on a daily basis to record the actual amount of time you spend eating, sleeping, commuting, working, watching television, caring for others and yourself, reading, and everything else in an adult’s life. However, if your schedule is regular, you might prefer to complete the chart in one sitting and, perhaps, by consulting your appointment book or planner.

   After you have recorded your activities, you will be ready to schedule study periods around these activities or, perhaps, instead of some of them. In the space below, write the number of hours you will be able to set aside for study each week.

   Hours Required = [ ]
3. Divide the first number by the second number.

This will give you the number of weeks you will need to set aside for independent study. For example, if you think you will require 170 hours of study and you have 10 hours available to study each week, divide 170 hours by 10 hours and you will get 17. This means that you will need about 17 weeks to complete this course of study. However, you will also need to allow about a week for review and self-testing. Moreover, to be on the safe side, you should also add two weeks to allow for unforeseen obstacles and times when you know you will not be able to study (e.g., during family illnesses or holidays). So, in this case, you should allot a total of 18 to 19 weeks to complete your study.

4. Schedule your examination to coincide with the end of your study period.

For example, if you plan to allow 18 weeks for study, identify a suitable examination date and begin study at least 18 weeks before that date. (The date you begin study assumes that you will have received all of your study materials, particularly textbooks, by that time.)

5. Format a long-term study plan.

You will need to use a calendar, planner, or some other tool to format and track your long-term study plan. Choose a method that is convenient and one that keeps you aware of your study habits on a daily basis. Identify the days and exact hours of each day that you will reserve for study throughout your whole independent study period. Check to see that the total number of hours you designate for study on your long-term study plan adds up to the number of hours you have determined you will need to complete this course of study (Step 1).

6. Record in your long-term study plan the content you plan to cover during each study period.

Enter the session numbers, review, and examination preparation activities you will complete during each study period. While it is suggested that approximately 160–170 hours of study is required for this exam, each and every student may require different timelines based on their comfort with, and comprehension of, the material.

You now have a tentative personal long-term study plan. Keep in mind that you will have to adjust your study plan, perhaps several times, as you study. It is only by actually beginning to work systematically through the material, using the content outline, that you will be able to determine accurately how long you should allow for each unit.

What Learning Strategy Should I Use?

The following guidelines are intended to help you acquire the grounding in the knowledge and skills required for successful completion of this examination.

1. Approach learning with a positive attitude.

Most students are capable of learning subject content if they devote enough time and effort to the task. This devotion will give you a positive edge and a feeling of control.

2. Diligently complete the exact work you specified in your study plan.

Your study plan is being designed for the specific purpose of helping you achieve the learning outcomes for this exam.

3. Be an active learner.

You should actively engage in the learning process. Read critically, take notes, and continuously monitor your comprehension. Keep a written record of your progress, highlight content you find difficult to grasp, and seek assistance from someone in your learning community who can help you if you have difficulty understanding a concept.

4. Be patient: you may not understand everything immediately.

When encountering difficulty with new material, be patient with yourself and don’t give up. Understanding will come with time and further study. Sometimes you may need to take a break and come back to difficult material. This is especially true for any primary source material (original letters, documents, and so forth) that you may be asked to read. The content outline will guide you through the material and help you focus on key points. You will find that many concepts introduced in earlier sessions will be explained in more detail in later sessions.
5. Apply your learning to your daily life.

Use insights you gain from your study to better understand the world in which you live. Apply the learning whenever you can. Look for instances that support or contradict your reading on the subject.

6. Accommodate your preferred way of learning.

How do you learn best? Common ways to learn are reading, taking notes and making diagrams, and by listening to someone (on video or live). Others learn by doing. Do any of these descriptions apply to you? Or does your learning style vary with the learning situation? Decide what works for you and try to create a learning environment to accommodate your preferences.

Study Tips

Become an active user of the resource materials. Aim for understanding rather than memorization. The more active you are when you study, the more likely you will be to retain, understand, and apply the information.

The following techniques are generally considered to be active learning:

• **preview or survey** each chapter
• **highlight or underline text** you believe is important
• **write questions or comments** in the margins
• **practice re-stating content** in your own words
• **relate what you are reading** to the chapter title, section headings, and other organizing elements of the textbook
• **find ways to engage** your eyes, your ears, and your muscles, as well as your brain, in your studies
• **study with a partner or a small group**
  (if you are an enrolled student, search for partners on MyExcelsior Community)
• **prepare your review notes** as flashcards or create recordings that you can use while commuting or exercising

When you feel confident that you understand a content area, review what you have learned. Take a second look at the material to evaluate your understanding. If you have a study partner, the two of you can review by explaining the content to each other or writing test questions for each other to answer. Review questions from textbook chapters may be helpful for partner or individual study, as well.

Study smart for your UEExcel exam, and succeed with our Student Success Guide.

Using UEExcel Practice Exams

The Contemporary Mathematics exam has a corresponding practice exam, which is delivered in the Canvas learning platform.

The official UEExcel practice exams are highly recommended as part of your study plan. They can be taken using any computer with a supported Web browser such as Google Chrome.

A practice exam package containing two forms is available for this exam, for $75. To register for the practice exam, visit [www.excelsior.edu](http://www.excelsior.edu) and log into your MyExcelsior account. Please note: You must be registered for the corresponding credit-bearing exam first, before you can register for the practice exam.

Practice exams are not graded. Rather, they are intended to help you make sure you understand the subject and give you a sense of what the questions will be like on the exam for credit. Ideally, you would check any questions you got wrong, look at the explanations, and go back to the textbook to reinforce your understanding. After taking both forms of the practice exam, you should feel confident in your answers and confident that you know the material listed in the content outline.

Practice exams are one of the most popular study resources. Practice exams are typically shorter than the credit-bearing exam. Since the questions are drawn from the same pool of questions that appear on the credit-bearing exam, what you will see when you sit for the graded exam will be roughly the same. Used as intended, these practice exams will enable you to:

• Review the types of questions you may encounter on the actual exam.
• Practice testing on a computer in a timed environment.
• Practice whenever and wherever it is convenient for you.
• Take two different forms of a practice exam within a 180-day period. (We highly recommend that you take the first form of the practice exam as a pretest, early in the study period. Use the results to identify
Exam Preparation Strategies

Each learner is different. However, all learners should read the content outline in the exam’s Content Guide and ensure that they have mastered the concepts. For someone with no prior knowledge of the subject, a rule of thumb is 135 hours of study for a three-credit exam—this number is just to give you an idea of the level of effort you will need, more or less.

Content Guides

This content guide is the most important resource. It lists the outcomes, a detailed content outline of what is covered, and textbooks and other study resources. It also has sample questions and suggestions for how to study. Content guides are updated periodically to correspond with changes in particular examinations and in textbook editions. Test-takers can download any of the latest free UExcel content guides by visiting the individual exam page or from the list at www.excelsior.edu/contentguides.

Prior Knowledge

A familiarity with precalculus topics including algebra, trigonometry, and functions is assumed.

Using the Content Outline

Each content area in the content outline includes the most important sections of the recommended resources for that area. These annotations are not intended to be comprehensive. You may need to refer to other chapters in the recommended textbooks. Chapter numbers and titles may differ among textbook editions.

This content outline contains examples of the types of information you should study. Although these examples are numerous, do not assume that everything on the exam will come from these examples. Conversely, do not expect that every detail you study will appear on the exam. Any exam is only a broad sample of all the questions that could be asked about the subject matter.

Using the Sample Questions and Rationales

Each content guide provides sample questions to illustrate those typically found on the exam. These
questions are intended to give you an idea of the level of knowledge expected and the way questions are typically phrased. The sample questions do not sample the entire content of the exam and are not intended to serve as an entire practice test.

Recommended Resources for the UExcel Exam in Contemporary Mathematics

The resources listed below are recommended by the examination development committee for use preparing for this exam. Resources listed under “Exam Verification Resources” were used to verify all the questions on the exam. Please refer to the Content Outline to see which parts of the exam are covered by which of the Exam Verification Resources. Resources listed under “Supplemental Resources” provide additional material that may deepen or broaden your understanding of the subject, or that may provide an additional perspective. Textbook resources, both Exam Verification and Supplemental, are available for purchase at the Excelsior College Bookstore.

You should allow ample time to obtain resources and to study sufficiently before taking the exam, so plan appropriately and with care.

A word about textbook editions: Textbook editions listed in the UExcel content guides may not be the same as those listed in the bookstore. Textbook editions may not exactly match up in terms of table of contents and organization, depending upon the edition. However, our team of exam developers checks exam content against every new textbook edition to verify that all subject areas tested in the exam are still adequately available in the study materials. If needed, exam developers will list supplemental resources to ensure that all topics in the exam are still sufficiently covered. Public libraries may have the textbooks you need, or may be able to obtain them for you through interlibrary loan to reduce textbook costs. You may also consider financial aid, if you qualify, to further help defray the steep cost of textbooks. A section on OER has been included in this guide to help you locate additional resources to augment your study.

Exam Verification Resources

Supplemental Resources
There are no Supplemental Resources for the Contemporary Mathematics exam. For additional resources, please see open educational resources (OER).

Reducing Textbook Costs
Many students know it is less expensive to buy a used textbook, and buying a previous edition is also an option. The Excelsior College bookstore includes a buyback feature and a used book marketplace, as well as the ability to rent digital versions of textbooks for as long as students need them. Students are encouraged to explore these and the many other opportunities available online to help defray textbook costs.

A Word About Open Educational Resources
Open educational resources (OER) are educational materials available for study at no cost on the Web. Some OER are available for anyone to access any time. Others, such as Massive Open Online Courses (MOOCs), require sign-up and are only available during certain windows. Please note that some MOOC providers offer certificates of completion or other products or services for a fee. No MOOC or other OER is a complete substitute for the content guide and officially Recommended Resources listed here in this content guide. However, by definition, MOOCs are essentially free of charge and include access to a main body of learning materials that may help you in your learning.

Being an independent learner preparing for credit by exam, you may not need any of the fee-based options that are offered elsewhere online. But if you are looking for a coherent academic course for self-study, lectures on specific topics, or audio or visual materials that fit your learning style better than print materials alone, a MOOC or other type of OER may be your answer. Keep in mind that none of these OER
were designed by Excelsior, nor are they guaranteed to match the exam content outlines completely. They are simply another tool available in your study kit.

We highly encourage using the Recommended Resources. In the content outline, you will see that the topics in the exam are referenced to specific portions of recommended textbooks. Using OER alone will not ensure you’ve completely covered the content in the exam, or it may not cover some topics in sufficient-enough depth without the use of the formal, recommended textbooks.

If the OER course you choose does not include a textbook for reference and you do not have significant practical theory-based experience in the field of study, use a college textbook to ensure adequate preparation for the exam, and use the exam’s content outline as a guide.

Combined with comparable college textbooks, OER provides you with a variety of choices in knowledge sources and learning experiences, to enhance your understanding of the subject matter.

**Choosing Open Educational Resources**

Most sites for university-based OER can be searched through www.ocwconsortium.org and/or www.oercommons.org.

Sites that specialize in Web courses designed by college professors under contract with the website sponsor, rather than in Web versions of existing college courses, include:

- www.education-portal.com
- www.opencourselibrary.org (abbreviated as OCL)

We have included specific courses that cover material for one or more UEExcel® exams from the sites in the listings above. It’s worth checking these sites frequently to see if new courses have been added that may be more appropriate or may cover an exam topic not currently listed.

In addition, sites like Khan Academy (www.khanacademy.com) and iTunes U feature relatively brief lessons on very specific topics rather than full courses. Full courses are also available on iTunes U (http://www.apple.com/education/ipad/itunes-u/). We have chosen a few courses and collections for this listing.

**Other Online Resources**

This section of the OER Guide is provided to allow learners to independently search for resources.

**Open Online Textbooks**

- BookBoon  
  http://bookboon.com/en/textbooks-ebooks
- Flatworld Knowledge  
  http://catalog.flatworldknowledge.com/#our-catalog

**College Readiness**

- Khan Academy  
  http://www.khanacademy.org/
- Hippocampus  
  http://www.hippocampus.org/
- Open Course Library  
  http://opencourselibrary.org/collg-110-college-success-course/

**Study Aids**

- Education Portal  
  http://education-portal.com/
- Khan Academy  
  http://www.khanacademy.org/
- Annenberg Learner  
  http://www.learner.org/
- OpenCourseWare  
  http://ocwconsortium.org/en/courses/search
- OER Commons  
  http://www.oercommons.org/
- Open Course Library  
  http://www.opencourselibrary.org/

**To achieve academic success, rate yourself at Excelsior College’s Self-Regulated Learning Lab. Visit the Diagnostic Assessment & Achievement of College Skills site at https://srl.daacs.net/ It’s free!**
General Description of the Examination

The UExcel Contemporary Mathematics examination is based on material typically taught in a one-semester, three-credit, lower-level course in applied mathematics. The content of the examination corresponds to course offerings such as Mathematics in Contemporary Society, Liberal Arts Math, or Math for Non-STEM (science, technology, engineering, and mathematics) Majors.

The examination measures the ability to apply mathematical knowledge and concepts to understand and analyze practical contemporary mathematical problems. Specifically, the exam covers graph theory, mathematical reasoning, statistics, and probability, and the application of mathematics to politics.

Those beginning to study for this exam should be familiar with arithmetic and elementary algebra.

Learning Outcomes

After you have successfully worked your way through the recommended study materials, you should be able to demonstrate the following learning outcomes:

1. Understand voting and apportionment using mathematical principles. (Aligns to 2.2)
2. Demonstrate a basic understanding of statistical concepts. (Aligns to 2.2)
3. Analyze data statistically. (Aligns to 2.2)
4. Calculate simple probabilities. (Aligns to 2.2)
5. Reason mathematically. (Aligns to 2.2)
6. Analyze and understand graphs, paths, and circuits. (Aligns to 2.2)

General Education Career Competencies Addressed in this Exam

GECC-2: Mathematical and Scientific Problem Solving: Apply mathematical concepts and reasoning to solve problems that involve quantitative information.
**Content Outline**

The content outline describes the various areas of the test, similar to the way a syllabus outlines a course. To fully prepare requires self-direction and discipline. Study involves careful reading, reflection, and systematic review.

The major content areas on the Contemporary Mathematics examination, the percent of the examination, and the hours to devote to each content area are listed below.

<table>
<thead>
<tr>
<th>Content Area</th>
<th>Percent of the Examination</th>
<th>Hours of Study*</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Mathematical Reasoning</td>
<td>25%</td>
<td>34</td>
</tr>
<tr>
<td>II. Probability and Statistics</td>
<td>30%</td>
<td>41</td>
</tr>
<tr>
<td>III. Mathematics and Politics</td>
<td>20%</td>
<td>27</td>
</tr>
<tr>
<td>IV. Graph Theory</td>
<td>25%</td>
<td>34</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Approximate: For those test-takers who know the topic well, less time may be needed to learn the subject matter. For those who are new to the subject matter, more time may be required for study.

**NOTE:** Occasionally, examples will be listed for a content topic to help clarify that topic. However, the content of the examination is not limited to the specific examples given.

**I. Mathematical Reasoning**

**25 PERCENT OF EXAM**

Blitzer

*Ch. 1, Problem Solving and Critical Thinking*

*Ch. 3, Logic*

A. Thinking critically
   1. Inductive reasoning
   2. Deductive reasoning
   3. Connective reasoning

B. Problem solving

1. Problem solving techniques
   a. Polya’s four steps

2. Estimation

3. Mathematical models

**II. Probability and Statistics**

**30 PERCENT OF EXAM**

Blitzer

*Ch. 11, Counting Methods and Probability Theory*

*Ch. 12, Descriptive Statistics and Statistics*

A. Statistics
   1. Sampling
      a. Random samples
   2. Frequency distributions
   3. Histograms
   4. Measures of central tendency
a. Mean  
b. Median  
c. Mode

5. Measures of dispersion  
a. Range  
b. Variance  
c. Standard deviation  
d. Percentiles  
e. Quartiles

6. Normal distribution

B. Probability  
1. Counting  
2. Permutations  
3. Combinations  
4. Simple probability  
a. Sample space  
b. Events  
5. Dependence and independence  
6. Expected value

III. Mathematics and Politics

20 PERCENT OF EXAM

Tannenbaum  
Ch. 1, The Mathematics of Elections  
Ch. 4, The Mathematics of Apportionment
Blitzer  
Ch. 13, Voting and Apportionment

A. Voting  
1. Preference ballots  
2. Preference schedules  
3. Plurality method  
4. Borda count method  
5. Plurality-with-elimination method  
6. Pairwise comparison method  
7. Flaws in all voting methods  
a. Majority criterion  
b. Condorcet criterion  
c. Monotonicity criterion  
d. Independent of irrelevant alternatives  
e. Arrow’s impossibility theorem

B. Apportionment  
1. The problem of apportionment  
2. Hamilton’s method  
3. Jefferson’s method  
4. Adams’ method  
5. Webster’s method  
6. Huntington-Hill method  
7. Paradoxes and flaws  
a. Alabama  
b. New states  
c. Population paradox  
d. Quota rule

8. Belinski and Young

IV. Graph Theory

25 PERCENT OF EXAM

Tannenbaum  
Ch. 5, The Mathematics of Getting Around  
Ch. 6, The Mathematics of Touring
Blitzer  
Ch. 14, Graph Theory

A. Graphs, paths, and circuits  
1. Definitions and graph theory  
2. Modeling  
a. Delivering the mail  
b. Travelling salesman  
c. The seven bridges of Königsberg

B. Euler paths and Euler circuits  
1. The degree of vertex  
2. Euler’s theorem  
3. Fleury’s algorithm
C. Hamilton paths and Hamilton circuits
   1. Travelling salesman problem
   2. Weighted graph
   3. Methods of finding the most efficient circuit
      a. Nearest neighbor
      b. Brute force
      c. Cheapest link
Sample Questions

The sample questions give you an idea of the level of knowledge expected in the exam and how questions are typically phrased. They are not representative of the entire content of the exam and are not intended to serve as a practice test.

Rationales for the questions can be found on pages 16–5 of this guide. In that section, the correct answer is identified and each answer is explained. The number in parentheses at the beginning of each rationale refers to the corresponding section of the content outline. For any questions you answer incorrectly, return to that section of the content outline for further study. You will be provided with an erasable white board to use during your exam. During your exam, a basic 8-function calculator will also be available on your computer. A typical calculator is illustrated on page 19.

The calculator button is in the top left hand corner of the page as each question is presented.

1. What is the next number in this pattern?
   8, 15, 29, 57, 113
   1) 191
   2) 197
   3) 213
   4) 225

2. Let $p$ and $q$ represent the following simple statements:
   $p$: Dogs bark.
   $q$: Cats meow.

   Which corresponds to the symbolic statement $\neg p \lor q$?
   1) Dogs do not bark or cats meow.
   2) Dogs bark or cats do not meow.
   3) Dogs bark or cats meow.
   4) Dogs do not bark or cats do not meow.

3. In one game, a basketball team took 95 shots. The team made 12 of its 15 free-throw attempts (worth one point each), 30 out of 68 two-point shot attempts, and 5 out of 12 three-point shot attempts. Which pieces of information are necessary in determining the number of points the team scored?
   (Select the 3 that apply.)
   1) the number of two-point shots made
   2) the number of all shots taken
   3) the number of all shots made
   4) the number of three-points shots made
   5) the number of free-throws

4. If the US population increases by one percentage point per year and the population is currently 310,000,000, what will the population be in two years?
   1) 312,000,000
   2) 312,231,000
   3) 316,200,000
   4) 316,231,000
5. What is the median of the following data set?
   14, 26, 13, 11, 0, 0, 35, 39
   1) 13.5
   2) 17.2
   3) 20
   4) 23

6. Consider the following array of scores on a standardized test:
   390 410 440 450 460 490 530 570 590 600 640 670 710
   The 15th percentile is given by which score?
   1) 400
   2) 410
   3) 420
   4) 430

7. How many pairs of items can be created by choosing one item from a group of \( M \) items and one item from a group of \( N \) items?
   1) \( M + N \)
   2) \( M \times N \)
   3) \( M^C_N \)
   4) \( M^P_N \)

8. What is \( 200!/198! \) ?
   1) 37,800
   2) 39,600
   3) 39,800
   4) 40,200

9. What is the probability that, of two people selected at random, at least one was born on a Friday?
   1) \( \frac{1}{7} \)
   2) \( \frac{2}{7} \)
   3) \( \frac{11}{49} \)
   4) \( \frac{13}{49} \)

10. A basketball player makes 20% of her three-point shots and 40% of her two-point shots. Based on this information, what is the expected value of one shot?
    1) 0.8 points
    2) 1 point
    3) 1.2 points
    4) 1.4 points

11. Four people are voting for the type of beverage to be served at a picnic. The choices are cola, ginger ale, and iced tea. Which could be among the valid preference ballots for this vote?
    (Select the 2 that apply.)
    1) ballot
    2) ballot
    3) ballot
    4) ballot

12. The members of a class are holding an election to choose among four choices for a field trip. Their preference schedule is shown below:

<table>
<thead>
<tr>
<th>Number of votes</th>
<th>9</th>
<th>8</th>
<th>6</th>
<th>3</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1\textsuperscript{st} choice</td>
<td>Zoo</td>
<td>Museum</td>
<td>Museum</td>
<td>Farm</td>
<td>Farm</td>
</tr>
<tr>
<td>2\textsuperscript{nd} choice</td>
<td>Park</td>
<td>Park</td>
<td>Park</td>
<td>Zoo</td>
<td>Museum</td>
</tr>
<tr>
<td>3\textsuperscript{rd} choice</td>
<td>Farm</td>
<td>Zoo</td>
<td>Farm</td>
<td>Park</td>
<td>Park</td>
</tr>
<tr>
<td>4\textsuperscript{th} choice</td>
<td>Museum</td>
<td>Farm</td>
<td>Zoo</td>
<td>Museum</td>
<td>Zoo</td>
</tr>
</tbody>
</table>

Using the Borda count method, which is the winning choice?
   1) farm
   2) museum
   3) park
   4) zoo
13. If a candidate wins an election and in a recount, one of the losing candidates withdraws, then the original winner should still win the election. This describes which voting criterion?
   1) majority
   2) Condorcet
   3) monotonicity
   4) independence-of-irrelevant-alternatives

14. Which method of apportionment might produce the Alabama paradox?
   1) Adams's
   2) Hamilton's
   3) Jefferson's
   4) Webster's

15. Which vertices have a degree of 3? (Select the 3 that apply.)
   1) A
   2) B
   3) C
   4) E
   5) G

16. Which graph has at least one Euler circuit?

17. What is the total weight of the Hamilton circuit D, B, E, C, A, D?

18. The chart below shows the distances between four cities, A, B, C, and D:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>*</td>
<td>12</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>12</td>
<td>*</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>10</td>
<td>*</td>
<td>7</td>
</tr>
<tr>
<td>D</td>
<td>8</td>
<td>6</td>
<td>7</td>
<td>*</td>
</tr>
</tbody>
</table>

Using the nearest neighbor method starting at A, what is the total distance for the Hamilton circuit obtained?
   1) 24
   2) 27
   3) 28
   4) 37
Rationales

1. (IA1)
   1) See 4).
   2) See 4).
   3) See 4).
   *4) To determine the next number in the sequence, take the previous number, double it, and subtract one. Therefore $113 \times 2 - 1 = 225$.

2. (IA3)
   *1) This is correct for $p \lor q$.
   2) This would be $p \lor \neg q$.
   3) This would be $\neg(p \lor q)$.
   4) This would be $\neg p \lor \neg q$.

3. (IB1)
   *1) To calculate the total number of points the team scored, it is necessary to know how many shots were made for each point value. Then add: (free throws made) + 2(two-point shots made) + 3(three-point shots made).
   2) It is not necessary to know the number of shots taken to calculate the number of points scored by the team.
   3) It is not necessary to know the number of shots made, separate from knowing how much each shot was worth.
   *4) See 1).
   *5) See 1).

4. (IB3)
   1) This would be the population if it increased by one million per year.
   2) See 4).
   3) This would be the population if it increased by two percentage points every two years.
   *4) $310 \text{ million} \times 1.01 = 313.1 \text{ million}$ and $313.1 \text{ million} \times 1.01 = 316.231 \text{ million}$.

5. (IIA4b)
   *1) There are 8 data points. Arrange them in order. The median is the sum of the fourth and fifth values divided by 2 = 13.5.
   2) This is the mean $(138 \div 8 = 17.2)$.
   3) This is an incorrect value.
   4) This is 138 divided by 6 (using only the nonzero values).

6. (IIA5d)
   1) See 2).
   *2) There are 13 scores. Therefore, the locator for the 15th percentile is $(0.15) \times 13 = 1.95$. Because this is not a whole number, we round it up to 2. Thus, the 15th percentile is given by the second score, which is 410.
   3) See 2).
   4) See 2).

*correct answer
7. (IIB1)
   1) This would result from using the fundamental counting theorem as additive instead of multiplicative.
   *2) \( M \times N \) is the correct answer according to the fundamental counting theorem.
   3) This would result from confusing the fundamental counting theorem with combinations.
   4) This would result from confusing the fundamental counting theorem with permutations.

8. (IIB2)
   1) \( 37,800 = 200 \times 189 \), which could be the result of a typo in computation.
   2) \( 39,600 = 200 \times 198 \), a mistake a person in a hurry might make by misreading the problem.
   *3) \( \frac{200!}{198!} = \frac{(200 \times 199 \times 198)!}{198!} = 200 \times 199 = 39,800 \)
   4) \( 40,200 = 200 \times 201 \)

9. (IIB4)
   1) See 4).
   2) See 4).
   3) See 4).
   *4) In the sample space of 49 combinations, there are 7 in which the first person was born on Friday plus seven more in which the second person was born on Friday, minus one if they were both born on Friday. Therefore, the probability is \( 13 \div 49 \).

10. (IIB6)
    1) See 4).
    2) See 4).
    3) See 4).
    *4) \( (.20 \times 3) + (.40 \times 2) = 1.4 \) points

11. (IIIA1)
    1) This is wrong because there are five ballots, not four.
    2) This is not a linear preference ballot because cola does not appear on the last ballot.
    *3) This is a valid preference ballot for four voters and three choices, because there are four ballots, and each ballot has a first, second, and third preference.
    4) This is wrong because no beverage is in first place on the fourth ballot.
    *5) See 3).

12. (IIIA4)
    1) The Farm comes in last with only 54 points.
    2) The Museum is the majority winner, but by the Borda count method, it comes in second place with 71 points.
    *3) The Park is the winner by the Borda count method, with 77 points.
    4) The Zoo appears first, winning the most common ballot, but it has only 68 points.

13. (IIIA7d)
    1) See 4).
    2) See 4).
    3) See 4).
    *4) This is a description of the independence-of-irrelevant-alternatives criterion because the elimination of a non-winning candidate should not logically affect the top vote getter.

14. (IIIB7a)
    1) See 2).
    *2) There is a flaw in Hamilton’s math. When the number of seats is increased, each state’s standard quota goes up, but not by the same amount. As the remainders change, some states can move ahead of others in the priority order for the surplus seats. This can result in a state losing a seat it already had.
    3) See 2).
    4) See 2).

*correct answer
15. (IVB)
   1) Vertex A has degree 2.
   2) Vertex B has degree 2.
   *3) Vertex C has degree 3.
   *4) Vertex E has degree 3.
   *5) Vertex G has degree 3.

16. (IVB1)
   1) There is no Euler circuit.
   2) See 1).
   *3) A, B, C, A, D, E, A is an Euler circuit.
   4) See 1).

17. (IVC2)
   1) See 3).
   2) See 3).
   *3) DB = 72; BE = 90; EC = 72; CA = 55; AE = 50
   4) See 3).

18. (IVC3a)
   1) See 3).
   2) See 3).
   *3) For path A, C, D, B, A, the total weight is
       \[3 + 7 + 6 + 12 = 28.\]
   4) See 3).

*correct answer
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- allow sufficient time to travel, park, and locate the test center
- be prepared for possible variations in temperature at the test center due to weather changes or energy conservation measures
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**DETAILED SCORE REPORT**

<table>
<thead>
<tr>
<th>Content Area</th>
<th>Percentage of Exam Covering Content Area</th>
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<td>85%</td>
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<tr>
<td>V  Content Area 5</td>
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<td>87%</td>
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*Percentage correct is based on both scored and unscored (pretest) items and was not used to calculate your letter grade.