DESIGN OF COMPUTER-AIDED INSTRUCTION
FOR BASIC STATISTICS

A Thesis Presented to
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Master of Science

by
Tonya L. Anderson
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CHAPTER 1

INTRODUCTION

To understand material taught in upper level industrial engineering courses, a student should have a solid foundation in probability and statistics. Upper level engineering students encounter many problems that require some knowledge of probability, descriptive statistics, and experimental design. Courses in these areas form a learning hierarchy; the knowledge gained in the lower level courses provides a foundation for the higher level ones, e.g. the lower level courses are prerequisites for the higher level ones. Sometimes, however, the student either did not learn the necessary skills in the lower level course or does not retain this knowledge when enrolling in the higher level course. In either case, the ability of the student to learn the material in the higher level course may be severely impeded. This problem is likely to be compounded as the student moves on to even higher level courses. One way to alleviate this problem is to devise a method of measuring the knowledge a student has retained from a previous course before a higher level course is taken.
In the mid 1950's Benjamin S. Bloom and his colleagues developed a "classification system for educational objectives" (Bloom, Hastings, and Madaus, 1971). This "classification system", known as a taxonomy, has been highly publicized and generally accepted in the field of education. Bloom's taxonomy consists of three main areas, each divided into hierarchically ordered levels. It is reasoned that each higher level of learning relies on a prior mastery of a lower level (Biehler and Snowman, 1986).

The three main areas that form the taxonomy are the cognitive, affective, and psychomotor domains. The cognitive domain deals with intellectual skills and is the area of interest for most educators. Development of attitudes and values constitute the affective domain. The psychomotor domain involves the evolution of the student's physical skills (Biehler and Snowman, 1986).

Generally, there is little or no attempt to evaluate the requisite cognitive skills that a student retains upon entering a higher level course. Various studies have shown that the material learned in a prerequisite course has a significant effect on the student's performance in the next level course (Gagne, 1985; Gagne, Briggs, and Wagner, 1988; Klimko, 1984).

There is little doubt that under normal school conditions the characteristics of students at the beginning of a series of learning tasks
have far more effect on what they will learn than does the quality of instruction they receive (Bloom, 1976).

With prerequisite learning playing such an important role in advanced courses, it is incumbent upon the student to have a thorough understanding of prerequisite material when entering a higher level course.

The purpose of this study is to design a system for measuring and enhancing the knowledge of a student entering a course for which techniques involving statistical inference and/or experimental design are a prerequisite. Chapter 2 discusses this system design problem in greater detail, while previous research as it pertains to this study will be examined in the literature review, Chapter 3. Chapter 4 will explain the solution methodology, and a walk through of the testing procedure is presented in Chapter 5. Chapter 6 will discuss recommended areas for further study.
CHAPTER 2

STATEMENT OF PROBLEM

Students in upper level industrial engineering courses must often apply basic concepts in probability and statistics in the more advanced classes. These necessary statistical concepts include probability, descriptive statistics, hypothesis testing, and experimental design. The learning in each of these areas builds on the skills learned in the preceding one(s), e.g., the knowledge necessary for the probability course is provided in the calculus courses.

In general, a passing grade in the prerequisite classes is all that is needed to enroll in a higher level course at most universities. However, a passing grade does not always ensure that a student has sufficiently learned the material. Additionally, when a student enrolls in a class it does not matter when the prerequisite class was taken, only that it was taken at some time in the past. If a long period of time has elapsed since the student has taken the prerequisite course, then the concepts may not be remembered.

Many researchers in the educational field recognize
the importance of prerequisite learning (Gagne, 1985).
According to Gagne (1985) a prerequisite is a "capability
of prior learning that is incorporated in new learning."
This new learning is then incorporated in even newer
learning, and the hierarchy continues.

Without altering new material to befit what the
student does know or reviewing the prerequisite material he
needs to know in the upper level course, there is no way to
compensate for the lack of prerequisite learning (Bloom,
1976). If a student does not adequately learn the early
material taught in a sequence, it is very difficult, if not
impossible, to be successful in the advanced classes in
that sequence. However, by assessing the student's
knowledge upon entering an upper level course, the student
can be given the opportunity to overcome any area of
weakness. The sooner deficiencies are discovered the
sooner the student can correct them and begin to comprehend
the new material.

Before attempting to measure student learning, the
following questions should be considered. How is learning
defined? How is it measured? What method of assessment
should be used? What medium should be used in presenting
this material to the students? What constitutes an area of
deficiency? How can deficiencies be corrected?

Learning as defined by Benjamin S. Bloom and his
colleagues in the mid 1950's was briefly discussed in Chapter 1. Learning was divided into three areas: cognitive, affective, and psychomotor, each of which is broken into hierarchial levels.

The cognitive domain, which focuses on intellectual tasks, is the area of interest of most educators in general and this study in particular. Its hierarchy contains six levels with knowledge as the lowest level. All other levels rely on prior mastery of it. The other levels in ascending order are comprehension, application, analysis, synthesis, and evaluation. Each one of these levels can be further divided if desired.

How can learning be measured? One way to measure prerequisite learning is to test students when they enter the advanced course. Questions which now need to be considered include: "What type of test should be used?", "How many questions should be on the test?", "How much time should the student be allotted to take the test?", "What is failing?", "What should be done if the student fails?", and "Can programmed instruction be used to help the student relearn the material?"

Most, if not all, of these questions have been discussed in the literature review. The problem then is to design a test that will measure the cognitive skills a student possesses when enrolling in courses that require a
knowledge of descriptive statistics, hypothesis testing, and experimental design. The test must effectively measure the student's knowledge of the proper material, and be easy to administer and score.
CHAPTER 3

LITERATURE REVIEW

Introduction

How human beings learn has been a topic of interest to educators and psychologists alike for many years. Learning, prerequisite learning, testing procedures, corrective action, and more recently computer learning are some of the subjects that have been major areas of investigation.

Bloom's Taxonomy

Bloom's taxonomy divides human learning into three domains: cognitive, affective, and psychomoter. Each of these domains is broken down into hierarchically ordered levels. Bloom felt that mastery of higher ordered or more complex objectives relies on prior mastery of the less complex material (Biehler and Snowman, 1986).

The cognitive domain, which pertains to intellectual skills, is the area of concentration in this study. As previously stated the cognitive domain is made up of the following levels (in ascending order): knowledge, comprehension, analysis, application, synthesis, and
evaluation. A brief outline detailing the cognitive domain of Bloom's taxonomy is provided by Biehler and Snowman in *Psychology Applied to Teaching: Fifth Edition*; a condensed copy of this is given in TABLE 3.1 on the following page. More detailed versions of the cognitive domain can be found in other texts (Bloom, Hastings, and Madaus, 1971; Gronlund, 1985).

**Prerequisite Learning**

Several studies conducted on the effects of prerequisite learning show that students entering an upper level course lacking the necessary cognitive entry behavior have a much more difficult time learning new material. On the other hand, if all students attempting to learn new material possess the necessary prerequisite learning, then given the proper instruction and motivation, they all should master the new learning with equal or decreased variation in time and achievement (Bloom, 1976).

In all hierarchial arrangements the earliest levels are the most important; this is especially true for learning.

Under highly sequential arrangements of learning tasks the most critical tasks are likely to be early ones in the sequence, since if these are not learned adequately, the student is likely to have great difficulty with later tasks (Bloom, 1976).

The sooner these difficulties can be diagnosed and
1.00 Knowledge. Remembering previously learned information.

1.10 Knowledge of specifics.
1.11 Knowledge of terminology.
1.12 Knowledge of specific facts.

1.20 Knowledge of ways and means of dealing with specifics.
1.21 Knowledge of conventions (rules).
1.22 Knowledge of trends and sequences.
1.23 Knowledge of classifications and categories.
1.24 Knowledge of criteria.
1.25 Knowledge of methodology.

1.30 Knowledge of universals and abstractions in a field.
1.31 Knowledge of principles and generalizations.
1.32 Knowledge of theories and structure.

2.00 Comprehension. Grasping the meaning of information.

2.10 Translation. Ability to put communication in another form.

2.20 Interpretation. Ability to reorder ideas and comprehend interrelationships.

2.30 Extrapolation. Ability to go beyond given data.

3.00 Application. Applying knowledge to actual situations.

4.00 Analysis. Breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized.

5.00 Synthesis. Rearranging component ideas into a new whole.

6.00 Evaluation. Making judgments based on internal evidence or external criteria.

TABLE 3.1 Taxonomy of Educational Objectives: Cognitive Domain
corrected the better the student's chances of successfully completing the sequence (Bloom, 1976).

Testing

Determining whether or not the student has mastered prerequisite skills requires some sort of measuring procedure. Designing, implementing, and interpreting a test that accurately measures the desired student learning is not easy. Many factors must be considered when creating a successful test including: types of tests, objective versus subjective tests, steps in planning a test, test reliability and validity, norm-referenced versus criterion-referenced tests, as well as some other considerations.

Types of Tests

According to Gronlund (1988) there are four types of tests: placement, formative, diagnostic, and summative. Placement tests are used to determine the prerequisite skills of the student entering the course or his entry performance on the course objectives. The formative test measures the student's learning progress. Diagnostic tests find areas where students are having problems. A summative test is used to certify student mastery or assign grades.

Although some diagnosis of student problem areas is
involved, placement tests, as they pertain to prerequisite entry skills, most closely fit the requirements of this study. Typically, questions of this type "are easy and criterion-referenced" (Gronlund, 1988). Criterion-referenced refers to the way the scoring is interpreted and will be discussed later.

**Objective versus Subjective Testing**

Tests may be classified as either objective or subjective by the student responses. On an objective test, the student's response is either correct or incorrect. The grader of a subjective test must exercise his opinion or judgment when scoring the test. Some examples of subjective tests are essay and short answer. True-false, multiple-choice, and matching are all types of objective tests (Gronlund, 1988). It should be noted that some educators include short answer in the objective testing category (Ebel, 1986). According to Green (1985) the strengths and weaknesses of the objective test are:

**Strengths**

1) Gives an extensive test sample
2) Can be made highly reliable
3) Can be graded objectively and quickly
4) Eliminates bluffing
5) Can be subjected to item analysis and further refinement
6) Can be adapted to several teaching objectives
7) Can be made highly valid for some teaching objectives

Weaknesses

1) Frequently neglects measurement of higher thought processes
2) May over emphasize rote learning
3) Promotes poor study habits
4) Encourages guessing
5) Is difficult to prepare
6) Costs more than an essay test to prepare and reproduce

If properly constructed, the advantages of the objective test outweigh its disadvantages. The fact that a single test can cover a wide range of material and can be scored quickly and fairly make objective testing particularly attractive, especially for computer-assisted instruction. The computer can be much more easily programmed to recognize a response that is either right or wrong than one that may be right but is misspelled. The most commonly used objective tests are true-false, matching, and multiple-choice.

True/False Tests

The advantages of the true-false test are its ease of construction and the breadth of material that can be tested in a short time (Gronlund, 1985). A major drawback,
however, is that in most cases it can only measure the most basic level of learning, knowledge. Another drawback is that even if a student has no idea of the correct answer he has a 50 percent chance of guessing the correct response. The "susceptibility to guessing" reduces the test's reliability, validity and diagnostic value (Gronlund, 1985). The true-false exam should only be used when the situation involves only two choices such as right or left or when distinguishing between two relevant ideas such as fact or opinion (Gronlund, 1985).

**Matching Tests**

A matching exam contains two columns, one containing premises and the other responses. Each premise can be correctly matched by a response, but sometimes the responses outnumber the premises. An advantage to such a test is that "it has a compact form which makes it possible to measure a large amount of related, factual material in a relatively short time" (Gronlund 1985). Matching tests are also easy to construct. A disadvantage of the matching exam is that the material measured is limited to factual, rote learning. Also, it is sometimes difficult to construct a set of questions that utilize the same set of responses (Ebel, 1965). Gronlund (1985) believes that matching tests should only be used when the same choices on
a multiple-choice exam are being used repeatedly.

**Multiple-Choice Tests**

Multiple-choice is, by far, the most common and "highly regarded" type of objective exam (Ebel, 1965). It consists of a stem followed by several alternative selections. One of these selections is the correct or best response; the other alternatives are referred to as distracters. The number of choices usually range from three to five. Aiken (1987) lists the following as advantages of multiple choice items:

1) Versatility, in that they can measure both simple and complex objectives at almost all grade levels and subject areas.

2) More adequate sampling, in that they can sample the domain of abilities more satisfactorily than essay items and almost all other objective items.

3) Less susceptibility than true-false items to random guessing and response sets.

4) Objectivity in scoring, in that they can be scored accurately and rapidly by a clerk.

5) Ease and objectivity of item analysis.

6) The provision of diagnostic information by an analysis of responses to item distracters.

7) Greater reliability than other test items, because they are both objective and less susceptible to guessing effects.

The most important asset of the multiple-choice exam is its "wide applicability in the various phases of achievement" (Gronlund, 1971). While matching and true-
false tests are restricted to measuring the knowledge level of Bloom’s taxonomy, multiple-choice questions can be constructed to measure higher ordered levels; although writing questions to measure the higher levels is extremely difficult. "Correctly constructed, it (a multiple-choice question) can measure the knowledge, comprehension, and application levels of Bloom’s cognitive taxonomy" (Stanton, 1983).

As revered as the multiple-choice item is, it too has disadvantages. According to Brightman (1987), the disadvantages of the multiple-choice exam are:

1) Good items, especially items measuring higher order objectives and having an adequate number of parallel options, are difficult to construct.

2) Multiple-choice items require greater response time than true-false items and may sample the domain of knowledge less adequately in the time available.

3) Multiple-choice items emphasize the recognition of the correct answer rather than recall and organization (construction) of information.

Depending on the number of distracters, an element of guessing is also involved in multiple-choice questions. Implementing a correction factor for guessing has been a controversial topic (Gronlund, 1988). Both Gronlund (1988) and Ebel (1965) support the theory that a correction factor should only be used in a special situation, such as a timed test where the bold test taker would have a decided advantage.
Because constructing multiple-choice items can be very difficult, most authors on test writing offer guidelines on constructing multiple-choice items. The following list is compiled from Aiken (1987), Brown (1971), Gronlund (1985), and Payne (1968). Many of these suggestions appear on more than one writer’s list.

1) Each item should test one, and only one, central idea.

2) Each item should be independent of every other item; one item should not aid in answering another item.

3) Write as clearly, simply, briefly, and correctly as possible, eliminating all nonfunctional words.

4) Avoid textbook phraseology and examples; whenever feasible, use new situations and terms.

5) The item stem should present the central problem and all qualifications; it should include all words that otherwise would occur in each alternative.

6) Avoid negatively stated items.

7) If an item includes controversial material, cite the authority whose opinion is being used.

8) Alternatives should be homogeneous in content, form, and grammatical structure.

9) There should be one, and only one, correct response; this alternative should be clearly correct to the informed reader.

10) All distracters should be plausible and attractive to students who do not know the correct answer; yet they should be clearly incorrect or inadequate.

11) Distracters may represent common misconceptions, logical alternatives, frequent mistakes, or other plausible but incorrect information.
12) Alternatives should not overlap, include or be synonymous with each other.

13) Avoid irrelevant clues to the correct response provided by response length, grammar, repetition of key words, common associations, explicitness of responses, etc.

14) If alternatives fall in logical arrangement - e.g., alphabetically, by magnitude - list them in this order.

15) The position of the correct responses should not fall in pattern but rather be randomized.

16) Although a certain amount of novelty, and even humor, is appropriate and may serve to interest and motivate examinees, ambiguous or "tricky" stems and options should not be used.

17) Use "none of the above", "all of the above", or "more than one of the above" as options sparingly. Also avoid specific determiners such as "always" or "never".

18) Put the options in stacked (paragraph) rather than tandem (back to back) format, using numbers for items and letters for options.

19) In testing for understanding of a term or concept, it is generally better to present the term in the stem and alternative definitions in the options.

20) Break any of these rules when you have a good reason for doing so.

Many studies (Duncan, 1983; Gronlund, 1985; Kolstad, Briggs, and Kolstad, 1985; Straton and Catts, 1980) have been conducted concerning the number of distracters associated with each item. No one right answer has ever been determined, but most educators believe that the total number of alternatives should be between three and five. On one hand, increasing the number of distracters reduces
the chances of guessing the correct choice, while on the other hand writing a multitude of plausible distracters is very difficult. Gronlund (1985) prefers "4-choice items because, with reasonable effort, three distracters can be obtained (the fourth distracter tends to be difficult to devise and is usually weaker than the others)."

**Planning the Test**

"The key to effective achievement testing is careful planning" (Gronlund, 1988). Careful planning is especially important in constructing multiple-choice items, since the test maker must not only provide a question and the answer, but also incorrect answers that uninformed students may consider correct. One can attempt to compensate for the lack of test writing experience by following guidelines devised by professionals. Gronlund (1988) devised the following four step plan for writing tests:

1) Determine the purpose of the test.
2) Identify and define the intended learning outcomes.
3) Prepare the test specifications.
4) Construct the relevant test items.

Determining the purpose of the test refers to deciding what type of test (placement, formative, diagnostic, or summative) the situation requires. It has already been resolved that under the circumstances of this study, the
placement test as it pertains to the student’s cognitive entry behavior is the best choice.

Identifying and defining the intended learning outcomes, concerns making sure that what the test measures "faithfully reflects the objectives of instruction" (Gronlund, 1988). Instructional objectives are statements that define "the abilities students should be able to display to demonstrate that important concepts and principles have been incorporated into their own structures of knowledge" (Ebel, 1986). To help determine the instructional objectives Gronlund (1988) recommends using the taxonomy developed by Bloom. Gronlund (1988) uses Bloom's taxonomy to provide general learning outcomes and to determine what the student must do to achieve those outcomes.

Preparing the test specifications involves the following:

1) Selecting the learning outcomes to be tested
2) Outlining the subject matter
3) Making a two-way chart (Gronlund, 1988).

Selecting learning outcomes to be tested in this study involves knowledge, intellectual skills, and abilities rather than laboratory skills or attitudes. Outlining the subject matter involves clearly stating what material the student is expected to know. The two-way chart is a
combination of content and outcomes. The content is the subject area being tested, and the outcomes are the learning outcomes derived from Bloom's taxonomy. The chart helps determine the areas of the test which receive the most emphasis. The number placed in each cell is the number of questions on the test that measure a certain content\outcome. An example will be provided later. "The purpose of the table (chart) is to provide assurance that the test will measure a representative sample of the learning outcomes and the subject matter topics to be measured" (Gronlund, 1988).

The fourth item on Gronlund's (1988) plan for test making is considerations in constructing relevant test items. Some of the components that make up these considerations include: subjective versus objective testing (discussed previously), improving the functioning content of items, selecting item difficulty, and determining the number of test items Gronlund (1988).

The functioning content of the test item involves how the test item is phrased. Phrasing items is very important; poor item wording can cause a knowledgeable student to respond incorrectly while an uninformed one responds correctly. Gronlund's (1988) list of "don'ts" to eliminate misunderstanding are:

1) Vocabulary that is unnecessarily difficult.
2) Sentence structure that is unnecessarily complex.
3) Statements containing ambiguity.
4) Statements that are excessively wordy.
5) Unclear pictorial materials.
6) Directions that are vague.
7) Material reflecting race, ethnic, or sex bias.

Gronlund (1988) recommends avoiding the previous errors by:
1) Writing each test item so that it presents a clearly formulated task.
2) Stating the items in simple, clear language.
3) Keeping the items free from biased and nonfunctional material.
4) Using a test format and directions that contribute to effective test taking.

According to Gronlund (1988) the level of item difficulty depends on how the results are to be interpreted. If the purpose of the test is to rank the students, then the test items should range from easy to difficult in order to obtain a wider variety of scores. On the other hand, if it is desirous to know whether or not students have attained a particular level of learning, then the questions should be written to test this level of learning.

The final element in constructing relevant test items is to determine the number of questions (Gronlund, 1988). Several factors must be considered when making this decision. Besides incorporating enough questions to
adequately evaluate the student's knowledge of the subject matter, there is the practical constraint of time. Most testing situations are limited to the length of a class period (40 to 50 minutes). For younger students (elementary school age) with a short attention span, test time should be no longer than 30 minutes. It is necessary to determine how many questions a student should be able to answer in the time allotted for the test. The type of questions (i.e. multiple-choice) and the complexity of learning being measured both impact the amount of time a student spends per question (Gronlund, 1988). Although there are no set rules for determining the number of items to include on an exam, the following is a rule of thumb.

As a rule of thumb, high school and college age students should be able to answer one multiple choice item, three short-answer items, or three true-false items per minute when the items are measuring knowledge outcomes. For measuring more complex learning outcomes such as comprehension and application, and for testing younger age groups, more time per item is needed (Gronlund, 1988).

Test Validity/Reliability

Two very important concepts which should be considered when constructing a test are validity and reliability. Without valid and reliable tests, scores are meaningless. Validity is defined as "the extent to which a test measures what it is supposed to measure" and reliability refers to the consistency in measurement of an exam if a student were
to retake it in the future (Biehler and Snowman, 1986).

The notion that a test should measure the intended learning outcomes is extremely important. According to Gronlund (1988) three ways to ensure validity during test development are:

1) Clearly define the domain of the learning task to be measured.

2) Carefully prepare test specifications.

3) Construct a representative sample of relevant items.

According to Gronlund (1985), some factors from both the test and its administration that contribute to lower validity include:

1) Unclear directions.

2) Reading vocabulary and sentence structure too difficult.

3) Inappropriate level of difficulty of the test items.

4) Poorly constructed test items.

5) Ambiguity.

6) Test items inappropriate for outcomes being measured.

7) Test too short.

8) Improper arrangement of items.

9) Identifiable pattern of answers.

10) Insufficient time to complete the test.

11) Unfair aid to individuals who ask for help.

12) Cheating during the exam.
13) Unreliable scoring for essay questions.

Validity is not an all or nothing proposition; it is a "matter of degree" (Gronlund, 1985).

A necessary but not sufficient condition for validity is reliability.

A test that provides totally inconsistent results cannot possibly provide valid information about the performance being measured. On the other hand, highly consistent test results may be measuring the wrong thing or used in inappropriate ways" (Gronlund, 1985).

According to Gronlund (1985) some of the factors that influence reliability are the length of the test, the spread of scores, the difficulty of the test, and objectivity. The longer the test, the more reliable it is because a more adequate sample is obtained and the effects of guessing are lessened. According to Gronlund (1985) usually the larger the spread of scores the more reliable they are. If a test is either too easy or too difficult, the scores will likely be grouped at the high or low end of the scale, producing low reliability. Tests high in objectivity are not susceptible to subjective judgments or opinions.

Situations which require high reliability are those where the decision is important, final, irreversible, unconfirmable, or has lasting consequences. Low reliability is allowable under the following circumstances: test results are of minor importance, reversible, or can be
Gronlund (1985) provides several methods for determining test reliability. These methods involve either taking two separate tests, dividing one test into halves, or using a formula to determine internal consistency.

**Norm-Referenced versus Criterion-Referenced Tests**

Two methods of interpreting the results of tests are norm-referenced and criterion-referenced. Norm-referenced tests are designed to "maximize differences in student performances" (Blood and Budd, 1972). Student scores are ranked highest to lowest and usually resemble a bell-shaped curve or normal distribution. Difficulty of test items is especially important for high reliability. Scores are often used to determine grades and ultimately, students are competing against each other (Blood and Budd, 1972; Sullivan, 1983).

For a criterion-referenced or mastery test the student must demonstrate that he has attained some previously determined level of proficiency (Sullivan, 1983). This type of test is usually regarded as pass/fail. If the student correctly answers a previously determined percentage of the items, he passes. The student should be aware of the passing grade prior to testing. The percentage for passing should be less than one hundred
percent to allow for student unreliability or misunderstanding (Blood and Budd, 1972). "Because criterion-referenced mastery tests are not designed to discriminate among individuals, statistical validation procedures play a less prominent role" (Gronlund, 1985).

When a student takes an exam, his level of competence is determined by the percentage of the questions he answers correctly. Depending on the type of interpretation, his performance is either ranked in comparison with other scores or classified as either pass/fail. The cutoff score between passing and failing is not always easy to determine and is to some extent, based on subjective judgment (Ebel and Frisbee, 1986).

Other Factors in Testing

There are other factors which need to be considered before a successful testing program can be established. The first of these factors is the test directions. Gronlund (1988) maintains that, besides being concise and simple, test directions should include each of the following:

1) Purpose of the test
2) Time allowed to complete the test
3) How to record answers
4) Whether to guess when in doubt about an answer.

The only previous mention of question arrangement has
concerned the pattern of the correct responses. However, the level of difficulty of each question in conjunction with its arrangement on the exam has also been investigated, and the following guidelines pertaining to item arrangement and item difficulty have been provided by Gronlund (1988).

1) For instructional purposes it is usually desirable to group together items that measure the same learning outcomes.

2) Where possible, the items should be arranged so that all items of the same type (true/false, multiple-choice, etc.) are grouped together.

3) The items should be arranged in order of increasing difficulty.

The test format is another factor which must be considered. Testing formats include oral examinations, classical pencil and paper tests, and testing via the computer. Since oral exams are the most individualized type of testing, they are also the most time consuming. To be reliable and valid, oral exams must be strictly structured; otherwise, "prejudice, partiality, and discrimination on grounds other than the relevant traits and abilities" could result from the personal interaction (Ebel and Frisbee, 1986). Because of the time requirements and the potential for test unreliability the use of oral exams is severely limited (Ebel and Frisbee, 1986). Pencil and paper and computer exams will be discussed later.

Determining whether the exam will be open book, closed
book, or take home is another concept which must be investigated. According to Ebel (1965) the following are advantages of open book testing:

1) Open book tests can be constructed and used in all the traditional test forms - essay, multiple-choice, true/false, etc.

2) Fear and emotional blocking are reduced.

3) There is less emphasis on memory of facts than on practical problems and reasoning.

4) Cheating is eliminated.

5) The approach is adaptable to the measurement of student attitudes.

The disadvantages of open book testing include:

1) Study efforts may be reduced.

2) Efforts to overlearn sufficiently to achieve full understanding may be discouraged.

3) Note passing and copying from other students are less obvious.

4) More superficial knowledge is encouraged (Ebel, 1965).

The take home test is an open book test outside of the classroom. The advantage is that the student can take the test without worrying about time constraints; however, there is the added risk that the work turned in by the student may not be his own (Ebel, 1965).

To ensure test validity, "equivalent" forms of a test should be considered (Gronlund, 1985). The purpose of the equivalent test is to retest a student shortly after he takes the initial exam. There are a number of reasons a
student may require a retest; for example, a student may have missed the test. An equivalent test would prevent an unfair advantage. Equivalent tests can also be used to verify scores that may be in question (Gronlund, 1985). If a student were to retake an exam with the identical items he could memorize the answers.

The last factor to be considered in testing is the test maker. The test maker must have a thorough understanding of the field covered on the test so as to "ask significant, novel questions, express them properly and plainly, and provide acceptable correct answers to them" (Ebel, 1965). The test maker must also be knowledgeable about the skill level of the students who are taking the test (Ebel, 1965). Test items that are too easy or too difficult result in an unreliable exam. Finally, the ability to produce well written questions that test the desired information is important (Ebel, 1965).

Computer-Aided Instruction

In the past thirty years technology has produced tremendous advances in the field of computers. Since the beginning of the computer age researchers have been exploring methods of using computers as an aid to education. The result is an area of study called computer-aided instruction (CAI) in the United States and computer-
aided learning (CAL) in the United Kingdom. Both of these phrases refer to the same area of investigation and are used interchangeably.

Incorporating computers into the field of education has been a slow process. During the 1960's and the early 1970's computer hardware was very expensive and required experienced personnel to operate (Van Lengen, 1985). Computer software was expensive and for the most part poorly written, and educators generally had a limited selection from which to choose due to the languages being used to create programs (Van Lengen, 1985). Those who were skilled in programming generally had little or no experience in educational theories, and therefore were largely unsuccessful in writing software for classroom use (Van Lengen, 1985). Another reason for the slow adaptation of the computer into school systems was the fear on the part of faculty that someday computers might replace them (Van Lengen, 1985).

In the 1970's two events spurred the use of computers in education: the creation of what may have been the first program developed especially for CAI and the development of microcomputers (Gagne, 1987). The development of the microcomputer was important because compared to the computers before it, the microcomputer is inexpensive and compact and can perform many of the tasks carried out by
larger computers (Gagne, 1987).

Although there has been a considerable increase in the use of computers in schools in the 1980’s, most of the effort has gone into teaching the students about the computer itself and not utilizing the computer as a teaching tool (Gagne, 1987). The main stumbling block to prevalent CAL in the classroom is the lack of software that considers "the important features of the human learning process" (Hudson, 1984). Most software developed are just "computerized versions of textbooks or lecture notes" (Hudson, 1984).

Textbooks have been and still are the "dominant delivery mechanism for learning" and the "most important learning mode" (Bork, 1987). First and foremost, books have the advantage of familiarity. Almost everyone is familiar with books while a small, but steadily increasing number are comfortable with computers (Bork, 1987). Another advantage of books is their "portability". While some computers can be carried, they always require a power source (Bork, 1987). Although it is difficult, if not impossible, to find a subject on which at least one book is not written, computer software is limited, and most of what is available is poorly written (Bork, 1987).

Many researchers in the educational field have investigated computer usage in the classroom and have found
it to have many beneficial qualities over traditional learning methods. Bork (1987) has listed the following advantages of computer learning:

1) Interactivity - The computer engages in a conversation with the student, constantly asking the student to respond, to do something, to play an active role in the learning process. Books for many readers, are passive learning devices.

2) Individualization - The book is the same for everyone, while the computer can individualize learning so that each student receives information specific to the student's needs.

3) Cost - Material displayed in books cost money while blank space on a screen can be used freely.

4) Timing - A computer screen can delay both before and after presenting important concepts. There is more versatility with computers.

Another advantage of CAI is that negative reinforcement, such as the embarrassment that a student receives when he makes a mistake in front of his classmates, is eliminated. With CAI the student, the computer, and perhaps the instructor are the only ones who know of the error (Brown, 1986). Added advantages of computer usage in the classroom are "greater student ease in using the computer, student perception of the computer as an integrated computational tool rather than a separate entity, greater flexibility in teaching provided by simulation programs and computational projects, and greater student interest in coursework" (Kellie, et al, 1984). The computer also serves as a motivational tool for
students, since students can not only determine their own pace, but they feel that using the computer is a reward (Waldrop, 1984).

Results of a survey conducted indicated that 74 percent of students preferred the computer test to conventional pencil-and-paper tests; 16 percent found no difference; and 10 percent preferred the traditional type tests. Students stated they found the computer tests interesting, appreciated working at their own pace, and felt comfortable using the computers (Webb, 1986).

In order for the student to reap the benefits of learning via the computer, the instructor should take an active role in the learning process. He can monitor, explain, and reinforce what the student is supposed to be learning (Brown, 1986). Ensuring that the CAI is aligned with the curriculum and that the student is correctly challenged are also jobs for the instructor (Brown, 1986).

According to Hudson (1984) there are two necessary requirements for good CAL writing. These are:

1) The ability to break down large bodies of information into smaller and smaller quanta of conceptual steps.

2) An ability to reconstruct the items in interesting, imaginative, and relevant ways by means of well-written, and well-presented frames on the television or video screen.

Without the words "on the television or video screen" the previous requirements closely resemble those of programmed instruction which was popular during the 1960's and early 1970's. Programmed instruction will be discussed later.
Although the computer is capable of carrying out many roles in the classroom, its role in this study includes computer based testing, evaluation, and programmed instruction. Educational researchers have praised the increasing popularity of using computer-aided learning (Wedman and Stefanich, 1984; Rainey, 1981); however, computer testing does have its limitations. With regard to Bloom's taxonomy, Brown (1986) reports that computers are more effective in the lower levels than the upper ones.

The final point considered in computer-aided learning is when to alert the student as to whether or not his answer to a test item is correct. In the past, most studies reported that immediate feedback was most beneficial. Waldrop (1986) reports that more research is necessary "regarding the role of feedback in CAI design." Feedback will be discussed further in the section covering programmed instruction.

Before the computer can begin to make a major difference in education two things must happen:

1) Teachers and faculty must overcome their fear of using the computer.

2) Quality software must be developed (Bork, 1987). With the price of micros decreasing, "it will be increasingly cheaper to learn via the computer than to learn in any other way whatsoever" (Bork, 1987).
Programmed Instruction

Every author who has ever dealt with programmed instruction (p. i.) has his own interpretation of what the topic encompasses. Everyone agrees that p. i. consists of dividing the material to be learned into small steps and systematically presenting it to the student via self-instruction. The student interacts with the program by responding to questions and is given immediate feedback regarding the correctness of his answers. Depending on the rightness of his answers and the type of program being used, the student proceeds through the program until completion.

Fry (1963) has compiled research and devised some generalizations and characteristics regarding programmed instruction. The generalizations include:

1) Programmed learning can be effective; students do learn using this method.
2) Programmed learning can reduce student error.
3) A learning program tends to level the differences in learning capabilities among students.
4) Individual learning time may vary widely since students work at their own pace.
5) Predictability of individual success may decrease because slow learners and others may perform better on programmed material than would have been indicated by previous behavior.
6) Motivation to learn may increase because of students immediate knowledge of success.

The characteristics of successful programs are:
1) Assumptions should be clearly stated in writing. These assumptions deal with the level of competence of the student.

2) Objectives should be explicitly stated. These objectives determine what the student should know when he finishes the program. They should be measurable.

3) Sequence of small steps should be logical. Material arranged in an orderly sequence of growing difficulty simplifies acquisition of knowledge and reduces student errors.

4) Student should actively respond. The student cannot learn by remaining passive.

5) Information is immediately feedback. This keeps the student from repeating the same error.

6) Student works at his own pace. This diminishes the rate of learning as a measure of learning.

7) Constant evaluation should be provided. This evaluates both the programmer and student success. If students make too many errors, the programmer needs to revise the program. The evaluation also pinpoints trouble areas for students.

Before writing a program to be used for individualized instruction it is necessary to fully define and consider several elements if the program is to be successful.

1) Student - The programmer must identify the group for which the program is being written. He should establish the age, cultural background, learning ability, previous experience, education, and training, motivation, and student expectations of the course.

2) Desired results - What is the student supposed to learn.

3) Subject matter - the programmer should start with the major areas and gradually break the material down into more detail.
4) Content: Order of presentation - The detailed breakdown of subject matter should be adapted for use in the program.

5) Teaching methods - Instead of p. i. the programmer may decide another method would be better.

6) Cost - Both time and money costs must be considered.

7) Program style - This is usually the preference of the programmer (Fry, 1963).

When considering the students the programmer must consider those components that influence learning. These components are:

1) Intelligence

2) Motivation
   A) Rewards
   B) Instructional level (attitude of student toward learning situation)
   C) Novelty effect (new, different method more effective for awhile)
   D) Pall effect (student loses interest in subject, bored or tired)

3) Learning environment
   A) Booth or open classroom
   B) Scheduled or unscheduled
   C) Supervision
   D) Competition
   E) Social pressures
   F) Attitude toward programming

4) Student personality
5) Biological factors (age, sex, health)
6) Previous learning (Fry, 1963).

Organizing the subject matter involves identifying objectives, developing measurement criteria, separating the material into detailed points, sequencing the material, and writing the test frames (Tabor et al, 1965). Studies have found that programmers should cover subject matter with which they are already familiar. "Understanding of a subject is necessary and basic to programming it successfully" (Lysaught and Williams, 1963).

The programmer should consider student limitations and the time allotted for the lesson. The program should be devised so that breaks are provided at convenient intervals. Student limitations include fatigue, boredom, etc. (Fry, 1963).

Everyone who programs has his own approach to developing the program. Although programmed instruction is no exception, there are several steps that all share. These common steps include:

1) Defining the objectives
2) Testing the program (pretests and posttests)
3) Experimental testing and validation (Pocztar, 1972).

It is common to approach program development as a series of feedback loops where each stage loops back to the previous stage. As a result, the programmer can always
backtrack, edit, and revise any previous work as the program evolves. Lysaught and Williams (1963) recommend the following approach:

1) Selection of subject matter
2) Preliminary organization
   A) Making assumptions about learners
   B) Declaration of objectives or goals
   C) Selection of programming model (type of program)
3) Organize subject matter
4) Construct the step-like programmed sequence
5) Check efficiency (initial testing, revision)
6) Evaluation of students
7) Edit and revise

One of the more difficult aspects of developing programmed instruction is building the frames. Callender provides some guidelines for presenting the material to the students.

1) The wording must be unambiguous.
2) The response required of the learner must be relevant.
3) The frame must be challenging and stimulating.
4) The frame must be well written and lively.
5) The frame must be structured for the maximum success of the student.

Throughout the programming activity the use of a checklist would ensure that all important elements have
been considered. Such a checklist, developed by Fry (1963), is given in TABLE 3.2

The most common methods of presenting material are linear sequencing, branching, or a combination of those two. Student interaction may also take one of several forms. Students can respond to multiple-choice, fill in the blank, or short answer questions.

When a program is linear, the subject matter is divided into very small parts. The student gives a response, verifies his answer, then moves on to the next part. All students follow an identical path through the forward moving chain. Because there is no method of receiving extra instruction, the error rate must be very low (Callender, 1969).

Linear programming, the most common type of p. i., was developed by B. F. Skinner as an extension to his studies in reinforcement theory. He showed that many topics can be taught to numerous types of individuals using reinforcement. Textbook material is easily adaptable to the linear programming form.

Linear programming does have some disadvantages. First, because the subject matter is divided into such small parts 1) it may be too simple for some students, leading to boredom and disinterest and 2) it takes much longer to cover the same material in linear programming
TABLE 3.2 Checklist for judging programs

SUBJECT MATTER
--- Covers subject (meets desired objectives)
--- Faculty opinion
--- Author's reputation
--- Publisher's reputation
--- Readability level

PROGRAMMING TECHNIQUE
--- Logical progression
--- Your own students' opinions
--- Your own students' error rate
--- Your own students' pull level
--- Evidence of tryout and revision
--- Meaningfulness of responses
--- Lesson size
--- Branching
--- Writer's style
--- Pleasing, convenient format
--- Response mode
--- Prompting

RESULTS
--- Evidence of your own students' learning
--- Evidence of field trials
--- Type of students used in field trials
--- How learning measured
--- Reputation of psychologist conducting field trials
--- Acceptance by faculty and students

EFFICIENCY
--- Cost, initial
--- Cost, long-term
--- Training time required
--- Quality of students required (IQ, previous training)
--- Quality of instructor required
--- Logistics (space, machine need)
than in the branching program method. Also, since each student follows the same path through the program, there is no way to make allowances for the individual learner except for the time factor. For these reasons linear programming will never be used extensively (O'Day, 1971).

In a branching program, the subject matter is not as finely divided as in a linear program. A branching program requires that a student read a series of frames and then answer a multiple-choice question. If the answer is correct the student continues along the main stem of the program. When the student gives an incorrect answer, he goes to a different part of the program for remedial instruction and then returns to the missed question (Callender, 1969).

The ability to add or delete frames depending on the student responses permits branching to adapt to the individual. The brighter student can move quickly through the larger blocks of information while the slower student receives the extra help he may need (O'Day, 1971). A disadvantage of this technique is that the student will eventually figure out the answer to the question by the process of elimination (Garner, 1966).

Each type of programming has advantages and disadvantages. The "best one" depends on what the program is trying to accomplish and the programmer's preference.
Some other points in determining programming method are:

1) **Target population** - Young children (under mental age 11) respond better to linear programming while branching is more appropriate for those over mental age 11.

2) **Subject matter** - Linear programming works best with detailed information while branching is better for teaching concepts.

3) **Book or machine** - The ideal situation is a mixture of both. Some factors that influence this decision include the learner, the environment, program format, financial resources, storage space and degree of learner control desired (Callender, 1969).

The question of when to provide feedback has been a subject of study ever since the origins of p.i. In the past researchers found that immediate feedback produced the best results, but more recent studies indicate that this may not be true with regard to the lower levels of Bloom’s taxonomy.

The degree of delay in presentation of feedback has no significant effect on retention of mathematical tasks at the first three taxonomic levels. Delay of feedback, however, did have a detrimental effect in retention of materials at the two higher levels (Waldrop, et al, 1986).

Other researchers have found feedback to have no significant effect on learning (Waldrop, et al, 1986). Research in this field will continue, but it is unknown if any definitive "best" methodology will be developed.

For all of the benefits of programmed instruction there is one major drawback, procrastination. Undergraduate students tend to put off assignments that do
not have a definite due date. Instead of following a self-paced system, many students followed a "no-paced one" (Rainey, 1981). One attempt to overcome this stumbling block has been to implement periodic testing and retesting procedures.

Although programmed instruction cannot match the personal interaction provided by a teacher, it can be used in conjunction with a teacher to provide a positive atmosphere for learning (Tillman and Glynn, 1987). Most educational researchers agree that the concepts of programmed instruction are highly successful in a learning situation (Gagne et al., 1988; Rainey, 1981; Stice, 1979). Tillman and Glynn (1987) reviewed an article in which 112 p. i. studies were examined.

The results ... allow one to make the generalizations that many programs teach as successfully as (or more successfully than) many teachers and sometimes that they do this in less time.

**Similar Case Studies**

Majorie Nan A. Webb described a computerized college placement exam developed by the Educational Testing Service (ETS) of Princeton, New Jersey, which was designed to allow students more flexible scheduling with regard to testing times and immediate access to scores. The pilot study was carried out at Central Piedmont Community College and had 173 student participants (Webb, 1986).
The results of a survey indicated that almost three quarters of the students preferred the computer testing situation (Webb, 1986). A few students took both the computerized and the pencil and paper versions of the test. These results gave ETS reason to believe that "there are substantial true relations" between the two versions of the test (Webb, 1986), although later correlations introduced some uncertainty to that theory. Research in this area is still being performed.

Harvey J. Brightman, a Professor of Decision Sciences at Georgia State University and two of his students developed a student study software package for a business statistics course. Students are given the test, called "Stattest", approximately a week before a scheduled exam to help determine not only the specific subject matter where the student may be having difficulties but also the types of questions that he misses (Brightman, Freeman, and Lewis, 1984).

Brightman's "Stattest" is divided into six major regions of statistics: descriptive statistics and basic probability concepts, probability models, inductive inference, experimental design and the analysis of variance, regression analysis, and time series analysis. Each region contains between 34 and 59 multiple-choice questions which are classified by subject matter and level
of learning (Brightman, Freeman, and Lewis, 1984).

Brightman tests four levels of learning with "Stattest". These four levels are knowledge, comprehension, application, and analysis. The higher order objectives, synthesis and evaluation, were not used by Brightman because he felt they (synthesis and evaluation) could not be adequately measured by multiple-choice questions, but if the questions were developed they would be too rigorous for the class (Brightman, Freeman, and Lewis, 1984).

As mentioned previously, the results of the test can pinpoint where students are having problems. If the student does particularly poor in a subject area across all question types, then he may need to review that section. If the student consistently misses the same type of questions, it could mean that he should alter his methods of studying (Brightman, Freeman, and Lewis, 1984). According to Brightman, Freeman, and Lewis (1984) the benefits of the test as they use it are:

1) It provides timely feedback to the student or the teacher on the student's progress.

2) It identifies specific student problem areas together with remedial recommendations.

3) It provides feedback to the teacher on his or her effectiveness in the classroom.
CHAPTER 4

METHODOLOGY

The design of this computer-aided evaluation system consists of three parts: the construction of the test, the design of the programmed instruction, the development of a program to present the test and, if necessary, the proper programmed instruction and a re-test to the student. Each section in this chapter will begin with a discussion of the selected methodology and the reason for choosing that methodology.

Test Construction

Type of Test

Because it is nearly, if not totally, impossible to have a computer program score a subjective test, this study will employ an objective test. An objective test allows for the labeling of each student's response as either right or wrong, and therefore the quick and accurate scoring of the exam. True/false, matching, and multiple-choice were all considered as possible test types.

Multiple-choice is the test format chosen for this study. Some of the more attractive features of multiple-
choice testing include its versatility and ease of scoring. Additionally, multiple-choice tests are less susceptible to guessing than true-false tests. The higher the number of reasonable distractors that are supplied for a multiple-choice question, the less chance the student has of guessing the correct answer. Most of the literature suggests that the best number of distractors for a multiple-choice question varies from two to four. The questions devised in this study have at least two distractors and will usually have three. The placement of the correct answer among the distractors is randomly determined. Since multiple-choice items require more response time than true-false items, the administrator has some latitude in how the test is administered. The test may be taken under normal classroom conditions or outside the classroom without supervision.

The topics covered on this test are descriptive statistics and experimental design. A complete list of the four major topics and their respective subtopics is given in TABLE 4.1. The topics and subtopics form one part of the Table of Specifications while another is the level learning measured by each question. Since evidence has shown that the higher levels cannot be adequately tested on a computer or on multiple-choice tests, this test will concentrate on the lower levels of learning: knowledge,
I) Estimators
   A) Properties of Estimators
   B) Method of Maximum Likelihood\ Method of Moments
   C) Confidence Intervals

II) Hypothesis Testing
   A) Properties of Hypothesis Testing
   B) Parametric Tests: Means
   C) Parametric Tests: Variances
   D) Nonparametric Tests
   E) Tests of Goodness of Fit\ Independence

III) Regression
   A) Properties of Regression
   B) Descriptive and Inferential Statistics
   C) Decomposition and Least Squares
   D) Anova Techniques

IV) Experimental Design
   A) Single Factor Design
   B) Multifactor Design
   C) Sum of Squares Decomposition
   D) Anova Techniques

TABLE 4.1 Topics covered on Test
comprehension, analysis, and application with the latter two levels being combined. Analysis and application will be combined not only because the distinction between the higher levels of the taxonomy can become blurred, but because good questions on these levels are difficult to construct. Table 4.2 is the two-way chart described in Chapter 3.

The purpose of the test is to assess student proficiency as opposed to ranking students and hence the test is criterion-referenced and the level of difficulty of the questions reflect the difficulty of the material and the type of learning being measured (knowledge, comprehension, etc.).

Each major topic on this test is scored independently, and the student is given programmed instruction in the areas of deficiency only. The passing score for each area is determined by an administrator, but a passing score of 50 to 75 percent is recommended.

Some of the questions on the test come from "Stattest" and the remaining were developed following the guidelines discussed in Chapter 3. All questions are placed in a question bank and are classified by subtopic/level of learning. Although the question bank contains 204 questions, the number of questions chosen from each subtopic/level of learning cell will depend on
<table>
<thead>
<tr>
<th>I) Estimators</th>
<th>Knowledge</th>
<th>Comprehension</th>
<th>Analysis</th>
<th>Application</th>
<th>TOTAL</th>
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<td>Para. Tests: Means</td>
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<td>Para. Tests: Var.</td>
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<td>IV) Experimental Design</td>
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<td>5</td>
<td>15</td>
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<tr>
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<td>5</td>
<td>15</td>
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</tr>
<tr>
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<td>5</td>
<td>5</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Anova Techniques</td>
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<td>5</td>
<td>5</td>
<td>15</td>
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<td>TOTAL</td>
<td>81</td>
<td>65</td>
<td>58</td>
<td>204</td>
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</table>

TABLE 4.2 Table of Specifications
parameters established by an administrator. The role of the administrator is discussed later in this chapter. The specific questions on the test will be randomly selected from the relevant cells. This testing format allows for many equivalent forms of a test to be generated. This contributes to the test's reliability and validity by creating a different test each time the exam is taken.

Research has shown that students tend to get restless after an hour of testing. Since multiple-choice questions should take one minute per question a test will not contain more than 64 questions. A test of this length could be completed in most normal classroom conditions or by the student outside the classroom under unsupervised conditions should the administrator decide to present the test in this manner.

Computer-Aided Testing

In the past 20 years the computer has gone from being virtually unheard of to being an integral part of people's lives. Although not everyone is comfortable or familiar with computers, most college students come in contact with them on a regular basis.

The advantages of using a computer make it an attractive alternative to the traditional method of testing. Some of these advantages, which have previously
discussed, are: interactivity, individualization, cost, and timing. Other advantages of using a computer in the test design is that it allows for easy generation of multiple tests; the student will receive immediate feedback; each test will be automatically scored and the individualized program instruction assigned; and the test and programmed instruction (which the student can take immediately following the test if so desired) will come in one package (a diskette).

Programmed Instruction

The programmed instruction is developed as a review aid for students who do not demonstrate proficiency in a topic. The student can read the programmed instruction in a single session or in different sessions. The programmed instruction is designed to help students review the subject area(s) for which they did not receive a passing score on the test and consists of instructional material as well as examples and multiple-choice questions. It is divided into frames with each screen constituting a frame and is presented in a linear as opposed to a branch style because of the low error rate associated with questions answered using the linear method.

The student can move forward and backward through frames to review previously covered programmed instruction
material. If the student has more than one area that requires programmed instruction, the student is given the option of quitting the program between reviewing topics. The student may then resume and complete the remaining topics that require programmed instruction at some time in the future. The students for whom this system is designed are senior undergraduate and graduate engineering students who have a solid background in calculus and at least two quarters of statistics. The instructional material and examples are taken from textbooks and adapted to meet the requirements of this study. These books include "The Statistics Problem Solver" by the Research and Education Association, Dr. M. Fogiel, Director; "Fundamental Concepts in the Design of Experiments" by Charles R. Hicks; "Probability and Statistics in Engineering and Management Science" by William W. Hines and Douglas C. Montgomery; and "Probability and Statistics for Engineers and Scientists" by Ronald E. Walpole and Raymond H. Myers.

Program

A computer program that can coordinate the testing and p. i. as well as incorporate administrative guidelines
for specifying the specific content and learning outcomes measured on the test has been written using the True BASIC programming language. True BASIC was selected because it is easy to use, familiar to the programmer and contains the necessary functions. The program is divided into a main program (TEST) and several subprograms. These subprograms consist of the question database (TEXT1, TEXT2, TEXT3, and TEXT4), the programmed instruction sets (PI1 and PI2), and the administrative adjustments section (ADMIN).

Main Program

The main program (TEST) begins by identifying the user as either an administrator or a student by asking for the user’s name. If the name matches the password, the main program loads the administrative subprogram (ADMIN). Otherwise, the user is classified as a student and given the following options:

1) TAKE THE TEST.
2) CONTINUE THE PROGRAMMED INSTRUCTION.
3) QUIT.

The third option stops program execution immediately. The student is given the option to quit at every feasible opportunity. However, once the student begins a test, it must be finished in one sitting. After completing the test the student may stop immediately or may begin the p. i.
Following the completion of each topic’s programmed instruction the student is given the option of stopping. Execution of the program is automatically stopped immediately after the test if the student requires no programmed instruction or after completion of the necessary programmed instruction.

The second option is for the student who has previously taken the test and has chosen to stop program execution before completing all of his programmed instruction. When the student stops execution before finishing the programmed instruction, the current program status is saved. When the student opts to continue with the programmed instruction, the previous position is retrieved and the student is returned to the appropriate portion of the p. i.

When the student selects the first option, TAKE THE TEST, the program reads parameters previously established by the administrator. One question is allotted to each cell that is to be tested as determined by the administrator. If a subtopic is to measure a higher level of learning, then questions will automatically be included that measure all of the levels below the one selected. This is done because of the hierarchical structure of Bloom’s taxonomy; higher level mastery can not occur until lower level mastery does. The remaining questions are distributed based on the importance rankings assigned
to the topics and subtopics by the administrator. The ranking process will be discussed in the "Administrative Subprogram" section. The total number of cells also determines how the remaining questions are distributed. If fewer cells are used, then lower priority subtopics can receive extra questions. The total number of questions on the test is usually around 60 to 64. If only a small number of cells (less than 12) are tested, the total number of questions could be considerably less. If an administrator chooses less than 12 cells, then the test contains 5 questions from each cell selected.

Once the number of questions per cell has been determined, the test generation begins. Beginning with the first cell to have at least one question, the program randomly selects a number that corresponds to a question in that cell. The cell number and the random number are then saved to ensure that the same question is not repeated on the test. The cell number, random number, and question number are converted to string variables and concatenated, and control is passed to the proper question bank subprogram. The subprogram prints the question and returns control to the main program. The main program then asks the student to "KEY IN THE LETTER OF YOUR RESPONSE". The student is then asked to confirm the answer by entering a '1' or given the opportunity to change the response by
entering a '2'. If the student's response matches the correct answer "YOU HAVE CHOSEN THE CORRECT ANSWER" appears; otherwise, "THE CORRECT RESPONSE IS" appears; followed by the correct response. The student is asked to hit any key when ready to continue (see Figure 4.1 on the following page). The time elapsed between the student entering any key and the next question appearing on the screen is between 5 and 6 seconds.

Arrays have been established to keep track of the number of right and wrong responses the student has for each cell. There are also arrays to monitor the cell number, the random number, and the response given by the student. These arrays can be used to pinpoint bad questions. If many students are consistently incorrectly answering the same question, then the question should be examined for ambiguous wording or some other problem.

Once the main program has presented the entire test to the student, the number of right and wrong answers is totalled for each major topic/learning outcome, each major topic, and each learning outcome, and for the entire test. The results and a guide to interpreting them are given to the student. When the student is finished viewing the results, notification is given of the areas in which programmed instruction is needed. If the student needs no programmed instruction, the results are sent to a text
QUESTION 1

THE PURPOSE OF CALCULATING THE MEAN SQUARE ERROR OF A POINT ESTIMATOR IS TO?

A) DETERMINE THE BIAS OF THE ESTIMATOR.
B) COMPARE THE ESTIMATOR TO OTHER ESTIMATORS.
C) CALCULATE THE VARIANCE OF THE ESTIMATOR.
D) COMPUTE THE EXPECTED VALUE OF THE ESTIMATOR.

KEY IN THE LETTER OF YOUR ANSWER:
D
ENTER '1' IF THIS IS THE ANSWER YOU DESIRE OR '2' TO RE-ENTER ANSWER:
1
THE CORRECT ANSWER IS B.

FIGURE 4.1 Sample Test Question
file, and the program is stopped.

If the student requires programmed instruction, then the option of quitting or continuing with the programmed instruction is given. If the student decides to quit, then the current status (areas requiring programmed instruction) is sent to a text file and the program ceases execution. The file is then retrieved when the student decides to continue with the programmed instruction.

If the student decides to continue, then the main program assigns a string to be passed to the one of the programmed instruction subprograms. The string variable is the first three letters of the first major topic that the student needs to review. The main program then relinquishes control, and either PI1 or PI2 is loaded. Once the student returns to the main program, the status is altered to reflect that the completion of that particular programmed instruction set. If there are no more areas requiring programmed instruction, then the student is asked to retake the test when convenient, and the program is stopped. If the student elects to continue the programmed instruction, then the process is repeated until the student decides to stop, or has completed all of the required programmed instruction.
Administrative Subprogram

The ADMIN subprogram is loaded and executed if the name entered in the main program matches the password. ADMIN is the only subprogram in which program execution is stopped. Control is never returned to the main program. The administrator is returned to the operating system after deciding to exit the program.

After the previously set parameters are read into the program from the text files, the first screen gives the administrator the following options:

1) VIEW TOPICS
2) VIEW CURRENT TEST CONDITIONS
3) CHANGE CURRENT TEST CONDITIONS
4) EXIT PROGRAM.

The first option, VIEW TOPICS, displays the topics and subtopics covered on the test. This option is for a user who is unfamiliar with the test and its content.

By viewing the current test conditions an administrator can determine what, if any, parameters need to be changed. The first screen of viewing current test conditions displays the current ranks of the major topics. The second through fifth screens show each set of subtopics with their ranks and levels of learning on the test. The final screen allows the user to see the score that is currently required to pass the test. The user is then
returned to the first screen.

Selecting the third option allows an administrator to individually tailor the test. The administrator is given the following choices from the change test design menu:

1) ALTER THE MAJOR TOPIC RANKINGS
2) ALTER THE SUBTOPIC RANKINGS
3) ALTER THE SUBTOPIC LEVELS
4) ALTER THE PASSING SCORE
5) RETURN TO THE PREVIOUS SCREEN.

If number '1' is selected the user will see the four major topics (estimators, hypothesis testing, regression and experimental design) on the screen along with a brief set of instructions. The user is asked to enter a rank ('0' through '4') for each of the major topics. A zero rank denotes that the administrator wishes to delete that entire topic from the test. A '1' through '4' rank indicates the priority that the administrator assigns to that topic. A '1' indicates the highest priority ranking. Assigning these ranks is very important; major topic ranks take precedence over subtopic ranks. For example a subtopic with a major rank of 1 and a subtopic rank of '2' has a higher priority than a subtopic with major rank '2' and a subtopic rank of '1'. If all four topics are of equal importance to the administrator, then he/she may give each topic a rank of '1'. Any of the ranks may be
used more than once or not at all. Major topics with higher priority ranks will be represented by more questions on the test. If most of the forty cells are to be on a test, a major topic with a rank of 4 will probably only have one question per cell (learning outcome) on the test. After all four rankings have been entered the user is returned to the change test design menu.

If the user selects number ‘2’ from the change test design menu the following options for modifying the subtopic rankings are given:

1) ALTER THE ESTIMATOR RANKINGS
2) ALTER THE HYPOTHESIS TESTING RANKINGS
3) ALTER THE REGRESSION RANKINGS
4) ALTER THE EXPERIMENTAL DESIGN RANKINGS
5) RETURN TO PREVIOUS MENU.

Choosing any of the first four options allows the administrator to reset the subtopic rankings for that topic. A zero rank indicates a subtopic is to be deleted. A ‘1’ signifies a subtopic with the highest priority, and ties are allowed among subtopics. After entering all of the chosen subtopic’s rankings the user is returned to the menu for modifying the subtopic rankings. When the administrator is finished altering rankings, control is returned to the change test design menu.

The third option on the change test design menu (alter the subtopic levels) allows the administrator to:
1) ALTER THE ESTIMATING SUBTOPICS LEVELS OF LEARNING

2) ALTER THE HYPOTHESIS TESTING SUBTOPICS LEVELS OF LEARNING

3) ALTER THE REGRESSION SUBTOPICS LEVELS OF LEARNING

4) ALTER THE EXPERIMENTAL DESIGN SUBTOPICS LEVELS OF LEARNING

5) RETURN TO THE PREVIOUS MENU.

The first four options give the opportunity to alter the levels of learning on the test. These levels of learning are derived from Bloom's taxonomy and include knowledge (level 1), comprehension (level 2), and application and analysis (level 3). Not all levels are represented for all subtopics. When a level higher than 1 is chosen for a subtopic the lower levels will automatically be included on the test i.e. by choosing level 2 as the highest learning outcome to be measured for a subtopic, an administrator includes knowledge for that subtopic as well. This is done because research has shown that a student's mastery of higher level material depends on understanding of lower level material. To accurately ascertain that a student has achieved mastery of a higher level, then mastery of all learning levels below it in the learning level hierarchy must be demonstrated.

Choosing options '1' through '4' gives the administrator the opportunity to change the highest levels of learning for each set of subtopics. With each subtopic
is its allowable levels of learning. The program will not let a user enter a level of learning that is not represented on the test. Once the administrator has finished altering the levels of learning, control is returned to the change test design menu.

The fourth choice involves altering the percentage of questions that a student must correctly answer to demonstrate proficiency for a topic. A score of 50 to 75 percent is recommended based on research previously discussed in the Literature Review. After entering the desired passing score, the administrator is returned to the menu to change test design.

When the administrator has made the desired changes to the test and has entered a '5' in the change test design menu, the new test parameters are stored on the diskette. The administrator is then returned to the first menu.

The final selection on the first menu is to EXIT PROGRAM. When an administrator chooses this option program execution is stopped and control is returned to the operating system.

Text Subprograms

The question bank is divided into four subprograms: TEXT1, TEXT2, TEXT3, and TEXT4. Each subprogram contains the question set for 10 cells. Each cell has at least five
different questions.

The time for the program to select a random number, pass control to the proper subprogram, and print the question is usually between 5 and 6 seconds. The fewer questions in the subprogram the less time this process takes. After repeated testing, it was determined that dividing the question bank into more than four parts does not significantly lower the time between questions. Also, each "text" subprogram uses at least 80,000 bytes of disk space. When considering time between questions versus disk space, four "text" programs allow the main program and all of the subprograms to fit on a high density disk with an acceptable time between questions.

When control is passed to a "text" subprogram, a string variable is passed to that subprogram. This string variable is a combination of letters representing the cell number, the generated random number, and the question number. The question number is printed on the screen for the student's benefit. The cell number identifies the question set (subtopic/level of learning), and the random number determines which question from that cell is chosen. Once the question with its alternatives has been located, it is printed on the screen. At this point execution on the subprogram is stopped and control is returned to the main program.
Programmed Instruction Subprogram

When one of the programmed instruction subprograms is loaded and executed, it receives a three letter string variable from the main program denoting which topic's set of programmed instruction is to be presented to the student. Each frame of the programmed instruction is printed on the screen and contains either instructional material, examples or questions. The screens with questions require that the student enter a letter response. The student may proceed with the programmed instruction by entering a '1' or review the previous screen by entering a '2'. On the first screen the student may advance only. When the student has entered a '1' on the final screen control is returned to the main program.

Technical Considerations

To keep students from tampering with the program, the executable code is bound using the True BASIC run-time package. By binding the compiled version of the program, the user cannot access the program. Some other advantages of binding are that a bound program runs faster than an unbound, uncompiled one, and the user does not need True BASIC to run the program.

A disadvantage of binding a program is that each bound program uses at least 80,000 bytes of disk space. In order
to keep all of the programs on one floppy disk, a high
density disk is used. This will not be a problem for the
students due to the availability of computers on campus
that run high density floppy disks.

Conclusions

Each part of this system, the test questions, the
programmed instruction, and the computer program, work
together to provide the student with a complete self-help
tool to reviewing basic statistics. If the student has not
mastered all of the material, the responses to the test
questions determine where help is needed. The programmed
instruction provides the corrective measures. A computer
program and a computer coordinate the test questions and
provide a convenient medium to present the tools.
The previous chapter provided the technical considerations associated with this system, and this chapter provides a detailed description of the actual testing procedure. Before a student takes the test, an instruction sheet provided to help the student through the testing procedure. This instruction sheet is an outline of the material presented in this chapter. The major steps involved in this system for the student are: accessing the test, taking the test, interpreting the results, and reading the programmed instruction.

The contents (the questions and the programmed instruction) have been reviewed by professors familiar with the topics as well as a group of graduate students who took the test and read through the programmed instruction. Both the professors and the graduate students offered suggestions to improve the testing and reviewing procedure. These suggestions were considered and incorporated into the system when feasible.
Accessing the Test

To take the test, the student must have a computer with a 5 1/4 inch high density disk drive as drive 'A'. The student must boot the computer with DOS and then place the testing diskette in drive 'A', type 'TEST', and then hit the 'ENTER' key.

The student is asked to enter his name, and is presented with three choices:

1) Take the test
2) Continue the programmed instruction
3) Quit.

To take the test the student would press '1' and then 'ENTER'.

Taking the Test

After the 'Take the test' option has been selected, the first question will appear on the screen. The question will be multiple-choice with two or three distractors and one 'best' answer. The student should select the best answer and enter the letter (a, b, c, or d, or A, B, C, or D) which represents that answer. Only the letter choices that are applicable to that question may be entered. The student is then given the option of altering the response. A '1' is entered if that is the answer the student wants to select, or a '2' can be entered if the student wishes to
select a different answer. The number of times that a student may change the answer is not limited as long as he/she keeps entering a '2'. Once a student has entered a '1', then the answer is compared to the correct answer, and the student is notified as to whether or not the response is correct. The student is then asked to enter any letter to continue the test. A sample question screen is given in FIGURE 5.1. The number of questions on the test will depend on parameters that were previously established by an administrator. The administrator's role in the program was explained in Chapter 4 in the Administrative Subprogram section.

Interpreting the Results

Once the test has been completed, a screen detailing the results and what each result signifies is presented to the student. FIGURE 5.2 is the 'Guide to Interpreting the Results', and FIGURE 5.3 is an example of a student's results. The student may toggle between the two screens by entering a '1'. The student is provided the number of right (R) and wrong (W) totals for each major topic/level of learning. Totals are also provided for each topic: estimators (E), hypothesis testing (H), regression (R), and experimental design (D) and for each of the levels of
QUESTION 1

WHAT IS NECESSARY FOR CONSISTENCY IN AN ESTIMATOR?

A) A SMALL VARIANCE.
B) A SMALL SAMPLE SIZE.
C) A LARGE SAMPLE SIZE.
D) THAT IT BE UNBIASED.

KEY IN THE LETTER OF YOUR ANSWER:
C
ENTER '1' IF THIS IS THE ANSWER YOU DESIRE OR '2' TO RE-ENTER ANSWER:
1
YOU HAVE CHOSEN THE CORRECT ANSWER.

FIGURE 5.1 Sample Test Question
GUIDE TO INTERPRETING YOUR RESULTS

'R' REPRESENTS RIGHT AND 'W' REPRESENTS WRONG

LEVELS:
- KNOW - QUESTIONS TESTING KNOWLEDGE
- COMP - QUESTIONS TESTING COMPREHENSION
- A-A - QUESTIONS TESTING APPLICATION AND ANALYSIS

TOPICS:
- ES - ESTIMATORS
- HT - HYPOTHESIS TESTING
- RE - REGRESSION
- ED - EXPERIMENTAL DESIGN

ENTER '1' TO VIEW YOUR TEST RESULTS
ENTER '2' TO CONTINUE WITH THE PROGRAM

FIGURE 5.2  Guide to Interpreting the Results
YOUR TEST RESULTS

LEVEL

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<thead>
<tr>
<th>TOPIC</th>
<th>KNOW</th>
<th>COMP</th>
<th>A-A</th>
<th>TOTAL</th>
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</thead>
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<td>3</td>
<td>2</td>
<td>8</td>
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<td>4</td>
</tr>
<tr>
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<td>3</td>
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<td>TAL W</td>
<td>7</td>
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<td>13</td>
<td>31</td>
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</tbody>
</table>

HIT '1' TO RETURN TO THE 'GUIDE OF TEST RESULTS'
HIT '2' TO CONTINUE WITH THE PROGRAM

FIGURE 5.3 Sample Test Results
learning: knowledge (K), comprehension (C), and application and analysis (A). A grand total for the entire test is also given. Whether or not a student has demonstrated proficiency in a major topic depends on the percentage of the total questions in that topic that were answered correctly. The percentage correct required to demonstrate proficiency is determined by the administrator before the student takes the test. The student enters '2' to leave the 'Guide' and 'Results' screens, and is then presented with the topics (if any) that require p. i.

**Reading the Programmed Instruction**

Once the student has had a chance to view the topics that require programmed instruction, the program may be stopped at this point and the programmed instruction continued at a later time. The student would do this by entering option '2' after entering their name. If the test has been successfully completed, the student is so informed, and program execution is stopped. If, on the other hand, the student does require programmed instruction and elects to read through it, then the first screen of the first topic requiring programmed instruction is presented to the student. The student then enters a '1' to advance to the next screen. After the first screen the student has the option of entering a '1' to move to the next screen or
entering a '2' to review the past screen. When a student encounters a screen containing a question, then student must enter a letter signifying what is believed to be the best response. The questions in the programmed instruction require the same actions as the test questions, except that instead of automatically moving forward the student has the option of reviewing previous material. Besides questions, the programmed instruction is composed of examples (FIGURE 5.4) and text material (FIGURE 5.5). When the student has reached the final screen in the programmed instruction for a topic and enters a '2' to continue, the student is presented a screen that lists the remaining topics (if any) that require programmed instruction. If the student has no topics remaining that require programmed instruction, then the student is asked to retake the test when convenient. On the other hand, if the student has topics remaining that required programmed instruction, then the options of quitting are again provided and the student may finish the program at a later time or proceed with the programmed instruction of the next topic on the list. This cycle is repeated until the student either decides to quit or has completed reading through all the topics that require programmed instruction. If a student decides not to finish a topic's programmed instruction, then the student must start the programmed instruction from the beginning.
EXAMPLE #1

GIVEN THE FOLLOWING BERNOULLI FUNCTION WHAT IS THE MAXIMUM LIKELIHOOD ESTIMATOR OF $p$, THE PROBABILITY OF SUCCESSFUL OPERATION?

$$L(p) = p(p - 1)^2$$

WE WISH TO FIND THAT VALUE OF $p$ WHICH MAXIMIZES THE EQUATION, THE LIKELIHOOD OF THIS PARTICULAR SEQUENCE. DIFFERENTIATING THIS WITH RESPECT TO $p$ AND SETTING THE DERIVATIVE EQUAL TO ZERO:

$$L(p) = (p^3) - (2p^2) + p$$
$$L'(p) = (3p^2) - 4p + 1 = 0$$

USING THE QUADRATIC FORMULA TO SOLVE WE FIND THAT $p$ EQUALS 1 OR $1/3$.

THE VALUE $p = 1$ WHEN SUBSTITUTED INTO THE ORIGINAL EQUATION YIELDS $L(p) = 0$. HENCE THE LIKELIHOOD IS MAXIMIZED WHEN $p = 1/3$. THIS IS THE MAXIMUM LIKELIHOOD ESTIMATE OF $p$. 

FIGURE 5.4 Sample Programmed Instruction Example
THE PARAMETRIC HYPOTHESIS TESTS CAN BE DIVIDED INTO TESTS ON MEANS AND TESTS ON VARIANCES. SOME SPECIFIC TESTS OF HYPOTHESES ON MEANS ARE:

1) MEAN, VARIANCE KNOWN.

2) EQUALITY OF TWO MEANS, VARIANCE KNOWN.

3) MEAN OF A NORMAL DISTRIBUTION, VARIANCE UNKNOWN.

4) MEANS OF TWO NORMAL DISTRIBUTIONS, VARIANCES UNKNOWN AND EQUAL.

5) MEANS OF TWO NORMAL DISTRIBUTIONS, VARIANCES UNKNOWN AND NOT EQUAL.

IN THE CASES WHERE THE POPULATION VARIANCE(S) ARE KNOWN, Z IS THE TEST STATISTIC CALCULATED. WHEN TWO MEANS ARE INVOLVED CALCULATIONS ARE MORE COMPLICATED. t IS THE TEST STATISTIC USED IN THOSE CASES WHEN THE VARIANCE IS NOT KNOWN.

A SPECIAL CASE OF THE TWO SAMPLE t-TEST OCCURS WHEN THE OBSERVATIONS ON TWO POPULATIONS OF INTEREST ARE COLLECTED IN PAIRS. THE TEST PROCEDURE CONSISTS OF ANALYZING DIFFERENCES BETWEEN THE TWO OBSERVATIONS. IF THERE IS NO DIFFERENCE IN THE MEANS, THEN THE MEAN OF THE DIFFERENCES SHOULD BE ZERO. THIS PROCEDURE IS CALLED THE PAIRED t-TEST.

FIGURE 5.5 Sample Programmed Instruction Text Material
The student should take the test and read through the programmed instruction as many times as it takes to successfully complete the test (require no programmed instruction).
RECOMMENDATIONS

While designing this system, several enhancements which might improve the testing procedure were discovered. Unfortunately, it is not feasible to incorporate these changes at this time. These recommendations for future improvements include:

1) The validity and reliability of the system could be better verified by administering the test to a larger group of students. The group could be divided into three sections. The first section could take the computerized version of the test and the programmed instruction, the second group could take a pencil and paper version of the test and programmed instruction, and the third group would not take the test or the programmed instruction in any form. Scores from the tests for the students in each of the three groups could be compared and contrasted.

2) After a large number of students have taken the test, each question should be formally reviewed to determine if an exceptionally high number of students are incorrectly or correctly answering that question. If too many students are correctly answering a question, then the question may be too easy, or it may be worded so that the student is cued to the correct response.

3) More questions could be provided for each topic/level of learning. This would provide less chance of a student taking a retest answering questions to which he/she has memorized the answers.

4) To avoid students getting impatient while waiting for the questions to appear on the screen, a method for reducing the six second lag time between questions, might be sought.
5) The test could be made more accessible if it could be run on a regular 5 1/4 inch floppy diskette, rather than on a high density one.

6) In conjunction with the written version of the programmed instruction, the student could also be presented auditory and visual stimulus to help the student review the material. The visual stimulus could be a video tape of a professor teaching the subject.

7) The programmed instruction could use branching instead of the linear method. The depth of branching procedure that the student goes through could depend on the number of times the student has had to review a particular topic, whether the student correctly answer the questions in the programmed instruction, and the student's preference.

8) The questions in the question bank and the programmed instruction can be altered by the administrator, but he/she must enter the uncompiled version of the program. A major enhancement to this system would be to provide an easier method for altering the testing material.

9) The test could be made available to more students if it could be run on a mainframe. Mainframe terminals are always available, and worries such as disk space and time between questions could be eliminated.
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APPENDIX A

STUDENT HELP GUIDE
This test covers four major topics: estimators, hypothesis testing, regression, and experimental design. Also different types of learning (knowledge, comprehension, and application and analysis) will be measured. The test has 60 - 64 questions and is closed book. Please take the test at your convenience on a pc with a high density disk drive capacity. If you do not "pass" a topic programmed instruction (p.i.) is provided to help you review. If you have any areas requiring p.i., please read through the instruction and retake the test at your convenience. This sheet will help guide you through the testing process.

1) Boot up the computer.

2) Place high density disk in drive A (make sure PC has high density disk drive capacity). Type "TEST" and enter.

3) Your choices will be: 1) Take the test; 2) Continue the programmed instruction; and 3) Quit. Enter '1' to take the test. If you have already taken the test and wish to continue the programmed instruction enter '2'. Enter '3' to quit.

4) If you select option '1' from step 3, then the first question will appear on the screen. After each question appears enter the letter (A thru C or D) of the best response.

5) Enter '1' to confirm your response, or enter '2' to change it and return to step 4.

6) After the correct response is revealed, enter 'X' to continue.

7) When the test is finished a guide to interpreting the results will be presented. Enter '1' to view your test results or '2' to continue (go to step 9).

8) Your totals for each topic/level of learning is displayed along with each topic's and learning outcome's total. Enter '1' to return to step 7 or enter '2' to continue.

9) The topics in which you require programmed instruction will be listed. Enter 'X' to continue. If you passed all of the topics the program execution is stopped.
10) You are given the option of taking the set of programmed instruction (enter '1') or quitting (enter '2'). If you enter '2' program execution is stopped and you choose option number 2 at step 3 when you wish to finish.

11) The p.i. is presented for the first topic listed under step 9.

12) If you have taken all of the p.i., then the program stops execution, and you are asked to retake the test at your convenience. Otherwise, return to step 9.
APPENDIX B

ADMINISTRATOR GUIDE
This User's Guide is for a computerized multiple-choice test for basic statistics. After the test is scored, programmed instruction is presented to help the student review the area(s) in which he/she does not demonstrate proficiency. The major topics covered on the test are estimators, hypothesis testing, regression and experimental design.

The type of learning for each subtopic is broken into hierarchically structured levels developed by B.S. Bloom and his colleagues in the mid 1950's. Mastering higher levels of learning is dependent on mastery of the lower level ones. On this test the levels of learning measured are the four lowest levels of Bloom's taxonomy: knowledge, comprehension, and application and analysis. The third and fourth levels, application and analysis, are combined. Questions testing the fifth and sixth levels are not appropriate for this test. Not all subtopics are tested at all three levels. The test questions are randomly selected from a questionbank which contains 204 questions. These questions are grouped in cells. Each cell (subtopic\level of learning) contains at least 5 questions. The test will consist of approximately 60 questions. The number of questions chosen from each cell depends on parameters established by an
The computer program that generates the test is written in True BASIC and must be run on a high density disk. The program consists of a main program and six "chained" programs. These chained programs are loaded and executed when the main program calls them. When they have finished executing control is returned to the main program. These chained programs include ADMIN, which allows the administrator to set the parameters for the test and is the subject of this Guide, TEXT(1-4), which contains the questionbank, and PI, which presents the necessary programmed instruction to the student.
Using the Program

Once the computer has been booted up and the testing disk placed in drive A, you access the main program by typing "TEST". The screen will ask you to enter your name. The ADMIN chain is loaded and executed if the name entered in the main program matches the password, WAPLINGER. ADMIN is the only chain in which program execution is stopped once control is returned to the main program. Instead you are returned to the operating system once you decide to exit the program.

After the previously set parameters are read into the program from the text files, the first screen gives you the following options:

1) VIEW TOPICS
2) VIEW CURRENT TEST CONDITIONS
3) CHANGE CURRENT TEST CONDITIONS
4) EXIT PROGRAM.

The first option, view topics, displays the topics and subtopics covered on the test. This option is for a user who is unfamiliar with the test and its content.

By viewing the current test conditions you can determine what, if any, parameters you may want to change. The first screen of viewing current test conditions displays the current ranks of the major topics. The second through fifth screens show each set of subtopics with their ranks
and their highest learning outcomes or levels of learning on the test. The final screen allows you to see the score that is currently required to pass the test. You are then returned to the first screen.

Selecting the third option allows you to tailor the test to suit your needs. You are given the following choices from the change test design menu:

1) ALTER THE MAJOR TOPIC RANKINGS
2) ALTER THE SUBTOPIC RANKINGS
3) ALTER THE SUBTOPIC LEVELS
4) ALTER THE PASSING SCORE
5) RETURN TO THE PREVIOUS SCREEN.

If number '1' is selected you will see the four major topics (estimators, hypothesis testing, regression and experimental design) on the screen along with a brief set of instructions. You are asked to enter a rank ('0' through '4') for each of the major topics. A zero rank denotes that you wish to delete that entire topic from the test. A '1' through '4' rank indicates the priority that you assign to that topic. A '1' indicates the highest priority ranking. Assigning these ranks is very important; major topic ranks take precedence over subtopic ranks. For example a subtopic with a major rank of 1 and a subtopic rank of '2' has a higher priority than a subtopic with major rank '2' and a subtopic rank of '1'. If all four topics of equal
importance to you, then you may give each topic a rank of '1'. Any of the ranks may be used more than once or not at all. The major topics with the higher priority ranks will be represented by more questions on the test. If most of the forty cells are to be on a test, a major topic with a rank of 4 will probably only have one question per cell (learning outcome) on the test. After all four ranks have been entered then you are returned to the change test design menu.

If you select number '2' from the change test design menu you are given the following options for modifying the subtopic rankings:

1) ALTER THE ESTIMATOR RANKINGS
2) ALTER THE HYPOTHESIS TESTING RANKINGS
3) ALTER THE REGRESSION RANKINGS
4) ALTER THE EXPERIMENTAL DESIGN RANKINGS
5) RETURN TO PREVIOUS MENU.

Choosing any of the first four options allows you to reset the subtopic rankings for that topic. A zero rank indicates a subtopic to be deleted. A '1' signifies a topic with the highest priority, and ties are allowed among subtopics. After entering all of the chosen subtopic's rankings you are returned to the menu for modifying the subtopic rankings. When you are finished altering rankings, you are returned to the change test design menu.
If the third option on the change test design menu is chosen the following choices are presented to the administrator:

1) ALTER THE ESTIMATING SUBTOPICS LEVELS OF LEARNING
2) ALTER THE HYPOTHESIS TESTING SUBTOPICS LEVELS OF LEARNING
3) ALTER THE REGRESSION SUBTOPICS LEVELS OF LEARNING
4) ALTER THE EXPERIMENTAL DESIGN SUBTOPICS LEVELS OF LEARNING
5) RETURN TO THE PREVIOUS MENU.

The first four options gives you the opportunity alter to the levels of learning on the test. These levels of learning are derived from Bloom’s taxonomy and include knowledge (level 1), comprehension (level 2), and application and analysis (level 3). Not all levels are represented for all subtopics. When a level higher than 1 is chosen for a subtopic the lower levels will automatically be included on the test. By choosing level 2 as the highest learning outcome to be measured for a subtopic, you include knowledge for that subtopic as well. This is due to the fact that research has shown that mastery of higher level material depends on understanding lower level material.

Choosing options ‘1’ through ‘4’ from the change levels menu gives you the opportunity to change the highest levels of learning for each set of subtopics. Beside each subtopic are its allowable levels of learning. The program will not
let you enter a level of learning that is not represented on the test. Once you have finished altering the levels of learning, you are returned to the change test design menu.

The fourth choice on the change test design menu involves altering the percentage questions that a student must correctly answer to demonstrate proficiency for a topic. A score of 50 to 75 percent is recommended. These numbers are determined from the research by testing experts presented in the Literature Review. After entering the desired passing score you are returned to the change test design menu.

When you have altered the test to fit your needs and have entered a 5. The new test parameters are then written to an outside text file to be stored. You are then returned to the first menu.

The final selection on the first menu is to "EXIT PROGRAM". When you choose this option program execution is stopped, and you are returned to the operating system.
Alter the Test

If you wish to alter (change, add or delete) the questions that the student is asked, then first determine which cell number contains the question and then which TEXT program contains that cell. A list of the topics and their cell numbers are given on the following page. The questions for cells 1 through 10 are located in program TEXT1, cells 11 through 21 in TEXT2, cells 22 through 34 in TEXT3, and cells 35 through 48 in TEXT4.

If you are deleting or changing a question then locate the specific question and make the desired changes keeping in mind to maintain the Tru BASIC programming format. A question, its choices and the PRINT blanks may be more than 20 lines. The other five lines on the screen are to allow for student response to the question. If a question is deleted, and it is not the last question in that cell, then after deleting the question rearrange the letters representing the remaining questions within that cell so that the questions are represented by consecutive letters of the alphabet in reverse order (Z, Y, X, etc.).

If you are adding a question then after the last previously existing question type:

```
ELSEIF RAN_NUM = m THEN
```

and using PRINT statements type in your multiple-choice question. "m" represents the next reverse order letter in the alphabet (Z, Y, X, etc.).
## Level of Learning

<table>
<thead>
<tr>
<th>Topic</th>
<th>Knowledge</th>
<th>Comprehension</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESTIMATORS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Properties of estimators</td>
<td>1</td>
<td>17</td>
<td>33*</td>
</tr>
<tr>
<td>Method of moments\max. likelihood</td>
<td>2</td>
<td>18*</td>
<td>34</td>
</tr>
<tr>
<td>Confidence Intervals</td>
<td>3</td>
<td>19</td>
<td>35</td>
</tr>
<tr>
<td><strong>HYPOTHESIS TESTING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Properties of hypothesis testing</td>
<td>4</td>
<td>20</td>
<td>36</td>
</tr>
<tr>
<td>Parametric tests (means)</td>
<td>5</td>
<td>21</td>
<td>37*</td>
</tr>
<tr>
<td>Parametric tests (variances)</td>
<td>6</td>
<td>22</td>
<td>38*</td>
</tr>
<tr>
<td>Nonparametric tests</td>
<td>7</td>
<td>23*</td>
<td>39*</td>
</tr>
<tr>
<td>Goodness of fit\Independence</td>
<td>8</td>
<td>24</td>
<td>40</td>
</tr>
<tr>
<td><strong>REGRESSION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Properties of Regression</td>
<td>9</td>
<td>25</td>
<td>41</td>
</tr>
<tr>
<td>Descriptive and inferential stats.</td>
<td>10</td>
<td>26*</td>
<td>42*</td>
</tr>
<tr>
<td>Decomposition and Least Squares</td>
<td>11</td>
<td>27</td>
<td>43</td>
</tr>
<tr>
<td>Anova techniques</td>
<td>12</td>
<td>28</td>
<td>44</td>
</tr>
<tr>
<td><strong>EXPERIMENTAL DESIGN</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single factor design</td>
<td>13</td>
<td>29</td>
<td>45</td>
</tr>
<tr>
<td>Multifactor design</td>
<td>14</td>
<td>30</td>
<td>46</td>
</tr>
<tr>
<td>Sum of squares decomposition</td>
<td>15</td>
<td>31</td>
<td>47</td>
</tr>
<tr>
<td>Anova techniques</td>
<td>16</td>
<td>32</td>
<td>48</td>
</tr>
</tbody>
</table>

* Denotes cells that are currently empty
Once the question(s) have been altered in the "TEXT" program to your satisfaction, you must make the appropriate changes in the main program if you have altered the number of questions or changed the sequence of the correct letter responses in a cell.

If you changed the number of questions in a cell, then you must change the proper NUM_QCE array position to reflect the new total number of questions in that cell. NUM_QCE is a one-dimensional array that has each array value (1 to 48) individually entered near the beginning of the program under INITIAL CONDITIONS. The numbers in the NUM_QCE array are used in conjunction with the random number generator of True BASIC to determine which questions the student sees on his/her test.

If the answer sequence in a cell has been changed, then you must find the proper cell in SUB LETTERS the adjust the letter sequence for that cell. If you have deleted a question, then remove the answer for that question and rearrange the remaining answers so that they are represented by the consecutive cardinal numbers (1, 2, 3, etc.) and match the remaining questions in the questionbank.

If you added a question after the last previously existing answer add:

```
ELSEIF RAN_NUM = m THEN
LET CR$ = n
```

where m is the number representing that question (m should
be one more than the number of the last previously existing question), and \( n \) is the correct letter response (capital A through C or D) to the multiple-choice question denoted by CR$.

If you altered an existing question but did not alter the letter of the correct answer, then you do not need to change anything in the TEST program. If, however, the correct answer sequence was changed, then you must go into SUB LETTERS and revise the correct letter sequence.

After you have made any changes it is imperative that the correct letter sequence be checked to ensure the accuracy of the test.
Altering the Programmed Instruction

The programmed instruction set is divided into two programs. The first program, PI1, deals with the first two major topics, estimators and hypothesis testing. The last two topics, regression and experimental design, are dealt with in the second program, PI2.

If you wish to alter a page of programmed instruction, first determine the topic and the number of the page (screen) to be changed then access to correct program. The pages are contained in subroutines. Each page subroutine is named "1PAGEn" where 1 is a letter denoting the topic: "E" for estimators, "H" for hypothesis testing, "R" for regression, and "D" for experimental design. n represents the page number in that sequence. Once the location of the change has been found, the changes can be made. The Tru BASIC format must be maintained. A page containing text or an example can have no more than 24 lines, and a question page can have no more than 20 lines on the screen. A question page subroutine contains the correct response near the beginning of the subroutine set equal to CR$.

If you need to add or delete a page then you must renumber the pages so that each page is one more than the one preceding it. You must then go to the subroutine that controls which screen a student sees for each topic (ESTIMATE, HYPOTEST, REGRESS, AND EXDES). These four
subroutines and the variable MARKER allow the student to progress through a topic's programmed instruction material and review material at his/her leisure. But when the number of pages in a set of programmed instruction has been altered, the IF statements that perform an action depending on the value of MARKER must be changed. If a page is added, the an extra ELSEIF MARKER = statement must be added. The program is to STOP execution when MARKER is equal to the number of the last page plus one. If a page has been deleted, then the ELSEIF MARKER = statement must be deleted. The same conditions hold for deciding when the program is to STOP execution.
APPENDIX C

MAIN PROGRAM
LIBRARY "EXEC.TRC"  ! ALLOWS THE PROGRAM TO 'CHAIN' OUTSIDE FILES

! DIMENSION STATEMENTS

DIM USED(48,10)  ! RANDOM NUMBERS USED IN A CELL
DIM COR(65)  ! CORRECT RESPONSES
DIM MIS(65)  ! INCORRECT RESPONSES
DIM RESP$(65)  ! LETTER OF STUDENT RESPONSE
DIM CORESP$(65)  ! LETTER OF CORRECT RESPONSE
DIM HI(65)  ! CELL NUMBER OF QUESTION
DIM JI(65)  ! RANDOM NUMBER OF QUESTION
DIM NEEDPI(7)  ! AREAS SUCCESSFULLY COMPLETED (1), REQUIRING P.I. (2), COMPLETED P.I. (3)
DIM NUMQCE(48)  ! NUMBER OF QUESTIONS PER CELL IN QUESTIONBANK
DIM MRANK(5)  ! MAJOR TOPIC RANKINGS
DIM S1RANK(5)  ! SUBTOPIC 1 (ESTIMATORS) RANKINGS
DIM S2RANK(5)  ! SUBTOPIC 2 (HYPOTHESIS TESTING) RANKINGS
DIM S3RANK(5)  ! SUBTOPIC 3 (REGRESSION) RANKINGS
DIM S4RANK(5)  ! SUBTOPIC 4 (EXPERIMENTAL DESIGN) RANKINGS
DIM LEVE1(5)  ! SUBTOPIC 1 HIGHEST LEVELS OF LEARNING
DIM LEVE2(5)  ! SUBTOPIC 2 HIGHEST LEVELS OF LEARNING
DIM LEVE3(5)  ! SUBTOPIC 3 HIGHEST LEVELS OF LEARNING
DIM LEVE4(5)  ! SUBTOPIC 4 HIGHEST LEVELS OF LEARNING
DIM NQOT(48)  ! NUMBER OF QUESTION FROM A CELL ON THE TEST

! INITIAL CONDITIONS

! INITIALIZING COUNTERS TO TRACK PARAMETERS READ IN FROM TEXT FILES

LET PP = 0  ! MAJOR TOPIC RANKINGS COUNTER
LET QQ = 0  ! SUBTOPIC 1 RANKINGS COUNTER
LET RR = 0  ! SUBTOPIC 2 RANKINGS COUNTER
LET SS = 0  ! SUBTOPIC 3 RANKINGS COUNTER
LET TT = 0  ! SUBTOPIC 4 RANKINGS COUNTER
LET UU = 0  ! SUBTOPIC 1 LEVEL OF LEARNING COUNTER
LET VV = 0 !SUBTOPIC 2 LEVEL OF LEARNING COUNTER
LET WW = 0 !SUBTOPIC 3 LEVEL OF LEARNING COUNTER
LET XX = 0 !SUBTOPIC 4 LEVEL OF LEARNING COUNTER

!OTHER INITIAL CONDITIONS
LET TQ = 0 !TOTAL QUESTIONS ASSIGNED TO TEST
LET GA = 1 !NUMBER OF TIMES THROUGH ASSIGNMENT
    !LOOP
LET TOT1 = 0 !TOTAL NUMBER OF TOPIC 1 CELLS ON TEST
LET TOT2 = 0 !TOTAL NUMBER OF TOPIC 2 CELLS ON TEST
LET TOT3 = 0 !TOTAL NUMBER OF TOPIC 3 CELLS ON TEST
LET TOT4 = 0 !TOTAL NUMBER OF TOPIC 4 CELLS ON TEST
LET RE = 0 !NUMBER OF ESTIMATOR QUESTIONS ANSWERED
    !RIGHT
LET RH = 0 !NUMBER OF HYPOTEST. QUESTIONS ANSWERED
    !RIGHT
LET RG = 0 !NUMBER OF REGRESS. QUESTIONS ANSWERED
    !RIGHT
LET RD = 0 !NUMBER OF EX. DES. QUESTIONS ANSWERED
    !RIGHT
LET WE = 0 !NUMBER OF ESTIMATOR QUESTIONS ANSWERED
    !WRONG
LET WH = 0 !NUMBER OF HYPOTEST. QUESTIONS ANSWERED
    !WRONG
LET WG = 0 !NUMBER OF REGRESS. QUESTIONS ANSWERED
    !WRONG
LET WD = 0 !NUMBER OF EX. DES. QUESTIONS ANSWERED
    !WRONG
LET TRK = 0 !NUMBER OF KNOWLEDGE QUESTIONS ANSWERED
    !RIGHT
LET TWK = 0 !NUMBER OF KNOWLEDGE QUESTIONS ANSWERED
    !WRONG
LET TRC = 0 !NUMBER OF COMPRE. QUESTIONS ANSWERED
    !RIGHT
LET TWC = 0 !NUMBER OF COMPRE. QUESTIONS ANSWERED
    !WRONG
LET TRA = 0 !NUMBER OF APP./ANN. QUESTIONS ANSWERED
    !RIGHT
LET TWA = 0 !NUMBER OF APP./ANN. QUESTIONS ANSWERED
    !WRONG
LET G = 0 !QUESTION NUMBER ON TEST
LET Y = 0 !CELL NUMBER
LET EZ = 0 !SET EQUAL TO 1 IF STUDENT NEEDS PI
LET TY = 0 !SET EQUAL TO 1 IF STUDENT HAS TAKEN
    !TEST MORE THAN 3 TIMES. RESULTS ARE
    !NOT TRACKED

FOR ER = 1 TO 48 !SET CORRECT AND INCORRECT RESPONSES AND
    LET COR(ER) = 0 !NUMBER OF QUESTIONS PER CELL EQUAL TO
    LET MIS(ER) = 0 !ZERO
LET NQOT(ER) = 0
NEXT ER

!NUMBER OF QUESTIONS IN THE QUESTIONBANK FOR EACH CELL

LET NUMQCE(1) = 5
LET NUMQCE(2) = 5
LET NUMQCE(3) = 5
LET NUMQCE(4) = 6
LET NUMQCE(5) = 5
LET NUMQCE(6) = 5
LET NUMQCE(7) = 5
LET NUMQCE(8) = 5
LET NUMQCE(9) = 5
LET NUMQCE(10) = 5
LET NUMQCE(11) = 5
LET NUMQCE(12) = 5
LET NUMQCE(13) = 5
LET NUMQCE(14) = 5
LET NUMQCE(15) = 5
LET NUMQCE(16) = 5
LET NUMQCE(17) = 5
LET NUMQCE(18) = 0
LET NUMQCE(19) = 5
LET NUMQCE(20) = 5
LET NUMQCE(21) = 5
LET NUMQCE(22) = 5
LET NUMQCE(23) = 0
LET NUMQCE(24) = 5
LET NUMQCE(25) = 5
LET NUMQCE(26) = 0
LET NUMQCE(27) = 5
LET NUMQCE(28) = 5
LET NUMQCE(29) = 5
LET NUMQCE(30) = 5
LET NUMQCE(31) = 5
LET NUMQCE(32) = 5
LET NUMQCE(33) = 0
LET NUMQCE(34) = 5
LET NUMQCE(35) = 5
LET NUMQCE(36) = 5
LET NUMQCE(37) = 0
LET NUMQCE(38) = 0
LET NUMQCE(39) = 0
LET NUMQCE(40) = 5
LET NUMQCE(41) = 5
LET NUMQCE(42) = 0
LET NUMQCE(43) = 5
LET NUMQCE(44) = 5
LET NUMQCE(45) = 5
LET NUMQCE(46) = 5
LET NUMQCE(47) = 5
LET NUMQCE(48) = 5

!RETRIEVE PARAMETERS FROM OUTSIDE FILES

SUB READIN

!RETRIEVE MAJOR TOPIC RANKINGS

OPEN #1:NAME "MJRANK", ACCESS OUTIN, CREATE NEWOLD,
       ORGANIZATION TEXT
DO WHILE MORE #1
   LET PP = PP + 1
   INPUT #1: MRANK(PP)
LOOP
LET PP = 0
CLOSE #1

!RETRIEVE ESTIMATOR SUBTOPIC RANKINGS

OPEN #11:NAME "SJ1RANK", ACCESS OUTIN, CREATE NEWOLD,
         ORGANIZATION TEXT
DO WHILE MORE #11
   LET QQ = QQ + 1
   INPUT #11: S1RANK(QQ)
LOOP
LET QQ = 0
CLOSE #11

!RETRIEVE HYPOTHESIS SUBTOPIC RANKINGS

OPEN #12:NAME "SJ2RANK", ACCESS OUTIN, CREATE NEWOLD,
         ORGANIZATION TEXT
DO WHILE MORE #12
   LET RR = RR + 1
   INPUT #12: S2RANK(RR)
LOOP
LET RR = 0
CLOSE #12

!RETRIEVE REGRESSION SUBTOPIC RANKINGS

OPEN #13:NAME "SJ3RANK", ACCESS OUTIN, CREATE NEWOLD,
         ORGANIZATION TEXT
DO WHILE MORE #13
   LET SS = SS + 1
   INPUT #13: S3RANK(SS)
LOOP
LET SS = 0
CLOSE #13

!RETRIEVE EXPERIMENTAL DESIGN RANKINGS

OPEN #14:NAME "SJ4RANK", ACCESS OUTIN, CREATE NEWOLD,
       ORGANIZATION TEXT
DO WHILE MORE #14
   LET TT = TT + 1
   INPUT #14: SJ4RANK(TT)
LOOP
LET TT = 0
CLOSE #14

!RETRIEVE ESTIMATOR LEVELS OF LEARNING

OPEN #21:NAME "LEV1", ACCESS OUTIN, CREATE NEWOLD,
       ORGANIZATION TEXT
DO WHILE MORE #21
   LET UU = UU + 1
   INPUT #21: LEV1(UU)
LOOP
LET UU = 0
CLOSE #21

!RETRIEVE HYPOTHESIS LEVELS OF LEARNING

OPEN #22:NAME "LEV2", ACCESS OUTIN, CREATE NEWOLD,
       ORGANIZATION TEXT
DO WHILE MORE #22
   LET VV = VV + 1
   INPUT #22: LEV2(VV)
LOOP
LET VV = 0
CLOSE #22

!RETRIEVE REGRESSION LEVELS OF LEARNING

OPEN #23:NAME "LEV3", ACCESS OUTIN, CREATE NEWOLD,
       ORGANIZATION TEXT
DO WHILE MORE #23
   LET WW = WW + 1
   INPUT #23: LEV3(WW)
LOOP
LET WW = 0
CLOSE #23
!RETRIEVE EXPERIMENTAL DESIGN LEVELS OF LEARNING

OPEN #24: NAME "LEV4", ACCESS OUTIN, CREATE NEWOLD, ORGANIZATION TEXT
DO WHILE MORE #24
   LET XX = XX + 1
   INPUT #24: LEVE4(XX)
LOOP
LET XX = 0
CLOSE #24

!RETRIEVE THE NUMBER OF TIMES A PARTICULAR STUDENT HAS COMPLETED THE TEST

LET WHOSIT$ = "M"&NAME$
OPEN #9: NAME WHOSIT$, ACCESS OUTIN, CREATE NEWOLD, ORGANIZATION TEXT
DO WHILE MORE #9
   INPUT #9: COMP
LOOP
CLOSE #9

!RETRIEVE THE PASSING SCORE

OPEN #4: NAME "SCOR", ACCESS OUTIN, CREATE NEWOLD, ORGANIZATION TEXT
DO WHILE MORE #4
   INPUT #4: SCORE
LOOP
CLOSE #4

END SUB

!THIS SUB DETERMINES WHETHER THE USER IS AN ADMINISTRATOR OR STUDENT

SUB RUNIT
CLEAR
PRINT "PLEASE ENTER YOUR NAME."
INPUT NAME$

IF NAME$ = "WAPLINGER" OR NAME$ = "waplinger" THEN !IF THE USER ENTERS
   CALL EXEC ("ADMIN.EXE",""") !THE NAME 'waplinger' HE\SHE IS DECLARED
   STOP !AN ADMINISTRATOR AND 'CHAINED'
ELSE
   CALL READIN !TO THE 'ADMIN' CHAIN
   CALL POSITION !IF THE USER IS A STUDENT THEN PREVIOUSLY SET PARAMETERS ARE
   END IF !READ IN FROM TEXT FILES
!STUDENT PROGRAM
!THIS SUB PRINTS THE STUDENT OPTIONS

SUB POSITION
DO
  CLEAR
  PRINT
  PRINT "PLEASE ENTER THE NUMBER OF THE OPTION YOU DESIRE."
  PRINT
  PRINT "  1) TAKE THE TEST"
  PRINT "  2) CONTINUE THE PROGRAMMED INSTRUCTION"
  PRINT "  3) QUIT"
  PRINT
  INPUT MUTE
LOOP UNTIL MUTE = 1 OR MUTE = 2 OR MUTE = 3
CLEAR
CALL INTIME

END SUB

!DEPENDING ON THE OPTION THE STUDENT HAS CHOSEN THE PROGRAM
!WILL EITHER GENERATE A TEST, RETRIEVE PREVIOUS STATUS OF
!THE STUDENT AND ALLOW HIM TO CONTINUE WITH THE PROGRAMMED
!INSTRUCTION, OR QUIT THE PROGRAM

SUB INTIME
IF MUTE = 1 THEN
  CALL TESTGEN
ELSEIF MUTE = 2 THEN
  CALL GETPI
  CALL PROGINST
ELSE
  STOP
END IF

END SUB

SUB GETPI
IF COMP = 0 THEN
  LET TI$ = "U" !IF THE STUDENT HAS COMPLETED THE TEST MORE
ELSEIF COMP = 1 THEN !THAN ONCE, OR IF MORE THAN
  !ONE PERSON USES
LET TIS$ = "D" !A TESTING DISK, THEN
!CONCATENATING NAME AND
ELSEIF COMP = 2 THEN !NUMBER ALLOWS THE STUDENT
!TO GET THE RIGHT
LET TIS$ = "R" !PROGRAMMED INSTRUCTION FOR HIS\HER
ELSE !MOST RECENT TEST COMPLETION
END IF
LET NUNAME$ = TIS$&NAME$
OPEN #8: NAME NUNAME$, ACCESS OUTIN, CREATE NEWOLD,
    ORGANIZATION TEXT
LET J = 0
DO WHILE MORE #8
    LET J = J + 1
    INPUT #8: NEEDPI(J)
LOOP
CLOSE #8
END SUB

!THIS SUB GENERATES THE TEST
SUB TESTGEN
    CALL CELTOTAL !SUMS NUMBER OF CELLS ON TEST
    CALL INITIATE !PUTS 1 QUESTION IN EVERY CELL ON TEST
    CALL GENTEST !SLOTS REMAINING QUESTIONS
    CALL CREATE !CREATES AND PRESENTS TEST
    CALL TOTAL !TOTALS RESULTS AND PRESENTS PI
END SUB

SUB CREATE
    CLEAR
    FOR Y = 1 TO 48 !EACH CELLS QUESTIONS ARE PRESENTED
        !ON TEST
    FOR Q = 1 TO NQOT(Y) !KEEPS TRACK THAT THE PROPER
        !NUMBER OF
        !QUESTIONS FROM A CELL ARE PRESENTED
        RANDOMIZE !GENERATES A RANDOM NUMBER
        LET RAN_NUM = INT(RND * NUMQCE(Y) + 1) !ENSURES RANDOM
        !NUMBER CORRESPONDS TO A QUESTION
        LET USED(Y,Q) = RAN_NUM !KEEPS TRACK OF USED QUESTIONS
        CALL CONVERT !CONVERTS RANDOM NUMBER TO LETTERS
        CALL IDENTIFY !CONVERTS CELL NUMBER TO LETTERS
        LET RX$ = RD$&RN$ !CONCATENATE CELL AND RANDOM
        !NUMBER LETTERS
        IF Q > 1 THEN !IF AT LEAST ONE QUESTION HAS BEEN USED
            CALL ALEMP !FROM A CELL, MAKE SURE THE PRESENT
END IF
  CALL ASKORNOT
  NEXT Q
NEXT Y
END SUB

SUB CELTOTAL !TOTALS THE NUMBER OF CELLS USED ON THE TEST
FOR PR = 1 TO 3
  LET TOT1 = TOT1 + LEVE1(PR) !TOTALS ESTIMATOR CELLS
NEXT PR
IF LEVE1(2) = 3 THEN !SINCE THERE IS NOT LEVEL 2,
  LET TOT1 = TOT1 - 1 !LEVEL 3 FOR SUBTOPIC 2, WE
  !MUST SUBTRACT 1
END IF !FROM THE TOTAL IF LEVEL 3 SUBTOPIC
  !2 IS USED
FOR PR = 1 TO 5
  LET TOT2 = TOT2 + LEVE2(PR) !TOTALS HYPOTHESIS TESTING
  !CELLS
NEXT PR
FOR PR = 1 TO 4
  LET TOT3 = TOT3 + LEVE3(PR) !TOTALS REGRESSION CELLS
  LET TOT4 = TOT4 + LEVE4(PR) !TOTALS EXPERIMENTAL DESIGN
  !CELLS
NEXT PR
  LET CELLTOT = TOT1 + TOT2 + TOT3 + TOT4 !TOTAL OVERALL
  !CELLS
END SUB

!PLACES ONE QUESTION IN EACH CELL THAT IS TESTED

SUB INITIATE
  CALL INITIAL1
  CALL INITIAL2
  CALL INITIAL3
  CALL INITIAL4
END SUB

!INITIALIZES ESTIMATOR CELLS (PUTS ONE QUESTION IN EACH
!CELL USED)
SUB INITIAL1

IF MRANK(1) <> 0 THEN  !IF ESTIMATOR RANK IS NOT 0 THEN
  IF S1RANK(1) <> 0 THEN  !IF THE SUBTOPIC 1 RANK IS NOT 0
    IF LEVE1(1) = 2 THEN  !IF SUBTOPIC 1 LEVEL OF LEARNING
      FOR N = 1 TO 17 STEP 16  !INITIALIZE BOTH KNOWLEDGE
        LET NQOT(N) = 1  !AND COMP.
        LET TQ = TQ + 1  !INCREASE NUMBER OF QUESTIONS
      NEXT N
    ELSEIF LEVE1(1) = 1 THEN  !IF SUBTOPIC 1 LEVEL OF
      LET NQOT(1) = 1  !LEARNING IS 1
      LET TQ = TQ + 1  !INCREASE NUMBER OF QUESTIONS
    ELSE  
      END IF
    END IF
  ELSEIF LEVE1(1) = 1 THEN  !IF SUBTOPIC 1 LEVEL OF
    LET NQOT(1) = 1  !LEARNING IS 1
    LET TQ = TQ + 1  !INCREASE NUMBER OF QUESTIONS
  ELSE  
    END IF
  END IF

ELSEIF LEVE1(1) = 0 THEN  
  END IF
END IF

IF S1RANK(2) <> 0 THEN  !IF SUBTOPIC 2 RANK IS NOT 0 THEN
  IF LEVE1(2) = 3 THEN  !IF SUBTOPIC 2 LEVEL OF LEARNING
    FOR N = 2 TO 34 STEP 32  !INITIALIZE KNOW. AND A-A (NO
      LET NQOT(N) = 1  !COMP. FOR ESTIMATORS SUBTOPIC 2)
      LET TQ = TQ + 1  !INCREASE NUMBER OF QUESTIONS ON
    NEXT N
  ELSEIF LEVE1(2) = 1 THEN  !IF SUBTOPIC 2 LEVEL OF
    LET NQOT(2) = 1  !LEARNING IS 1
    LET TQ = TQ + 1  !INCREASE NUMBER OF QUESTIONS
  ELSE  
    END IF
  END IF
END IF

IF S1RANK(3) <> 0 THEN  !IF SUBTOPIC 3 RANK IS NOT 0 THEN
  IF LEVE1(3) = 3 THEN  !IF SUBTOPIC 3 LEVEL OF LEARNING
    FOR N = 3 TO 35 STEP 16  !INITIALIZE KNOW., COMP.,
      LET NQOT(N) = 1  !AND A-A
      LET TQ = TQ + 1  !INCREASE NUMBER OF QUESTIONS
    NEXT N
  ELSEIF LEVE1(3) = 1 THEN  !IF SUBTOPIC 3 LEVEL OF
    LET NQOT(3) = 1  !LEARNING IS 1
    LET TQ = TQ + 1  !INCREASE NUMBER OF QUESTIONS
  ELSE  
    END IF
  END IF
END IF
NEXT N
ELSEIF LEVE1(3) = 2 THEN !IF SUBTOPIC 3 LEVEL OF
!LEARNING IS 2
FOR N = 3 TO 19 STEP 16 !INITIALIZE KNOW., AND COMP
LET NQOT(N) = 1
LET TQ = TQ + 1 ;INCREASE NUMBER OF QUESTIONS
!ON TEST
NEXT N
ELSEIF LEVE1(3) = 1 THEN !IF SUBTOPIC 3 LEVEL OF
!LEARNING IS 1
LET NQOT(3) = 1 !INITIALIZE JUST KNOWLEDGE
LET TQ = TQ + 1 !INCREASE NUMBER OF
!QUESTIONS ON TEST
ELSE
END IF
END IF
END IF
END SUB

!INITIALIZES HYPOTHESIS CELLS
!SEE ESTIMATORS (SUB INITIAL1) FOR DOCUMENTATION PROCEDURE

SUB INITIAL2

IF MRANK(2) <> 0 THEN
  IF S2RANK(1) <> 0 THEN
    IF LEVE2(1) = 3 THEN
      FOR N = 4 TO 36 STEP 16
        LET NQOT(N) = 1
        LET TQ = TQ + 1
      NEXT N
    ELSEIF LEVE2(1) = 2 THEN
      FOR N = 4 TO 20 STEP 16
        LET NQOT(N) = 1
        LET TQ = TQ + 1
      NEXT N
    ELSEIF LEVE2(1) = 1 THEN
      LET NQOT(4) = 1
      LET TQ = TQ + 1
    ELSE
      END IF
    END IF
  END IF
ELSE
END IF
END IF

IF S2RANK(2) <> 0 THEN
  IF LEVE2(2) = 2 THEN
    FOR N = 5 TO 21 STEP 16
      LET NQOT(N) = 1
      LET TQ = TQ + 1
    NEXT N
  ELSEIF LEVE2(2) = 1 THEN

LET NQOT(5) = 1
LET TQ = TQ + 1
ELSE
END IF
END IF

IF S2RANK(3) < 0 THEN
IF LEVE2(3) = 2 THEN
FOR N = 6 TO 22 STEP 16
LET NQOT(N) = 1
LET TQ = TQ + 1
NEXT N
ELSEIF LEVE2(3) = 1 THEN
LET NQOT(6) = 1
LET TQ = TQ + 1
ELSE
END IF
END IF

IF S2RANK(4) < 0 THEN
LET NQOT(7) = 1
LET TQ = TQ + 1
END IF

IF S2RANK(5) < 0 THEN
IF LEVE2(5) = 3 THEN
FOR N = 8 TO 40 STEP 16
LET NQOT(N) = 1
LET TQ = TQ + 1
NEXT N
ELSEIF LEVE2(5) = 2 THEN
FOR N = 8 TO 24 STEP 16
LET NQOT(N) = 1
LET TQ = TQ + 1
NEXT N
ELSEIF LEVE2(5) = 1 THEN
LET NQOT(8) = 1
LET TQ = TQ + 1
ELSE
END IF
END IF
END IF

END SUB

!INITIALIZED REGRESSION CELLS
!SEE ESTIMATORS (SUB INITIAL1) FOR DOCUMENTATION PROCEDURE

SUB INITIAL3
IF MRANK(3) <> 0 THEN
  IF S3RANK(1) <> 0 THEN
    IF LEVE3(1) = 3 THEN
      FOR N = 9 TO 41 STEP 16
        LET NQOT(N) = 1
        LET TQ = TQ + 1
      NEXT N
    ELSEIF LEVE3(1) = 2 THEN
      FOR N = 9 TO 25 STEP 16
        LET NQOT(N) = 1
        LET TQ = TQ + 1
      NEXT N
    ELSEIF LEVE3(1) = 1 THEN
      LET NQOT(9) = 1
      LET TQ = TQ + 1
    ELSE
      END IF
  END IF
ENDIF

IF S3RANK(2) <> 0 THEN
  LET NQOT(10) = 1
  LET TQ = TQ + 1
END IF

IF S3RANK(3) <> 0 THEN
  IF LEVE3(3) = 3 THEN
    FOR N = 11 TO 43 STEP 16
      LET NQOT(N) = 1
      LET TQ = TQ + 1
    NEXT N
  ELSEIF LEVE3(3) = 2 THEN
    FOR N = 11 TO 27 STEP 16
      LET NQOT(N) = 1
      LET TQ = TQ + 1
    NEXT N
  ELSEIF LEVE3(3) = 1 THEN
    LET NQOT(11) = 1
    LET TQ = TQ + 1
  ELSE
    END IF
  END IF
ENDIF

IF S3RANK(4) <> 0 THEN
  IF LEVE3(4) = 3 THEN
    FOR N = 12 TO 44 STEP 16
      LET NQOT(N) = 1
      LET TQ = TQ + 1
    NEXT N
  ELSEIF LEVE3(4) = 2 THEN
    FOR N = 12 TO 28 STEP 16
      LET NQOT(N) = 1
      LET TQ = TQ + 1
    NEXT N
  ELSE
    END IF
  END IF
ENDIF
LET NQOT(N) = 1
LET TQ = TQ + 1
NEXT N
ELSEIF LEVE3(4) = 1 THEN
LET NQOT(12) = 1
LET TQ = TQ + 1
ELSE
END IF
END IF
END IF
END SUB

!INITIALIZED EXPERIMENTAL DESIGN
!SEE ESTIMATORS (SUB INITIAL1) FOR DOCUMENTATION PROCEDURE

SUB INITIAL4

IF MRANK(4) <> 0 THEN
IF S4RANK(1) <> 0 THEN
IF LEVE4(1) = 3 THEN
FOR N = 13 TO 45 STEP 16
LET NQOT(N) = 1
LET TQ = TQ + 1
NEXT N
ELSEIF LEVE4(1) = 2 THEN
FOR N = 13 TO 29 STEP 16
LET NQOT(N) = 1
LET TQ = TQ + 1
NEXT N
ELSEIF LEVE4(1) = 1 THEN
LET NQOT(13) = 1
LET TQ = TQ + 1
ELSE
END IF
END IF

IF S4RANK(2) <> 0 THEN
IF LEVE4(2) = 3 THEN
FOR N = 14 TO 46 STEP 16
LET NQOT(N) = 1
LET TQ = TQ + 1
NEXT N
ELSEIF LEVE4(2) = 2 THEN
FOR N = 14 TO 30 STEP 16
LET NQOT(N) = 1
LET TQ = TQ + 1
NEXT N
ELSEIF LEVE4(2) = 1 THEN
LET NQOT(14) = 1
LET TQ = TQ + 1
ELSE
END IF
END IF

IF S4RANK(3) <> 0 THEN
  IF LEVE4(3) = 3 THEN
    FOR N = 15 TO 47 STEP 16
      LET NQOT(N) = 1
      LET TQ = TQ + 1
    NEXT N
  ELSEIF LEVE4(3) = 2 THEN
    FOR N = 15 TO 31 STEP 16
      LET NQOT(N) = 1
      LET TQ = TQ + 1
    NEXT N
  ELSEIF LEVE4(3) = 1 THEN
    LET NQOT(15) = 1
    LET TQ = TQ + 1
  ELSE
    END IF
  END IF
END IF

IF S4RANK(4) <> 0 THEN
  IF LEVE4(4) = 3 THEN
    FOR N = 16 TO 48 STEP 16
      LET NQOT(N) = 1
      LET TQ = TQ + 1
    NEXT N
  ELSEIF LEVE4(4) = 2 THEN
    FOR N = 16 TO 32 STEP 16
      LET NQOT(N) = 1
      LET TQ = TQ + 1
    NEXT N
  ELSEIF LEVE4(4) = 1 THEN
    LET NQOT(16) = 1
    LET TQ = TQ + 1
  ELSE
    END IF
  END IF
END IF

END SUB

!THE TOTAL NUMBER OF QUESTIONS (FOX) DEPENDS ON THE NUMBER
!OF CELLS BEING TESTED. NO MORE THAN 64 QUESTIONS WILL
!APPEAR ON ANY TEST.

SUB GENTEST
IF CELLTOT > 34 THEN  !IF 35 OR MORE CELLS ARE
  LET FOX = INT(CELLTOT * 1.5)  !TESTED THEN FOX
  !EQUALS 1.5 TIMES THE
  CALL EX1  !NUMBER OF CELLS.
  !ONLY THE HIGHEST RANKS
  !RECEIVE THE EXTRA
  !QUESTIONS (FOX = TOTAL CELLS TESTED).
ELSEIF CELLTOT < 35 AND CELLTOT > 29 THEN !IF 30 TO 34
  LET FOX = INT(CELLTOT * 1.75) !CELS ARE TESTED
  !FOX EQUALS TOTAL CELLS
  !TIMES 1.75
  CALL EX1 !ONLY THE HIGHEST RANKS
  !RECEIVE THE EXTRA QUESTIONS.
ELSEIF CELLTOT < 30 AND CELLTOT > 24 THEN !IF 25 TO 29
  LET FOX = INT(CELLTOT * 2.0)  !CELS ARE TESTED
  !FOX EQUALS TOTAL CELLS
  !TIMES 2.0
  CALL EX2 !HIGH AND MEDIUM RANKED
  !CELLS GET EXTRA QUESTIONS.
ELSEIF CELLTOT < 25 AND CELLTOT > 19 THEN !IF 20 TO 24 CELLS
  LET FOX = INT(CELLTOT * 2.5)  !ARE TESTED
  !FOX EQUALS TOTAL CELLS
  !TIMES 2.5.
  CALL EX3 !HIGH, MEDIUM AND SOME
  !LOWER RANKED
  !CELLS GET EXTRA QUESTIONS.
ELSEIF CELLTOT < 20 AND CELLTOT > 14 THEN !IF 15 TO 19 CELLS
  LET FOX = INT(CELLTOT * 3.0)  !ARE TESTED
  !FOX EQUALS TOTAL CELLS
  !TIMES 3.0.
  CALL EX3 !HIGH, MEDIUM AND SOME LOWER
  !RANKED CELLS GET EXTRA
  !QUESTIONS.
ELSEIF CELLTOT < 15 AND CELLTOT > 9 THEN !IF 10 TO 14 CELLS
  LET FOX = INT(CELLTOT * 3.5)  !ARE TESTED
  !FOX EQUALS TOTAL CELLS
  !TIMES 3.5.
  CALL EX4 !ALL CELLS TESTED GET EXTRA
  !QUESTIONS.
ELSEIF CELLTOT < 10 AND CELLTOT > 6 THEN !IF 7 TO 9 CELLS
  LET FOX = INT(CELLTOT * 4.0)  !ARE TESTED
  !FOX EQUALS TOTAL CELLS
  !TIMES 4.0.
  CALL EX4 !ALL CELLS TESTED GET EXTRA
ELSEIF CELLTOT < 7 AND CELLTOT > 3 THEN !IF 4 TO 6 CELLS ARE TESTED
LET FOX = INT(CELTOT * 4.5) !FOX EQUALS TOTAL CELLS TIMES 4.5.
call EX4 !ALL CELLS TESTED GET EXTRA QUESTIONS.
ELSEIF CELLTOT < 4 AND CELLTOT > 0 THEN !IF 1 TO 3 CELLS ARE TESTED
LET FOX = INT(CELTOT * 5.0) !FOX EQUALS TOTAL CELLS TIMES 5.0.
call EX4 !ALL CELLS TESTED GET EXTRA QUESTIONS.
ELSE
END IF
END SUB

SUB EX1 !DISTRIBUTES QUESTIONS TO THE HIGHEST RANKING CELLS.
DO
FOR L = 3 TO 1 STEP -1 !SENDS QUESTIONS TO HIGHEST LEARNING LEVELS FIRST.
CALL SLOT1 !THE SLOT SUB CONTAIN MAJOR TOPIC AND SUBTOPIC
CALL SLOT2 !RANKINGS TO INCLUDE ON THE TEST.
CALL SLOT3
CALL SLOT4
CALL SLOT5
CALL SLOT6
NEXT L
LET GA = GA + 1!COUNTER TO ENSURE THAT NO MORE THAN 5 QUESTIONS FROM ANY CELLS IS INCLUDED ON THE TEST.
LOOP
END SUB

SUB EX2 !DISTRIBUTES QUESTIONS TO THE HIGH AND MEDIUM RANKED CELLS
DO
FOR L = 3 TO 1 STEP -1 !SENDS QUESTIONS TO THE HIGHEST LEARNING LEVEL FIRST.
CALL SLOT1 !SLOT SUBS CONTAIN MAJOR TOPIC AND SUBTOPIC
CALL SLOT2 !RANKS TO INCLUDE ON THE TEST.
CALL SLOT3
CALL SLOT4
CALL SLOT5
CALL SLOT6
CALL SLOT7
CALL SLOT8
CALL SLOT9
CALL SLOT10
NEXT L
LET GA = GA + 1 !COUNTER TO ENSURE THAT NO MORE THAN 5
!QUESTIONS FROM ANY CELL ARE ON THE TEST.
LOOP
END SUB

SUB EX3 !DISTRIBUTES QUESTIONS TO HIGH, MEDIUM AND SOME
!LOWER RANKING CELLS.
DO
FOR L = 3 TO 1 STEP -1 !SENDS QUESTIONS TO HIGHER LEARNING
!LEVELS FIRST.
    CALL SLOT1 !SLOT SUBS CONTAIN THE MAJOR TOPIC AND
    CALL SLOT2 !SUBTOPIC RANKINGS TO INCLUDE ON A TEST.
    CALL SLOT3
    CALL SLOT4
    CALL SLOT5
    CALL SLOT6
    CALL SLOT7
    CALL SLOT8
    CALL SLOT9
    CALL SLOT10
    CALL SLOT11
    CALL SLOT12
    CALL SLOT13
    CALL SLOT14
NEXT L
LET GA = GA + 1 !COUNTER TO ENSURE THAT NO MORE THAN 5
!QUESTIONS FROM ANY CELL ARE INCLUDED ON THE TEST.
LOOP
END SUB

SUB EX4 !DISTRIBUTES QUESTIONS TO ALL CELLS.
DO
FOR L = 3 TO 1 STEP -1 !SENDS QUESTIONS TO HIGHER
!LEARNING LEVELS FIRST.
CALL SLOT1 !SUB SLOTS CONTAIN MAJOR TOPIC AND SUBTOPIC
CALL SLOT2 !RANKINGS TO INCLUDE ON THE TEST.
CALL SLOT3
CALL SLOT4
CALL SLOT5
CALL SLOT6
CALL SLOT7
CALL SLOT8
CALL SLOT9
CALL SLOT10
CALL SLOT11
CALL SLOT12
CALL SLOT13
CALL SLOT14
CALL SLOT15
CALL SLOT16
CALL SLOT17
CALL SLOT18
NEXT L
LET GA = GA + 1 !COUNTER INCLUDED TO ENSURE THAT NO MORE
!THAN 5 QUESTIONS ARE INCLUDED FROM ANY CELL.
LOOP
END SUB

!SLOT SUBROUTINES CONTAIN RANKS TO INCLUDE AND SEARCH
!FINDS THEM.

SUB SLOT1

LET J = 1 !MAJOR TOPIC RANK 1.
LET K = 1 !SUBTOPIC RANK 1.
CALL SEARCH
END SUB

SUB SLOT2

LET J = 1 !MAJOR TOPIC RANK 1.
LET K = 2 !SUBTOPIC RANK 2.
CALL SEARCH
END SUB

SUB SLOT3

LET J = 2 !MAJOR TOPIC RANK 2.
LET K = 1 !SUBTOPIC RANK 1.
CALL SEARCH
END SUB

SUB SLOT4
LET J = 1  !MAJOR TOPIC RANK 1.
LET K = 3  !SUBTOPIC RANK 3.
CALL SEARCH
END SUB

SUB SLOT5
LET J = 2  !MAJOR TOPIC RANK 2.
LET K = 2  !SUBTOPIC RANK 2.
CALL SEARCH
END SUB

SUB SLOT6
LET J = 3  !MAJOR TOPIC RANK 3.
LET K = 1  !SUBTOPIC RANK 1.
CALL SEARCH
END SUB

SUB SLOT7
LET J = 1  !MAJOR TOPIC RANK 1.
LET K = 4  !SUBTOPIC RANK 4.
CALL SEARCH
END SUB

SUB SLOT8
LET J = 2  !MAJOR TOPIC RANK 2.
LET K = 3  !SUBTOPIC RANK 3.
CALL SEARCH
END SUB
SUB SLOT9
LET J = 3
LET K = 2
CALL SEARCH
END SUB

SUB SLOT10
LET J = 4
LET K = 1
CALL SEARCH
END SUB

SUB SLOT11
LET J = 1
LET K = 5
CALL SEARCH
END SUB

SUB SLOT12
LET J = 2
LET K = 4
CALL SEARCH
END SUB

SUB SLOT13
LET J = 3
LET K = 3
CALL SEARCH
END SUB

SUB SLOT14
LET J = 4
LET K = 2
CALL SEARCH
SUB SEARCH !DETERMINES IF ENOUGH QUESTIONS HAVE BEEN
!GENERATED, IF NOT MORE QUESTIONS ARE SLOTTED.

IF TQ >= FOX OR GA >= 5 THEN !IF TOTAL NUMBER OF
!QUESTIONS ON THE TEST
!EQUALS OR EXCEEDS THE DESIGNATED NUMBER OR SOME CELLS
!HAVE 5 QUESTIONS, THEN QUESTION PLACEMENT IS
!STOPPED AND THE TEST IS READY TO PRESENT TO THE
!STUDENT
CALL CREATE !PRESENTS TEST TO STUDENT
ELSE
FOR N = 1 TO 4 !IF MORE QUESTIONS ARE NEEDED
!THEN A QUESTION IS
IF MRANK(N) = J THEN  
  !SENT TO THE MAJOR TOPIC  
  !RANK, SUBTOPIC RANK,  
  IF N = 1 THEN  
    !AND LEARNING LEVEL THAT IS NEXT IN LINE TO RECEIVE AND EXTRA QUESTION.  
    CALL FIND1
  ELSEIF N = 2 THEN  
    CALL FIND2
  ELSEIF N = 3 THEN  
    CALL FIND3
  ELSEIF N = 4 THEN  
    CALL FIND4
  ELSE
    END IF
  END IF
NEXT N
END IF
END SUB

SUB FIND1  
  !IF MAJOR TOPIC 1'S RANK MATCHES THAT OF THE NEXT SCHEDULED QUESTION IT IS SEARCHED TO FIND A SUBTOPIC RANK MATCH.
  IF S1RANK(1) = K THEN  
    !K IS THE SUBTOPIC RANK.

    !IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH, AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA QUESTION.
    IF L = 1 AND NQOT(1) <> 0 AND NQOT(1) < NUMQCE(1) THEN  
      LET NQOT(1) = NQOT(1) + 1
      LET TQ = TQ + 1
    ELSEIF L = 2 AND NQOT(17) <> 0 AND NQOT(17) < NUMQCE(17) THEN  
      LET NQOT(17) = NQOT(17) + 1
      LET TQ = TQ + 1
    ELSE
      END IF
    END IF

    IF S1RANK(2) = K THEN

      !IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH, AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA QUESTION.
      IF L = 1 AND NQOT(2) <> 0 AND NQOT(2) < NUMQCE(2) THEN
LET NQOT(2) = NQOT(2) + 1
LET TQ = TQ + 1
ELSEIF L = 3 AND NQOT(3) <> 0 AND NQOT(3) < NUMQCE(3) THEN
  LET NQOT(3) = NQOT(3) + 1
  LET TQ = TQ + 1
ELSE
  END IF
END IF

IF S1RANK(3) = K THEN

!IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH, !AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA !QUESTION.

IF L = 1 AND NQOT(3) <> 0 AND NQOT(3) < NUMQCE(3) THEN
  LET NQOT(3) = NQOT(3) + 1
  LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(19) <> 0 AND NQOT(19) < NUMQCE(19) THEN
  LET NQOT(19) = NQOT(19) + 1
  LET TQ = TQ + 1
ELSEIF L = 3 AND NQOT(35) <> 0 AND NQOT(35) < NUMQCE(35) THEN
  LET NQOT(35) = NQOT(35) + 1
ELSE
  END IF
END IF

END SUB

SUB FIND2

IF S2RANK(1) = K THEN

!IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH, !AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA !QUESTION.

IF L = 1 AND NQOT(4) <> 0 AND NQOT(4) < NUMQCE(4) THEN
  LET NQOT(4) = NQOT(4) + 1
  LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(20) <> 0 AND NQOT(20) < NUMQCE(20) THEN
  LET NQOT(20) = NQOT(20) + 1
  LET TQ = TQ + 1
ELSEIF L = 3 AND NQOT(36) <> 0 AND NQOT(36) < NUMQCE(36) THEN
LET NQOT(36) = NQOT(36) + 1
LET TQ = TQ + 1
ELSE
END IF
END IF

IF S2RANK(2) = K THEN

! IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH,
! AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA
! QUESTION.

IF L = 1 AND NQOT(5) <> 0 AND NQOT(5) < NUMQCE(5) THEN
    LET NQOT(5) = NQOT(5) + 1
    LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(21) <> 0 AND NQOT(21) < NUMQCE(21) THEN
    LET NQOT(21) = NQOT(21) + 1
    LET TQ = TQ + 1
ELSE
END IF
END IF

IF S2RANK(3) = K THEN

! IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH,
! AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA
! QUESTION.

IF L = 1 AND NQOT(6) <> 0 AND NQOT(6) < NUMQCE(6) THEN
    LET NQOT(6) = NQOT(6) + 1
    LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(22) <> 0 AND NQOT(22) < NUMQCE(22) THEN
    LET NQOT(22) = NQOT(22) + 1
    LET TQ = TQ + 1
ELSE
END IF
END IF

IF S2RANK(4) = K THEN

! IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH,
! AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA
! QUESTION.
IF L = 1 AND NQOT(7) <> 0 AND NQOT(7) < NUMQCE(7) THEN
    LET NQOT(7) = NQOT(7) + 1
    LET TQ = TQ + 1
END IF
END IF

IF S2RANK(5) = K THEN

! IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH,
! AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA
! QUESTION.

IF L = 1 AND NQOT(8) <> 0 AND NQOT(8) < NUMQCE(8) THEN
    LET NQOT(8) = NQOT(8) + 1
    LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(24) <> 0 AND NQOT(24) < NUMQCE(24) THEN
    LET NQOT(24) = NQOT(24) + 1
    LET TQ = TQ + 1
ELSEIF L = 3 AND NQOT(40) <> 0 AND NQOT(40) < NUMQCE(40) THEN
    LET NQOT(40) = NQOT(40) + 1
    LET TQ = TQ + 1
ELSE
END IF
END IF

END SUB

SUB FIND3

IF S3RANK(1) = K THEN

! IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH,
! AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA
! QUESTION.

IF L = 1 AND NQOT(9) <> 0 AND NQOT(9) < NUMQCE(9) THEN
    LET NQOT(9) = NQOT(9) + 1
    LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(25) <> 0 AND NQOT(25) < NUMQCE(25) THEN
    LET NQOT(25) = NQOT(25) + 1
    LET TQ = TQ + 1
ELSEIF L = 3 AND NQOT(41) <> 0 AND NQOT(41) < NUMQCE(41) THEN
    LET NQOT(41) = NQOT(41) + 1
    LET TQ = TQ + 1
ELSE


END IF
END IF

IF S3RANK(2) = K THEN

!IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH,
!AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA
!QUESTION.

IF L = 1 AND NQOT(10) <> 0 AND NQOT(10) < NUMQCE(10) THEN
   LET NQOT(10) = NQOT(10) + 1
   LET TQ = TQ + 1
END IF
END IF

IF S3RANK(3) = K THEN

!IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH,
!AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA
!QUESTION.

IF L = 1 AND NQOT(11) <> 0 AND NQOT(11) < NUMQCE(11) THEN
   LET NQOT(11) = NQOT(11) + 1
   LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(27) <> 0 AND NQOT(27) < NUMQCE(27) THEN
   LET NQOT(27) = NQOT(27) + 1
   LET TQ = TQ + 1
ELSEIF L = 3 AND NQOT(43) <> 0 AND NQOT(43) < NUMQCE(43) THEN
   LET NQOT(43) = NQOT(43) + 1
   LET TQ = TQ + 1
ELSE
END IF
END IF

IF S3RANK(4) = K THEN

!IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH,
!AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA
!QUESTION.

IF L = 1 AND NQOT(12) <> 0 AND NQOT(12) < NUMQCE(12) THEN
   LET NQOT(12) = NQOT(12) + 1
   LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(28) <> 0 AND NQOT(28) < NUMQCE(28) THEN

LET NQOT(28) = NQOT(28) + 1
LET TQ = TQ + 1
ELSEIF L = 3 AND NQOT(44) <> 0 AND NQOT(44) < NUMQCE(44) THEN
    LET NQOT(44) = NQOT(44) + 1
    LET TQ = TQ + 1
ELSE
    END IF
END IF
END SUB

SUB FIND4

IF S4RANK(1) = K THEN

!IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH, !AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA !QUESTION.

IF L = 1 AND NQOT(13) <> 0 AND NQOT(13) < NUMQCE(13) THEN
    LET NQOT(13) = NQOT(13) + 1
    LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(29) <> 0 AND NQOT(29) < NUMQCE(29) THEN
    LET NQOT(29) = NQOT(29) + 1
    LET TQ = TQ + 1
ELSEIF L = 3 AND NQOT(45) <> 0 AND NQOT(45) < NUMQCE(45) THEN
    LET NQOT(45) = NQOT(45) + 1
    LET TQ = TQ + 1
ELSE
    END IF
END IF

IF S4RANK(2) = K THEN

!IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH, !AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA !QUESTION.

IF L = 1 AND NQOT(14) <> 0 AND NQOT(14) < NUMQCE(14) THEN
    LET NQOT(14) = NQOT(14) + 1
    LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(30) <> 0 AND NQOT(30) < NUMQCE(30) THEN
    LET NQOT(30) = NQOT(30) + 1
    LET TQ = TQ + 1
ELSEIF L = 3 AND NQOT(46) <> 0 AND NQOT(46) < NUMQCE(46) THEN
  LET NQOT(46) = NQOT(46) + 1
  LET TQ = TQ + 1
ELSE
END IF
END IF

IF S4RANK(3) = K THEN

!IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH,!
!AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA!
!QUESTION.

IF L = 1 AND NQOT(15) <> 0 AND NQOT(15) < NUMQCE(15) THEN
  LET NQOT(15) = NQOT(15) + 1
  LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(31) <> 0 AND NQOT(31) < NUMQCE(31) THEN
  LET NQOT(31) = NQOT(31) + 1
  LET TQ = TQ + 1
ELSEIF L = 3 AND NQOT(47) <> 0 AND NQOT(47) < NUMQCE(47) THEN
  LET NQOT(47) = NQOT(47) + 1
  LET TQ = TQ + 1
ELSE
END IF
END IF

IF S4RANK(4) = K THEN

!IF THE SUBTOPIC RANKS MATCH, THE LEVELS OF LEARNING MATCH,!
!AND THE CELL IS BEING TESTED, THEN IT RECEIVES AN EXTRA!
!QUESTION.

IF L = 1 AND NQOT(16) <> 0 AND NQOT(16) < NUMQCE(16) THEN
  LET NQOT(16) = NQOT(16) + 1
  LET TQ = TQ + 1
ELSEIF L = 2 AND NQOT(32) <> 0 AND NQOT(32) < NUMQCE(32) THEN
  LET NQOT(32) = NQOT(32) + 1
  LET TQ = TQ + 1
ELSEIF L = 3 AND NQOT(48) <> 0 AND NQOT(48) < NUMQCE(48) THEN
  LET NQOT(48) = NQOT(48) + 1
  LET TQ = TQ + 1
ELSE
END IF
END IF

END SUB
SUB CONVERT
!THIS SUBROUTINE CONVERTS THE RANDOM NUMBER THAT IS
!GENERATED TO PICK A QUESTION FROM A CELL INTO A LETTER TO
!BE PASSED TO THE QUESTION BANK (TEXT1 THRU TEXT4).

IF RAN_NUM = 1 THEN
  LET RN$ = "Z"
ELSEIF RAN_NUM = 2 THEN
  LET RN$ = "Y"
ELSEIF RAN_NUM = 3 THEN
  LET RN$ = "X"
ELSEIF RAN_NUM = 4 THEN
  LET RN$ = "W"
ELSEIF RAN_NUM = 5 THEN
  LET RN$ = "V"
ELSEIF RAN_NUM = 6 THEN
  LET RN$ = "U"
ELSEIF RAN_NUM = 7 THEN
  LET RN$ = "T"
ELSEIF RAN_NUM = 8 THEN
  LET RN$ = "S"
ELSE
  PRINT "RANDOM NUMBER OUT OF BOUNDS"
END IF
END SUB

SUB ALEMP !IF A CELL HAS MORE THAN ONE QUESTION ON THE
!TEST, THIS SUBROUTINE DETERMINES IF THE RANDOM
!NUMBER GENERATED HAS ALREADY BEEN USED. IF IT
!HAS THEN A NEW NUMBER IS GENERATED.

FOR Q = 1 TO Q - 1
  IF RAN_NUM = USED(Y,Q) THEN
    LET REDO = 1
  END IF
NEXT Q
END SUB

SUB ASKORNOT !IF THE RANDOM NUMBER HAS NOT BEEN USED FOR
!THAT CELL THEN INCREASE THE QUESTION NUMBER BY
!ONE, CALL THE PROPER TEXT, ASK THE DESIGNATED
!QUESTION, HAVE THE STUDENT RESPOND, AND
!CHECK AND RECORD THE RESPONSE.

IF REDO = 0 THEN
  LET G = G + 1

CALL QNUM
PRINT "QUESTION ";G
LET RS$ = RX$&RG$
CALL PROTEXT
CALL LETTERS
CALL RESPOND
CALL CHECK
ELSE  !IF THE RANDOM NUMBER HAS BEEN USED REDUCE Q BY
    !ONE AND GENERATE A NEW RANDOM NUMBER.
    LET Q = Q - 1
    LET REPO = 0
END IF

END SUB

SUB QNUM !CONVERTS THE QUESTION NUMBERS TO STRINGS TO BE
    !PASSED TO THE TEXT1 THRU TEXT4 FILES AND PRINTED
    !ON THE SCREEN FOR THE STUDENTS.

    IF G = 1 THEN
        LET RG$ = "GA"
    ELSEIF G = 2 THEN
        LET RG$ = "GB"
    ELSEIF G = 3 THEN
        LET RG$ = "GC"
    ELSEIF G = 4 THEN
        LET RG$ = "GD"
    ELSEIF G = 5 THEN
        LET RG$ = "GE"
    ELSEIF G = 6 THEN
        LET RG$ = "GF"
    ELSEIF G = 7 THEN
        LET RG$ = "GG"
    ELSEIF G = 8 THEN
        LET RG$ = "GH"
    ELSEIF G = 9 THEN
        LET RG$ = "GI"
    ELSEIF G = 10 THEN
        LET RG$ = "GJ"
    ELSEIF G = 11 THEN
        LET RG$ = "GK"
    ELSEIF G = 12 THEN
        LET RG$ = "GL"
    ELSEIF G = 13 THEN
        LET RG$ = "GM"
    ELSEIF G = 14 THEN
        LET RG$ = "GN"
    ELSEIF G = 15 THEN
        LET RG$ = "GO"
    ELSEIF G = 16 THEN
LET RG$ = "GP"
ELSEIF G = 17 THEN
  LET RG$ = "GQ"
ELSEIF G = 18 THEN
  LET RG$ = "GR"
ELSEIF G = 19 THEN
  LET RG$ = "GS"
ELSEIF G = 20 THEN
  LET RG$ = "GT"
ELSEIF G = 21 THEN
  LET RG$ = "GU"
ELSEIF G = 22 THEN
  LET RG$ = "GV"
ELSEIF G = 23 THEN
  LET RG$ = "GW"
ELSEIF G = 24 THEN
  LET RG$ = "GX"
ELSEIF G = 25 THEN
  LET RG$ = "GY"
ELSEIF G = 26 THEN
  LET RG$ = "GZ"
ELSEIF G = 27 THEN
  LET RG$ = "HA"
ELSEIF G = 28 THEN
  LET RG$ = "HB"
ELSEIF G = 29 THEN
  LET RG$ = "HC"
ELSEIF G = 30 THEN
  LET RG$ = "HD"
ELSEIF G = 31 THEN
  LET RG$ = "HE"
ELSEIF G = 32 THEN
  LET RG$ = "HF"
ELSEIF G = 33 THEN
  LET RG$ = "HG"
ELSEIF G = 34 THEN
  LET RG$ = "HH"
ELSEIF G = 35 THEN
  LET RG$ = "HI"
ELSEIF G = 36 THEN
  LET RG$ = "HJ"
ELSEIF G = 37 THEN
  LET RG$ = "HK"
ELSEIF G = 38 THEN
  LET RG$ = "HL"
ELSEIF G = 39 THEN
  LET RG$ = "HM"
ELSEIF G = 40 THEN
  LET RG$ = "HN"
ELSEIF G = 41 THEN
LET RG$ = "HO"
ELSEIF G = 42 THEN
  LET RG$ = "HP"
ELSEIF G = 43 THEN
  LET RG$ = "HQ"
ELSEIF G = 44 THEN
  LET RG$ = "HR"
ELSEIF G = 45 THEN
  LET RG$ = "HS"
ELSEIF G = 46 THEN
  LET RG$ = "HT"
ELSEIF G = 47 THEN
  LET RG$ = "HU"
ELSEIF G = 48 THEN
  LET RG$ = "HV"
ELSEIF G = 49 THEN
  LET RG$ = "HW"
ELSEIF G = 50 THEN
  LET RG$ = "HX"
ELSEIF G = 51 THEN
  LET RG$ = "HY"
ELSEIF G = 52 THEN
  LET RG$ = "HZ"
ELSEIF G = 53 THEN
  LET RG$ = "JA"
ELSEIF G = 54 THEN
  LET RG$ = "JB"
ELSEIF G = 55 THEN
  LET RG$ = "JC"
ELSEIF G = 56 THEN
  LET RG$ = "JD"
ELSEIF G = 57 THEN
  LET RG$ = "JE"
ELSEIF G = 58 THEN
  LET RG$ = "JF"
ELSEIF G = 59 THEN
  LET RG$ = "JG"
ELSEIF G = 60 THEN
  LET RG$ = "JH"
ELSEIF G = 61 THEN
  LET RG$ = "JJ"
ELSEIF G = 62 THEN
  LET RG$ = "JK"
ELSEIF G = 63 THEN
  LET RG$ = "JL"
ELSEIF G = 64 THEN
  LET RG$ = "JM"
ELSEIF G = 65 THEN
  LET RG$ = "JN"
ELSE
END IF

END SUB

SUB IDENTIFY ' CONVERTS CELL NUMBERS TO STRINGS TO BE PASSED
' TO THE TEXT1 THRU TEXT4 CHAINS TO IDENTIFY THE
' PROPER CELL TO BE USED TO GET THE QUESTION.

IF Y = 1 THEN
    LET RD$ = "AA"
ELSEIF Y = 2 THEN
    LET RD$ = "AB"
ELSEIF Y = 3 THEN
    LET RD$ = "AC"
ELSEIF Y = 4 THEN
    LET RD$ = "AD"
ELSEIF Y = 5 THEN
    LET RD$ = "AE"
ELSEIF Y = 6 THEN
    LET RD$ = "AF"
ELSEIF Y = 7 THEN
    LET RD$ = "AG"
ELSEIF Y = 8 THEN
    LET RD$ = "AH"
ELSEIF Y = 9 THEN
    LET RD$ = "AI"
ELSEIF Y = 10 THEN
    LET RD$ = "AJ"
ELSEIF Y = 11 THEN
    LET RD$ = "AK"
ELSEIF Y = 12 THEN
    LET RD$ = "AL"
ELSEIF Y = 13 THEN
    LET RD$ = "AM"
ELSEIF Y = 14 THEN
    LET RD$ = "AN"
ELSEIF Y = 15 THEN
    LET RD$ = "AO"
ELSEIF Y = 16 THEN
    LET RD$ = "AP"
ELSEIF Y = 17 THEN
    LET RD$ = "BA"
ELSEIF Y = 19 THEN
    LET RD$ = "BB"
ELSEIF Y = 20 THEN
    LET RD$ = "BC"
ELSEIF Y = 21 THEN
    LET RD$ = "BD"
ELSEIF Y = 22 THEN
    LET RD$ = "BE"
ELSEIF Y = 24 THEN
  LET RD$ = "BF"
ELSEIF Y = 25 THEN
  LET RD$ = "BG"
ELSEIF Y = 27 THEN
  LET RD$ = "BH"
ELSEIF Y = 28 THEN
  LET RD$ = "BI"
ELSEIF Y = 29 THEN
  LET RD$ = "BJ"
ELSEIF Y = 30 THEN
  LET RD$ = "BK"
ELSEIF Y = 31 THEN
  LET RD$ = "BL"
ELSEIF Y = 32 THEN
  LET RD$ = "BM"
ELSEIF Y = 34 THEN
  LET RD$ = "CA"
ELSEIF Y = 35 THEN
  LET RD$ = "CB"
ELSEIF Y = 36 THEN
  LET RD$ = "CC"
ELSEIF Y = 40 THEN
  LET RD$ = "CD"
ELSEIF Y = 41 THEN
  LET RD$ = "CE"
ELSEIF Y = 43 THEN
  LET RD$ = "CF"
ELSEIF Y = 44 THEN
  LET RD$ = "CG"
ELSEIF Y = 45 THEN
  LET RD$ = "CH"
ELSEIF Y = 46 THEN
  LET RD$ = "CI"
ELSEIF Y = 47 THEN
  LET RD$ = "CJ"
ELSEIF Y = 48 THEN
  LET RD$ = "CK"
ELSE
  PRINT "TEXT NUMBER OUT OF BOUNDS"
END IF
END SUB

SUB PROTEXT  !THE QUESTION BANK WITH THE DESIGNATED
  !QUESTION IS CALLED. THE QUESTION BANK DEPENDS
  !ON THE CELL NUMBER (Y).
  IF Y <= 10 THEN
    CALL EXEC_RETURN ("TEXT1.EXE", RS$)
  END IF
ELSEIF $Y \geq = 11$ AND $Y \leq = 21$ THEN
    CALL EXEC_RETURN ("TEXT2.EXE",RS$)
ELSEIF $Y \geq = 22$ AND $Y \leq = 34$ THEN
    CALL EXEC_RETURN ("TEXT3.EXE",RS$)
ELSEIF $Y \geq = 35$ AND $Y \leq = 48$ THEN
    CALL EXEC_RETURN ("TEXT4.EXE",RS$)
ELSE
    PRINT "$Y$ OUT OF BOUNDS IN PROTEXT"
END IF
END SUB

SUB LETTERS !CORRECT RESPONSES TO QUESTIONS

IF $Y = 1$ THEN !PROPERTIES OF ESTIMATORS - KNOWLEDGE
    IF RAN_NUM = 1 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "B"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "D"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
    ELSEIF $Y = 2$ THEN !MAXIMUM LIKELIHOOD/MOMENTS - KNOW.
        IF RAN_NUM = 1 THEN
            LET CR$ = "C"
        ELSEIF RAN_NUM = 2 THEN
            LET CR$ = "B"
        ELSEIF RAN_NUM = 3 THEN
            LET CR$ = "A"
        ELSEIF RAN_NUM = 4 THEN
            LET CR$ = "A"
        ELSEIF RAN_NUM = 5 THEN
            LET CR$ = "D"
        ELSE
            PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
        END IF
    ELSEIF $Y = 3$ THEN !CONFIDENCE INTERVALS - KNOWLEDGE
        IF RAN_NUM = 1 THEN
            LET CR$ = "D"
        ELSEIF RAN_NUM = 2 THEN
            LET CR$ = "B"
        ELSEIF RAN_NUM = 3 THEN
            LET CR$ = "D"
        ELSEIF RAN_NUM = 4 THEN
            LET CR$ = "D"
        ELSEIF RAN_NUM = 5 THEN
            LET CR$ = "D"
        ELSE
            PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
        END IF
    ELSEIF $Y = 4$ THEN !OTHER - KNOWLEDGE
        IF RAN_NUM = 1 THEN
            LET CR$ = "D"
        ELSEIF RAN_NUM = 2 THEN
            LET CR$ = "B"
        ELSEIF RAN_NUM = 3 THEN
            LET CR$ = "D"
        ELSEIF RAN_NUM = 4 THEN
            LET CR$ = "D"
        ELSEIF RAN_NUM = 5 THEN
            LET CR$ = "D"
        ELSE
            PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
        END IF
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
END SUB
LET CR$ = "A"
ELSEIF RAN_NUM = 5 THEN
   LET CR$ = "C"
ELSE
   PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 4 THEN !PROPERTIES OF HYPOTHESIS TESTING
   !TESTING - KNOWLEDGE
   IF RAN_NUM = 1 THEN
      LET CR$ = "B"
   ELSEIF RAN_NUM = 2 THEN
      LET CR$ = "B"
   ELSEIF RAN_NUM = 3 THEN
      LET CR$ = "D"
   ELSEIF RAN_NUM = 4 THEN
      LET CR$ = "A"
   ELSEIF RAN_NUM = 5 THEN
      LET CR$ = "A"
   ELSEIF RAN_NUM = 6 THEN
      LET CR$ = "C"
   ELSE
      PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
   END IF
ELSEIF Y = 5 THEN !PARAMETRIC TESTS (MEANS) - KNOWLEDGE
   IF RAN_NUM = 1 THEN
      LET CR$ = "B"
   ELSEIF RAN_NUM = 2 THEN
      LET CR$ = "A"
   ELSEIF RAN_NUM = 3 THEN
      LET CR$ = "D"
   ELSEIF RAN_NUM = 4 THEN
      LET CR$ = "C"
   ELSEIF RAN_NUM = 5 THEN
      LET CR$ = "A"
   ELSE
      PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
   END IF
ELSEIF Y = 6 THEN !PARAMETRIC TESTS (VARIANCES) - KNOWLEDGE
   IF RAN_NUM = 1 THEN
      LET CR$ = "B"
   ELSEIF RAN_NUM = 2 THEN
      LET CR$ = "A"
   ELSEIF RAN_NUM = 3 THEN
      LET CR$ = "B"
   ELSEIF RAN_NUM = 4 THEN
      LET CR$ = "C"
   ELSEIF RAN_NUM = 5 THEN
      LET CR$ = "D"
   ELSE
      PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
ELSEIF Y = 7 THEN  !NONPARAMETRIC TEST - KNOWLEDGE
    IF RAN_NUM = 1 THEN
        LET CR$ = "B"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "C"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
ELSEIF Y = 8 THEN  !GOODNESS OF FIT/INDEPENDENCE - KNOW.
    IF RAN_NUM = 1 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "B"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
ELSEIF Y = 9 THEN  !PROPERTIES OF REGRESSION - KNOWLEDGE
    IF RAN_NUM = 1 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "B"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "B"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
ELSEIF Y = 10 THEN  !DESCRIPTIVE AND INFERENTIAL
    ! STATISTICS - KNOWLEDGE
    IF RAN_NUM = 1 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 3 THEN
LET CR$ = "A"
ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "C"
ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "B"
ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 11 THEN !DECOMPOSITION AND LEAST SQUARES - KNOWLEDGE
    IF RAN_NUM = 1 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "D"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
ELSEIF Y = 12 THEN !ANOVA (REGRESSION) - KNOWLEDGE
    IF RAN_NUM = 1 THEN
        LET CR$ = "B"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "B"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
ELSEIF Y = 13 THEN !SINGLE FACTOR DESIGN - KNOWLEDGE
    IF RAN_NUM = 1 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "B"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
ELSEIF Y = 14 THEN !MULTIFACTOR DESIGN - KNOWLEDGE
    IF RAN_NUM = 1 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "B"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "B"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "C"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
ELSEIF Y = 15 THEN !SUM OF SQUARES DECOMPOSITION - KNOWLEDGE
    IF RAN_NUM = 1 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "C"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
ELSEIF Y = 16 THEN !ANOVA (EXPERIMENTAL DESIGN) - KNOWLEDGE
    IF RAN_NUM = 1 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "C"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
ELSEIF Y = 17 THEN !PROPERTIES OF ESTIMATORS - COMPREHENSION
    IF RAN_NUM = 1 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 2 THEN
LET CR$ = "C"
ELSEIF RAN_NUM = 3 THEN
  LET CR$ = "B"
ELSEIF RAN_NUM = 4 THEN
  LET CR$ = "C"
ELSEIF RAN_NUM = 5 THEN
  LET CR$ = "C"
ELSE
  PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 19 THEN
  !CONFIDENCE INTERVALS - COMPREHENSION
  IF RAN_NUM = 1 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "C"
  ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
  END IF
ELSEIF Y = 20 THEN
  !PROPERTIES OF HYPOTHESIS
  !TESTING - COMPREHENSION
  IF RAN_NUM = 1 THEN
    LET CR$ = "A"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "C"
  ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
  END IF
ELSEIF Y = 21 THEN
  !PARAMETRIC TESTS (MEANS) - !COMPREHENSION
  IF RAN_NUM = 1 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "A"
  ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "C"
  ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
  END IF
LET CR$ = "C"
ELSE
  PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 22 THEN        !PARAMETRIC TESTS (VARIANCES) - !COMPREHENSION
  IF RAN_NUM = 1 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "D"
  ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
  END IF
ELSEIF Y = 24 THEN        !GOODNESS OF FIT/INDEPENDENCE - !COMPREHENSION
  IF RAN_NUM = 1 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "A"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "D"
  ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
  END IF
ELSEIF Y = 25 THEN        !PROPERTIES OF REGRESSION - !COMPREHENSION
  IF RAN_NUM = 1 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "A"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "D"
  ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
  END IF
ELSEIF Y = 27 THEN        !DECOMPOSITION AND LEAST SQUARES -
!COMPREHENSION

IF RAN_NUM = 1 THEN
  LET CR$ = "B"
ELSEIF RAN_NUM = 2 THEN
  LET CR$ = "C"
ELSEIF RAN_NUM = 3 THEN
  LET CR$ = "A"
ELSEIF RAN_NUM = 4 THEN
  LET CR$ = "B"
ELSEIF RAN_NUM = 5 THEN
  LET CR$ = "B"
ELSE
  PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF

ELSEIF Y = 28 THEN !ANOVA (REGRESSION) - COMPREHENSION
  IF RAN_NUM = 1 THEN
    LET CR$ = "D"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "D"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "D"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "A"
  ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
  END IF
ELSEIF Y = 29 THEN !SINGLE FACTOR DESIGN - COMPREHENSION
  IF RAN_NUM = 1 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "A"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "D"
  ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "A"
  ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
  END IF
ELSEIF Y = 30 THEN !MULTIFACTOR DESIGN - COMPREHENSION
  IF RAN_NUM = 1 THEN
    LET CR$ = "D"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "D"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "C"
LET CR$ = "D"
ELSEIF RAN_NUM = 5 THEN
  LET CR$ = "C"
ELSE
  PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 31 THEN !SUM OF SQUARES DECOMPOSITION - !COMPREHENSION
  IF RAN_NUM = 1 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "D"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "A"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "C"
  ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 32 THEN !ANOVA (EXPERIMENTAL DESIGN) - !COMPREHENSION
  IF RAN_NUM = 1 THEN
    LET CR$ = "A"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "C"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "C"
  ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 34 THEN !MAXIMUM LIKELIHOOD\MOMENTS - !APPLICATION\ANALYSIS
  IF RAN_NUM = 1 THEN
    LET CR$ = "D"
  ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "B"
  ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "B"
  ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
ELSEIF Y = 35 THEN
    !CONFIDENCE INTERVALS -
    !APPLICATION\ANALYSIS
    IF RAN_NUM = 1 THEN
        LET CR$ = "B"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "B"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
ELSEIF Y = 36 THEN
    !PROPERTIES OF HYPOTHESIS TESTING-
    !APPLICATION\ANALYSIS
    IF RAN_NUM = 1 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "A"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "D"
    ELSEIF RAN_NUM = 6 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 7 THEN
        LET CR$ = "B"
    ELSEIF RAN_NUM = 8 THEN
        LET CR$ = "B"
    ELSE
        PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
    END IF
ELSEIF Y = 40 THEN
    !GOODNESS OF FIT\INDEPENDENCE-
    !APPLICATION\ANALYSIS
    IF RAN_NUM = 1 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 2 THEN
        LET CR$ = "B"
    ELSEIF RAN_NUM = 3 THEN
        LET CR$ = "B"
    ELSEIF RAN_NUM = 4 THEN
        LET CR$ = "C"
    ELSEIF RAN_NUM = 5 THEN
        LET CR$ = "D"
    ELSE
PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 41 THEN !PROPERTIES OF REGRESSION -
APPLICATION\ANALYSIS
IF RAN_NUM = 1 THEN
    LET CR$ = "A"
ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "A"
ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "B"
ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "C"
ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "D"
ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 43 THEN !DECOMPOSITION AND LEAST SQUARES-
APPLICATION\ANALYSIS
IF RAN_NUM = 1 THEN
    LET CR$ = "B"
ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "C"
ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "C"
ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "B"
ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "B"
ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 44 THEN !ANOVA (REGRESSION) -
APPLICATION\ANALYSIS
IF RAN_NUM = 1 THEN
    LET CR$ = "C"
ELSEIF RAN_NUM = 2 THEN
    LET CR$ = "C"
ELSEIF RAN_NUM = 3 THEN
    LET CR$ = "C"
ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "B"
ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "D"
ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 45 THEN !SINGLE FACTOR DESIGN -
APPLICATION\ANALYSIS
IF RAN_NUM = 1 THEN
LET CR$ = "B"
ELSEIF RAN_NUM = 2 THEN
LET CR$ = "D"
ELSEIF RAN_NUM = 3 THEN
LET CR$ = "A"
ELSEIF RAN_NUM = 4 THEN
LET CR$ = "B"
ELSEIF RAN_NUM = 5 THEN
LET CR$ = "D"
ELSE
PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 46 THEN !MULTIFACTOR DESIGN - !APPLICATION\ANALYSIS
IF RAN_NUM = 1 THEN
LET CR$ = "B"
ELSEIF RAN_NUM = 2 THEN
LET CR$ = "A"
ELSEIF RAN_NUM = 3 THEN
LET CR$ = "C"
ELSEIF RAN_NUM = 4 THEN
LET CR$ = "B"
ELSEIF RAN_NUM = 5 THEN
LET CR$ = "C"
ELSE
PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 47 THEN !SUM OF SQUARES DECOMPOSITION - !APPLICATION\ANALYSIS
IF RAN_NUM = 1 THEN
LET CR$ = "B"
ELSEIF RAN_NUM = 2 THEN
LET CR$ = "D"
ELSEIF RAN_NUM = 3 THEN
LET CR$ = "D"
ELSEIF RAN_NUM = 4 THEN
LET CR$ = "C"
ELSEIF RAN_NUM = 5 THEN
LET CR$ = "B"
ELSE
PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSEIF Y = 48 THEN !ANOVA (EXPERIMENTAL DESIGN) - !APPLICATION\ANALYSIS
IF RAN_NUM = 1 THEN
LET CR$ = "B"
ELSEIF RAN_NUM = 2 THEN
LET CR$ = "C"
ELSEIF RAN_NUM = 3 THEN
LET CR$ = "B"
ELSEIF RAN_NUM = 4 THEN
    LET CR$ = "C"
ELSEIF RAN_NUM = 5 THEN
    LET CR$ = "B"
ELSE
    PRINT "RAN_NUM OUT OF BOUNDS IN ANSWERS"
END IF
ELSE
    PRINT "Y OUT OF BOUNDS"
END IF
END SUB

SUB RESPOND !PRINTS COMMANDS THAT ALLOW STUDENTS TO ENTER THEIR RESPONSE.
DO
    DO
        SET CURSOR 21,1
        PRINT "KEY IN THE LETTER OF YOUR ANSWER: ";
        INPUT CHOICE$
        IF CHOICE$ = "a" THEN
            !STUDENTS CAN ONLY ENTER A RESPONSE OF A, a, B, b, C, c, D, OR d.
            LET CHOICE$ = "A"
        ELSEIF CHOICE$ = "b" THEN
            LET CHOICE$ = "B"
        ELSEIF CHOICE$ = "c" THEN
            LET CHOICE$ = "C"
        ELSEIF CHOICE$ = "d" THEN
            LET CHOICE$ = "D"
        ELSE
            END IF
        END IF
    LOOP UNTIL CHOICE$ = "A" OR CHOICE$ = "B" OR CHOICE$ = "C" OR CHOICE$ = "D"
    DO
        SET CURSOR 22,1
        PRINT "ENTER '1' IF THIS IS THE ANSWER YOU DESIRE OR '2' TO RE-ENTER YOUR ANSWER: ";
        INPUT CONFIRMS
        !THIS ALLOWS THE STUDENTS TO CHANGE THEIR ANSWERS
    LOOP UNTIL CONFIRMS = CHRS(049) OR CONFIRMS = CHRS(050)
END SUB

SUB CHECK !THIS SUBROUTINE CHECKS AND SAVES THE STUDENT'S RESPONSE.
SET CURSOR 23,1
IF CHOICE$ = CR$ THEN
   PRINT "YOU HAVE CHosen THE CORRECT ANSWER."
   LET COR(Y) = COR(Y) + 1
ELSE
   PRINT "THE CORRECT ANSWER IS "; CR$;
   LET MIS(Y) = MIS(Y) + 1
END IF
LET RESP$(G) = CHOICE$  !SAVES STUDENT'S RESPONSE
LET CORESP$(G) = CR$    !SAVES CORRECT RESPONSE
LET HI(G) = Y           !SAVES CELL NUMBER
LET JI(G) = RAN_NUM     !SAVES RANDOM NUMBER
SET CURSOR 24,1
PRINT "PLEASE HIT RETURN TO CONTINUE ";
INPUT CHR$(013)
CLEAR

END SUB

SUB TOTAL  !AFTER THE TEST IS COMPLETED TOTAL IS CALLED
CALL ANSWERS  !SAVES RESPONSES
CALL ADDTOT   !TOTALS RIGHT\WRONG ANSWERS FOR CATEGORIES
DO
   CALL GUIDE   !DISPLAYS GUIDE TO INTERPRETING THE RESULTS
LOOP UNTIL ROUND = 2
CALL REACH    !TOTALS RIGHT AND WRONG ANSWERS
CALL SENDPI   !SEND STUDENT'S STATUS TO TEXT FILES
CALL ZERO     !DETERMINES IF STUDENT NEEDS ANY PROGRAMMED
               !INSTRUCTION
STOP
END SUB

SUB ANSWERS  !SENDS STUDENT RESPONSES TO TEXT FILE FOR
               !THE FIRST THREE TIMES THAT A STUDENT TAKES
               !THE TEST. THE FIRST TIME THE NAME IS "U"
               !PLUS THE STUDENT'S NAME, THE SECOND TIME "D" 
               !PLUS THE STUDENT'S NAME, AND THE THIRD TIME 
               !"R" PLUS THE STUDENTS NAME. EACH NAME IS
               !PRECEDED BY "X".

IF COMP = 0 THEN
   LET TI$ = "U"
ELSEIF COMP = 1 THEN
   LET TI$ = "D"
ELSEIF COMP = 2 THEN
    LET TI$ = "R"
ELSE
    LET TY = 1
END IF
IF COMP < 3 THEN
    LET TRAKTIM$ = "X"&TI$&NAME$
    CALL TRACK
END IF

END SUB

SUB TRACK ! SENDS RESPONSES TO OUTSIDE TEXT FILES.
OPEN #2: NAME TRAKTIM$, ACCESS OUTIN, CREATE NEWOLD, ORGANIZATION TEXT
ERASE #2
FOR K = 1 TO G
    PRINT #2: K;HI(K);JI(K);CORESP$(K);RESP$(K)
NEXT K
CLOSE #2
END SUB

SUB ADDTOT ! ADDS CATEGORY TOTALS
! INITIAL CONDITIONS - VARIABLES EQUAL TO 0
LET ARE = 0 ! APPLICATION\ANALYSIS RIGHT ESTIMATORS
LET AWE = 0 ! APPLICATION\ANALYSIS WRONG ESTIMATORS
LET ARH = 0 ! APPLICATION\ANALYSIS RIGHT HYPOTHESIS TESTING
LET AWH = 0 ! APPLICATION\ANALYSIS WRONG HYPOTHESIS TESTING
LET ARG = 0 ! APPLICATION\ANALYSIS RIGHT REGRESSION
LET AWG = 0 ! APPLICATION\ANALYSIS WRONG REGRESSION
LET ARD = 0 ! APPLICATION\ANALYSIS RIGHT EXPERIMENTAL DESIGN
LET AWD = 0 ! APPLICATION\ANALYSIS WRONG EXPERIMENTAL DESIGN

! ADDS KNOWLEDGE TOTALS
FOR U = 1 TO 16
    LET TRK = COR(U) + TRK
    LET TWK = MIS(U) + TWK
NEXT U

! ADDS COMPREHENSION TOTALS
FOR U = 17 TO 32
    LET TRC = COR(U) + TRC
    LET TWC = MIS(U) + TWC
NEXT U

!ADDS APPLICATION\ANALYSIS TOTALS
FOR U = 33 TO 48
    LET TRA = COR(U) + TRA
    LET TWA = MIS(U) + TWA
NEXT U

!ESTIMATOR TOTALS
FOR U = 1 TO 3
    LET RE = RE + COR(U)
    LET WE = WE + MIS(U)
NEXT U
    LET KRE = RE !KNOWLEDGE RIGHT ESTIMATOR
    LET KWE = WE !KNOWLEDGE WRONG ESTIMATOR
FOR U = 17 TO 19
    LET RE = RE + COR(U)
    LET WE = WE + MIS(U)
NEXT U
    LET CRE = RE - KRE !COMPREHENSION RIGHT ESTIMATOR
    LET CWE = WE - KWE !COMPREHENSION WRONG ESTIMATOR
FOR U = 33 TO 35
    LET ARE = ARE + COR(U)!APPLICATION\ANALYSIS RIGHT ESTIMATOR
    LET AWE = AWE + MIS(U)!APPLICATION\ANALYSIS WRONG ESTIMATOR
NEXT U

!HYPOTHESIS TESTING TOTALS
FOR U = 4 TO 8
    LET RH = RH + COR(U)
    LET WH = WH + MIS(U)
NEXT U
    LET KRH = RH !KNOWLEDGE RIGHT HYPOTHESIS TESTING
    LET KWH = WH !KNOWLEDGE WRONG HYPOTHESIS TESTING
FOR U = 20 TO 24
    LET RH = RH + COR(U)
    LET WH = WH + MIS(U)
NEXT U
    LET CRH = RH - KRH !COMPREHENSION RIGHT HYPOTHESIS TESTING
    LET CWH = WH - KWH !COMPREHENSION WRONG HYPOTHESIS TESTING
FOR U = 36 TO 40
    LET ARH = ARH + COR(U)!APPLICATION\ANALYSIS RIGHT
LET AWH = AWH + MIS(U)

NEXT U

!REGRESSION TOTALS

FOR U = 9 TO 12
    LET RG = RG + COR(U)
    LET WG = WG + MIS(U)
NEXT U

LET KRR = RG
LET KWR = WG

FOR U = 25 TO 28
    LET RG = RG + COR(U)
    LET WG = WG + MIS(U)
NEXT U

LET CRR = RG - KRR
LET CWR = WG - KWR

FOR U = 41 TO 44
    LET ARG = ARG + COR(U)
    LET AWG = AWG + MIS(U)
NEXT U

!EXPERIMENTAL DESIGN TOTALS

FOR U = 13 TO 16
    LET RD = RD + COR(U)
    LET WD = WD + MIS(U)
NEXT U

LET KRD = RD
LET KWD = WD

FOR U = 29 TO 32
    LET RD = RD + COR(U)
    LET WD = WD + MIS(U)
NEXT U

LET CRD = RD - KRD
LET CWD = WD - KWD

FOR U = 45 TO 48
    LET ARD = ARD + COR(U)
    LET AWD = AWD + MIS(U)
NEXT U
!MAJOR TOPIC TOTALS

LET RE = KRE + CRE + ARE !TOTAL RIGHT ESTIMATORS
LET WE = KWE + CWE + AWE !TOTAL WRONG ESTIMATORS

LET RH = KRH + CRH + ARH !TOTAL RIGHT HYPOTHESIS TESTING
LET WH = KWH + CWH + AWH !TOTAL WRONG HYPOTHESIS TESTING

LET RG = KRR + CRR + ARG !TOTAL RIGHT REGRESSION
LET WG = KWR + CWR + AWG !TOTAL WRONG REGRESSION

LET RD = KRD + CRD + ARD !TOTAL RIGHT EXPERIMENTAL DESIGN
LET WD = KWD + CWD + AWD !TOTAL WRONG EXPERIMENTAL DESIGN

!TOTAL OVER ALL TOPICS\LEVELS OF LEARNING

LET RT = TRK + TRC + TRA !TOTAL RIGHT
LET WT = TWK + TWC + TWA !TOTAL WRONG

END SUB

SUB GUIDE !DISPLAYS A SCREEN TO HELP THE STUDENT
!INTERPRET HIS RESULTS.

CLEAR
DO
PRINT " GUIDE TO INTERPRETING YOUR RESULTS"
PRINT " 'R' REPRESENTS RIGHT AND 'W' REPRESENTS WRONG"
PRINT " LEVELS: KNOW - QUESTIONS TESTING KNOWLEDGE"
PRINT " COMP - QUESTIONS TESTING COMPREHENSION"
PRINT " A-A - QUESTIONS TESTING APPLICATION AND
    ANALYSIS"
PRINT " TOPICS: ES - ESTIMATORS"
PRINT " HT - HYPOTHESIS TESTING"
PRINT " RE - REGRESSION"
PRINT " ED - EXPERIMENTAL DESIGN"
PRINT " ENTER '1' TO VIEW YOUR TEST RESULTS"
PRINT " ENTER '2' TO CONTINUE WITH THE PROGRAM"
INPUT ROUND
LOOP UNTIL ROUND = 1 OR ROUND = 2
CLEAR
IF ROUND = 1 THEN
   CALL RESULTS !DISPLAYS STUDENT RESULTS
END IF

END SUB
SUB RESULT  !DISPLAYS STUDENT TOTALS RIGHT\WRONG FOR EACH
!MAJOR TOPIC\LEVEL OF LEARNING.

PRINT "  YOUR TEST RESULTS "
PRINT PRINT "  LEVEL"
PRINT PRINT "  KNOW  COMP  A-A  TOTAL"
PRINT "TOPIC"
PRINT "ES R - "
PRINT " W - "
PRINT PRINT "HT R - "
PRINT " W - "
PRINT PRINT "RE R - "
PRINT " W - "
PRINT PRINT "ED R - "
PRINT " W - "
PRINT PRINT "TO- R - "
PRINT " TAL W - "
PRINT

!SETS CURSOR AT DESIRED POSITION TO PRING RIGHT\WRONG
!TOTALS.

SET CURSOR 7,15
PRINT KRE
SET CURSOR 8,15
PRINT KWE
SET CURSOR 7,32
PRINT CRE
SET CURSOR 8,32
PRINT CWE
SET CURSOR 7,49
PRINT ARE
SET CURSOR 8,49
PRINT AWE
SET CURSOR 7,66
PRINT RE
SET CURSOR 8,66
PRINT WE
SET CURSOR 10,15
PRINT KRH
SET CURSOR 11,15
PRINT KWH
SET CURSOR 10,32
PRINT TWC
SET CURSOR 19,49
PRINT TRA
SET CURSOR 20,49
PRINT TWA
SET CURSOR 19,66
PRINT RT
SET CURSOR 20,66
PRINT WT
PRINT

!IF THE STUDENT WANTS TO RETURN TO THE RESULTS GUIDE ENTER
!1 AND ENTER 2 TO CONTINUE WITH THE PROGRAM.

PRINT "HIT '1' TO RETURN TO THE 'GUIDE OF TEST RESULTS'"
PRINT "HIT '2' TO CONTINUE WITH THE PROGRAM"
INPUT ROUND
CLEAR
END SUB

SUB REACH !DETERMINES THE TOTAL QUESTION IN EACH MAJOR TOPIC

FOR X = 1 TO 4
    IF X = 1 THEN
        LET JJ = RE !NUMBER RIGHT ESTIMATORS
        LET KK = WE !NUMBER WRONG ESTIMATORS
    ELSEIF X = 2 THEN
        LET JJ = RH !NUMBER RIGHT HYPOTHESIS TESTING
        LET KK = WH !NUMBER WRONG HYPOTHESIS TESTING
    ELSEIF X = 3 THEN
        LET JJ = RG !NUMBER RIGHT REGRESSION
        LET KK = WG !NUMBER WRONG REGRESSION
    ELSEIF X = 4 THEN
        LET JJ = RD !NUMBER RIGHT EXPERIMENTAL DESIGN
        LET KK = WD !NUMBER WRONG EXPERIMENTAL DESIGN
    ELSE
        END IF
    LET TOT = JJ + KK !COMPUTES TOTALS.
    CALL CHEKHELP !DETERMINES IF STUDENT HAS DEMONSTRATED
    !PROFICIENCY IN A TOPIC.
NEXT X
END SUB

SUB CHEKHELP !DETERMINES IF A STUDENT HAS DEMONSTRATED
!PROFICIENCY IN A TOPIC.

LET PSCORE = SCORE*(.01) !SCORE IS A PARAMETER SET BY THE
SUB ADMINISTRATOR AND READ IN FROM A TEXT FILE.

IF KK > 0 THEN !IF NO QUESTIONS ARE ASKED OR IF THE STUDENT ANSWER THEM ALL CORRECTLY, THEN THE TOPIC IS EXEMPT FROM REQUIRING THE PROGRAMMED INSTRUCTION.

IF (PSCORE * TOT) > JJ THEN !IF THE STUDENT DOES NOT ANSWER AT LEAST THE PASSING SCORE TIMES THE TOTAL NUMBER CORRECT THEN THE TOPIC IS ASSIGNED A VALUE

LET NEEDPI(X) = 2 !OF 2 WHICH MEANS THE STUDENT WILL RECEIVE PROGRAMMED INSTRUCTION IN THAT TOPIC.

ELSE

LET NEEDPI(X) = 1 !A 1 INDICATES A STUDENT HAS DEMONSTRATED PROFICIENCY IN A TOPIC.

END IF

ELSE

LET NEEDPI(X) = 0 !IF THE TOPIC IS NOT USED THEN INDICATE THIS WITH A ZERO.

END IF

END SUB

SUB SENDPI !THIS SUBROUTINE SENDS THE TOPIC’S STATUS TO AN OUTSIDE TEXT FILE WHICH CAN BE READ BACK TO THE PROGRAM SHOULD THE STUDENT DECIDE TO QUIT THE PROGRAM.

LET NUNAME$ = TIS$&NAME$ !THIS LETS THE NAME OF THE TEXT FILE INDICATE THE INDIVIDUAL WHO SENT IT THERE AND THE NUMBER OF TIMES HE\SHE HAS TAKEN THE TEST.

OPEN #8: NAME NUNAME$, ACCESS OUTIN, CREATE NEWOLD, ORGANIZATION TEXT

ERASE #8

FOR J = 1 TO 4

PRINT #8: NEEDPI(J)

NEXT J

CLOSE #8

END SUB
SUB ZERO !THIS SUBROUTINE DETERMINES IF A STUDENT HAS 
!PASSED ALL AREAS OF THE TEST

FOR I = 1 TO 4
    IF NEEDPI(I) = 2 THEN !A 2 INDICATES THE STUDENT DID 
        !NOT PASS
        LET EZ = 1
    END IF
NEXT I
IF EZ = 0 THEN !IN THE BEGINNING OF THE PROGRAM IN THE 
    !INITIAL CONDITIONS, EZ WAS SET TO ZERO, 
    !IF IT IS STILL ZERO AFTER THE FOR - NEXT 
    !LOOP THEN THE STUDENT HAS PASSED ALL 
    !TOPICS.

    PRINT "CONGRATULATIONS YOU HAVE SUCCESSFULLY COMPLETED 
    THE TEST."
    CALL DONE
    STOP
ELSE
    CALL PROGINST !IF A STUDENT DID NOT PASS ALL AREAS THEN 
        !PROGINST PROVIDES HIM\HER WITH THE PROPER 
        !PROGRAMMED INSTRUCTION.
END IF
END SUB

SUB SUBJECTS !DISPLAYS THE SUBJECTS THAT REQUIRE 
    !PROGRAMMED INSTRUCTION.

PRINT
    IF M = 1 THEN 
        PRINT " - ESTIMATORS"
    ELSEIF M = 2 THEN 
        PRINT " - HYPOTHESIS TESTING"
    ELSEIF M = 3 THEN 
        PRINT " - REGRESSION"
    ELSEIF M = 4 THEN 
        PRINT " - EXPERIMENTAL DESIGN"
    ELSE
    END IF
END SUB

SUB QUITNOW !ALLOWS THE STUDENT TO QUIT AFTER THE TEST OR 
    !AFTER ANY SET OF PROGRAMMED INSTRUCTION HE\SHE 
    !RECEIVES.

DO
    CLEAR
    PRINT
PRINT "PLEASE ENTER THE NUMBER OF THE OPTION YOU DESIRE."
PRINT "  1) CONTINUE WITH PROGRAMMED INSTRUCTION"
PRINT "  2) QUIT"
PRINT
INPUT STCHOICE
LOOP UNTIL STCHOICE = 1 OR STCHOICE = 2
END SUB

SUB PROGINST !COORDINATES PROGRAMMED INSTRUCTION
FOR I = 1 TO 4 !CHECKS EACH TOPIC TO SEE IF P. I. IS NEEDED
    IF NEEDPI(I) = 2 THEN
        PRINT "THESE ARE THE AREA(S) THAT REQUIRE PROGRAMMED INSTRUCTION:"
        FOR M = 1 TO 4
            IF NEEDPI(M) = 2 THEN
                CALL SUBJECTS !DISPLAYS SUBJECTS NEEDING P.I.
            END IF
        NEXT M
        PRINT
    END IF
NEXT M
PRINT
PRINT "PLEASE ENTER ANY LETTER TO CONTINUE."
INPUT X$
CALL QUITNOW !ALLOWS STUDENTS TO QUIT WHILE HE\SHE STILL HAS MORE P.I. TO READ.

IF STCHOICE = 2 THEN
    PRINT
    PRINT
    PRINT "PLEASE CONTINUE THE PROGRAMMED INSTRUCTION AT YOUR CONVENIENCE."
    STOP
ELSEIF STCHOICE = 1 THEN
    CALL GETNAME !PREPARES STRING VARIABLE TO PASS TO P.I. !CHAIN TO DENOTE WHICH SET OF P.I. IS TO BE GIVEN TO THE STUDENT.
    CALL EXEC_RETURN ("PI.EXE",HELP$) !CHAIN TO PI, HELP$ IS STRING !VARIABLE PASSED FROM THIS PROGRAM.
    LET NEEDPI(I) = 3 !ONCE A STUDENT HAS COMPLETED THE SET OF P.I. THE MAJOR TOPIC STATUS IS CHANGED FROM 2 TO 3.
    CALL SENDPI !THE NEW STATUS IS SENT TO THE
CLEAR
END IF
END IF
IF I = 4 THEN !IF THE STUDENT HAS COMPLETED ALL OF HIS\HER
  !REQUIRED P.I. THEN HE\SHE IS ASKED TO RETAKE
  !THE TEST AT A LATER DATE AND PROGRAM EXECUTION
  !IS STOPPED.
PRINT "PLEASE RETAKE THE TEST AT YOUR CONVENIENCE."
CALL DONE !ONCE A STUDENT HAS FULLY COMPLETED THE TEST
  !AND THE P.I. DONE IS INCREASED BY ONE.
STOP
END IF
NEXT I
END SUB

SUB GETNAME !DETERMINES A STRING VARIABLE TO BE SENT
  !TO THE CHAINED PROGRAM TO DENOTE WHICH SET
  !OF P.I. THE STUDENT IS TO GET.
IF I = 1 THEN
  LET HELP$ = "EST"   !FOR ESTIMATOR PROGRAMMED
    !INSTRUCTION.
ELSEIF I = 2 THEN
  LET HELP$ = "HYP"   !FOR HYPOTHESIS TESTING PROGRAMMED
    !INSTRUCTION.
ELSEIF I = 3 THEN
  LET HELP$ = "REG"   !FOR REGRESSION PROGRAMMED
    !INSTRUCTION.
ELSEIF I = 4 THEN
  LET HELP$ = "EXP"   !FOR EXPERIMENTAL DESIGN PROGRAMMED
    !INSTRUCTION.
ELSE
  PRINT "HELP OUT OF BOUNDS IN GETNAME"
END IF
END SUB

SUB DONE !IF A STUDENT HAS FULLY COMPLETED THE TEST,
  !THEN THIS IS INDICATED BY INCREASING 'COMP'
  !IN AN OUTSIDE TEXT FILE. THIS IS USED TO ALLOW
  !US TO KEEP RECORDS FOR MULTIPLE TEST COMPLETIONS
  !FOR AN INDIVIDUAL.
LET COMP = COMP + 1
OPEN #9: NAME WHOSIT$, ACCESS OUTIN, CREATE NEWOLD, ORGANIZATION TEXT
ERASE #9
PRINT #9: COMP
CLOSE #9
END SUB

CLEAR
CALL RUNIT
!ONLY LINE IN MAIN PROGRAM - CALLS SUBROUTINE THAT DETERMINE
!WHETHER THE USER IS A STUDENT OR AN ADMINISTRATOR.

END
APPENDIX D

ADMINISTRATIVE PROGRAM
PROGRAM ADMIN
!DIMENSION STATEMENTS !THESE VALUES WILL BE READ FROM
!OUTSIDE FILES USING 'OPEN' COMMANDS

DIM MRANK(5) !MAJOR TOPIC RANKINGS
DIM S1RANK(5) !SUBTOPIC 1 (ESTIMATOR) RANKINGS
DIM S2RANK(5) !SUBTOPIC 2 (HYPOTHESIS TESTING) RANKINGS
DIM S3RANK(5) !SUBTOPIC 3 (REGRESSION) RANKINGS
DIM S4RANK(5) !SUBTOPIC 4 (EXPERIMENTAL DESIGN) RANKINGS
DIM LEVE1(5) !SUBTOPIC 1 HIGHEST LEVEL OF LEARNING
DIM LEVE2(5) !SUBTOPIC 2 HIGHEST LEVEL OF LEARNING
DIM LEVE3(5) !SUBTOPIC 3 HIGHEST LEVEL OF LEARNING
DIM LEVE4(5) !SUBTOPIC 4 HIGHEST LEVEL OF LEARNING

!INITIAL CONDITIONS

LET PP = 0 !MAJOR TOPIC RANKINGS COUNTER
LET QQ = 0 !SUBTOPIC 1 RANKINGS COUNTER
LET RR = 0 !SUBTOPIC 2 RANKINGS COUNTER
LET SS = 0 !SUBTOPIC 3 RANKINGS COUNTER
LET TT = 0 !SUBTOPIC 4 RANKINGS COUNTER
LET UU = 0 !SUBTOPIC 1 HIG. LEVEL OF LEARNING COUNTER
LET VV = 0 !SUBTOPIC 2 HIG. LEVEL OF LEARNING COUNTER
LET WW = 0 !SUBTOPIC 3 HIG. LEVEL OF LEARNING COUNTER
LET XX = 0 !SUBTOPIC 4 HIG. LEVEL OF LEARNING COUNTER

!THE 'OPEN' STATEMENTS ALLOW PREVIOUSLY ESTABLISHED VALUES
!TO BE READ

OPEN #1: NAME "MJRANK", ACCESS OUTIN, CREATE NEWOLD,
   ORGANIZATION TEXT
DO WHILE MORE #1
   LET PP = PP + 1
   INPUT #1: MRANK(PP)
LOOP
CLOSE #1

OPEN #11: NAME "SJ1RANK", ACCESS OUTIN, CREATE NEWOLD,
   ORGANIZATION TEXT
DO WHILE MORE #11
   LET QQ = QQ + 1
   INPUT #11: S1RANK(QQ)
LOOP
CLOSE #11

OPEN #12: NAME "SJ2RANK", ACCESS OUTIN, CREATE NEWOLD,
   ORGANIZATION TEXT
DO WHILE MORE #12
   LET RR = RR + 1
INPUT #12: S2RANK(RR)
LOOP
CLOSE #12

OPEN #13: NAME "SJ3RANK", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
DO WHILE MORE #13
  LET SS = SS + 1
  INPUT #13: S3RANK(SS)
LOOP
CLOSE #13

OPEN #14: NAME "SJ4RANK", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
DO WHILE MORE #14
  LET TT = TT + 1
  INPUT #14: S4RANK(TT)
LOOP
CLOSE #14

OPEN #21: NAME "LEV1", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
DO WHILE MORE #21
  LET UU = UU + 1
  INPUT #21: LEVE1(UU)
LOOP
CLOSE #21

OPEN #22: NAME "LEV2", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
DO WHILE MORE #22
  LET VV = VV + 1
  INPUT #22: LEVE2(VV)
LOOP
CLOSE #22

OPEN #23: NAME "LEV3", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
DO WHILE MORE #23
  LET WW = WW + 1
  INPUT #23: LEVE3(WW)
LOOP
CLOSE #23

OPEN #24: NAME "LEV4", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
DO WHILE MORE #24
  LET XX = XX + 1
  INPUT #24: LEVE4(XX)
LOOP
CLOSE #24

OPEN #4: NAME "SCOR", ACCESS OUTIN, CREATE NEWOLD, ORGANIZATION TEXT
DO WHILE MORE #4
   INPUT #4:SCORE
   LOOP
CLOSE #4

!THESE STATEMENTS PRINT THE MAIN MENU SCREEN FOR THE ADMINISTRATOR. THIS SCREEN IS DISPLAYED UNTIL A VALID CHOICE IS ENTERED.

DO
   DO
      CLEAR
      PRINT "PLEASE SELECT THE NUMBER OF THE OPTION OF YOUR CHOICE."
      PRINT " 1) VIEW TOPICS"
      PRINT " 2) VIEW CURRENT TEST DESCRIPTION"
      PRINT " 3) CHANGE CURRENT TEST DESCRIPTION"
      PRINT " 4) EXIT PROGRAM"
      INPUT DC
      LOOP UNTIL DC = 1 OR DC = 2 OR DC = 3 OR DC = 4
   CALL DECIS
   LOOP UNTIL DC = 4
   STOP

SUB DECIS !DEPENDING ON THE ADMINISTRATORS CHOICE ANOTHER SCREEN IS DISPLAYED

   IF DC = 1 THEN
      CALL SETOPICS !THIS IS CALLED IF THE ADMIN. WISHES TO SEE THE TOPICS
   ELSEIF DC = 2 THEN
      CALL COND !THIS IS CALLED IF THE ADMIN. WISHES TO SEE THE CURRENT CONDITIONS
   ELSEIF DC = 3 THEN
      CALL CHACOND !THIS IS CALLED IF THE ADMIN. WISHES TO CHANGE THE CURRENT CONDITIONS
   ELSE
      END IF

END SUB
SUB SETOPICS !THIS SUB. DISPLAYS ALL OF THE TOPICS THAT CAN BE TESTED

DO
CLEAR
PRINT " TOPICS"
PRINT " I) ESTIMATORS\CONFIDENCE INTERVALS"
PRINT " A) PROPERTIES OF ESTIMATORS"
PRINT " B) METHOD OF MOMENTS\MAXIMUM LIKELIHOOD"
PRINT " C) CONFIDENCE INTERVALS"
PRINT " II) HYPOTHESIS TESTING"
PRINT " A) PROPERTIES OF HYPOTHESIS TESTING"
PRINT " B) PARAMETRIC TESTS - MEANS"
PRINT " C) PARAMETRIC TESTS - VARIANCES"
PRINT " D) NONPARAMETRIC TESTS"
PRINT " E) GOODNESS OF FIT\INDEPENDENCE"
PRINT " III) REGRESSION"
PRINT " A) PROPERTIES OF REGRESSION"
PRINT " B) DESCRIPTIVE AND INFERENTIAL STATISTICS"
PRINT " C) DECOMPOSITION AND LEAST SQUARES"
PRINT " D) ANOVA TECHNIQUES"
PRINT " IV) EXPERIMENTAL DESIGN"
PRINT " A) SINGLE FACTOR DESIGN"
PRINT " B) MULTIFACTOR DESIGN"
PRINT " C) SUM OF SQUARES DECOMPOSITION"
PRINT " D) ANOVA TECHNIQUES"
PRINT "HIT 'X' TO CONTINUE"

INPUT ONCE$
LOOP UNTIL ONCE$ = "X" OR ONCE$ = "x" !THIS MAINTAINS THE !SCREEN UNTIL !A VALID CHARACTER IS ENTERED

END SUB

SUB COND !THIS SUB DISPLAYS ALL OF THE CURRENT CONDITIONS

CALL MAJRANK !THIS DISPLAYS THE MAJOR TOPIC RANKINGS.
CALL EXPLAIN !THIS EXPLAINS THE RANKING PROCEDURE.
CALL SUBRANK1 !THIS DISPLAYS THE RANKINGS FOR ESTIMATOR !SUBTOPICS.
CALL SUBRANK2 !THIS DISPLAYS THE RANKINGS FOR HYPOTHESIS !TEST. SUBTOPICS
CALL SUBRANK3 !THIS DISPLAYS THE RANKINGS FOR REGRESSION !SUBTOPICS.
CALL SUBRANK4 !THIS DISPLAYS THE RANKINGS FOR EXP. !DESIGN SUBTOPICS.

CALL PASS !THIS DISPLAYS THE PASSING SCORE.

END SUB

SUB MAJRANK !THIS PRINTS OUT THE MAJOR TOPIC RANKINGS
DO
  CLEAR
  PRINT "NOTE: 1 IS THE HIGHEST RANKING."
  PRINT "0 INDICATES A TOPIC HAS BEEN DELETED."
  PRINT "ESTIMATORS - MRANK(1)
  PRINT "HYPOTHESIS TESTING - MRANK(2)
  PRINT "REGRESSION - MRANK(3)
  PRINT "EXPERIMENTAL DESIGN - MRANK(4)
  PRINT "HIT 'X' TO CONTINUE."
  INPUT ONCE$ LOOP UNTIL ONCE$ = "X" OR ONCE$ = "x" !THIS MAINTAINS THE !SCREEN UNTIL !THE CORRECT LETTER IS INPUTTED.
END SUB

SUB EXPLAN !THIS SCREEN EXPLAINS THE RANKING PROCEDURE.
DO
  CLEAR
  PRINT "THE FOLLOWING SCREENS SHOW THE CURRENT DESCRIPTION OF THE TEST BY 
  PRINT "BOTH THE RANKINGS OF THE SUBTOPIC WITHIN THE TOPIC AND THE HIGHEST"
  PRINT "LEVEL OF LEARNING MEASURED. THE LEVELS OF LEARNING REFER THE 
  PRINT "HIERARCHICAL STRUCTURE DEVELOPED BY B. S. BLOOM. LEVEL 1 IS 
  PRINT "KNOWLEDGE; 2, COMPREHENSION; AND 3, APPLICATION AND ANALYSIS."
  PRINT "HIT 'X' TO CONTINUE."
  INPUT ONCE$ LOOP UNTIL ONCE$ = "X" OR ONCE$ = "x" !THIS MAINTAINS THE !SCREEN UNTIL !THE DESIRED LETTER IS INPUTTED.
END SUB
SUB SUBRANK1 !THIS PRINTS OUT THE ESTIMATOR SUBTOPIC
!RANKINGS AND LEVELS OF LEARNING
DO
CLEAR
PRINT " THESE ARE THE RANKINGS AND HIGHEST LEARNING LEVEL TESTED"
PRINT " FOR ESTIMATOR SUBTOPICS:
PRINT
PRINT " 1) PROPERTIES OF ESTIMATORS: RANK - ";S1RANK(1)
PRINT " LEVEL - ";LEVE1(1)
PRINT
PRINT " 2) METHOD OF MOMENTS\MAXIMUM LIKELIHOOD: RANK - ";S1RANK(2)
PRINT 
PRINT " 3) CONFIDENCE INTERVALS: RANK - ";S1RANK(3)
PRINT " LEVEL - ";LEVE1(3)
PRINT
PRINT "HIT 'X' TO CONTINUE."
INPUT ONCE$
LOOP UNTIL ONCE$ = "X" OR ONCE$ = "x" !SCREEN IS MAINTAINED
END SUB

SUB SUBRANK2 !THIS PRINTS THE HYPOTHESIS TESTING SUBTOPIC
!RANKINGS AND LEVELS OF LEARNING
DO
CLEAR
PRINT " THESE ARE THE RANKINGS AND HIGHEST LEARNING LEVEL TESTED"
PRINT " FOR HYPOTHESIS TESTING SUBTOPICS:
PRINT
PRINT " 1) PROPERTIES OF HYPOTHESIS TESTING: RANK - ";S2RANK(1)
PRINT " LEVEL - ";LEVE2(1)
PRINT
PRINT " 2) PARAMETRIC TESTS - MEAN: RANK - ";S2RANK(2)
PRINT " LEVEL - ";LEVE2(2)
PRINT
PRINT " 3) PARAMETRIC TESTS - VARIANCES: RANK - ";S2RANK(3)
PRINT " LEVEL - ";LEVE2(3)
PRINT
PRINT " 4) NONPARAMETRIC TESTS: RANK - ";S2RANK(4)
PRINT " LEVEL - ";LEVE2(4)
PRINT
PRINT "5) TESTS OF GOODNESS OF FIT\INDEPENDENCE: RANK - ";S2RANK(5) 
PRINT "LEVEL ";LEVE2(5) 
PRINT "HIT 'X' TO CONTINUE." 
INPUT ONCE$ 
LOOP UNTIL ONCE$ = "X" OR ONCE$ = "x" !SCREEN IS MAINTAINED 
END SUB 

SUB SUBRANK3 !THIS PRINTS THE REGRESSION SUBTOPIC RANKINGS 
!AND LEVELS OF LEARNING 
DO 
CLEAR 
PRINT 
PRINT "THESE ARE THE RANKINGS AND HIGHEST LEARNING 
LEVELS TESTED" 
PRINT "FOR REGRESSION SUBTOPICS:"
PRINT 
PRINT "1) PROPERTIES OF REGRESSION: RANK - ";S3RANK(1) 
PRINT "LEVEL - ";LEVE3(1) 
PRINT 
PRINT "2) DESCRIPTIVE AND INFERENTIAL STATISTICS: RANK 
- ";S3RANK(2) 
PRINT "LEVEL - ";LEVE3(2) 
PRINT 
PRINT "3) DECOMPOSITION AND LEAST SQUARES: RANK 
- ";S3RANK(3) 
PRINT "LEVEL - ";LEVE3(3) 
PRINT 
PRINT "4) ANOVA: RANK - ";S3RANK(4) 
PRINT "LEVEL - ";LEVE3(4) 
PRINT 
PRINT "HIT 'X' TO CONTINUE."
INPUT ONCE$ 
LOOP UNTIL ONCE$ = "X" OR ONCE$ = "x" !SCREEN IS MAINTAINED 
END SUB 

SUB SUBRANK4 !THIS PRINTS THE EXP. DESIGN SUBTOPIC 
!RANKINGS AND LEVELS OF LEARNING 
DO 
CLEAR 
PRINT 
PRINT "THESE ARE THE RANKINGS FOR THE EXPERIMENTAL 
DESIGN SUBTOPICS:"
PRINT 
PRINT "1) SINGLE FACTOR DESIGN: RANK - ";S4RANK(1) 
PRINT "LEVEL - ";LEVE4(1)
PRINT "2) MULTIFACTOR DESIGN: RANK - ";S4RANK(2)
PRINT " LEVEL - ";LEVE4(2)
PRINT
PRINT "3) SUM OF SQUARES DECOMPOSITION: RANK - ";S4RANK(3)
PRINT " LEVEL - ";LEVE4(3)
PRINT
PRINT "4) ANOVA: RANK - ";S4RANK(4)
PRINT " LEVEL - ";LEVE4(4)
PRINT
PRINT "HIT 'X' TO CONTINUE."
INPUT ONCE$
LOOP UNTIL ONCE$ = "X" OR ONCE$ = "x" !SCREEN IS MAINTAINED
END SUB

SUB PASS
!THIS DISPLAYS THE PASSING SCORE REQUIRED BY !THE STUDENT
DO
CLEAR
PRINT "THE STUDENT MUST ANSWER ";SCORE;" PERCENT OF THE QUESTIONS "
PRINT "CORRECTLY TO DEMONSTRATE PROFICIENCY IN A TOPIC."
PRINT "HIT 'X' TO CONTINUE."
INPUT ONCE$
LOOP UNTIL ONCE$ = "X" OR ONCE$ = "x" !SCREEN IS MAINTAINED
END SUB

SUB CHACOND
!THIS SUBROUTINE ALLOWS THE ADMINISTRATOR !TO ALTER THE TEST CONDITIONS. THE MENU OF !CHOICES IS PRINTED HERE
DO
DO
CLEAR
PRINT "PLEASE SELECT THE NUMBER OF THE OPTION OF YOUR CHOICE."
PRINT "1) ALTER THE MAJOR TOPIC RANKINGS"
PRINT "2) ALTER THE SUBTOPIC RANKINGS"
PRINT "3) ALTER THE LEVELS"
PRINT "4) ALTER THE PASSING SCORE"
PRINT " 5) RETURN TO THE MAIN MENU"
PRINT
INPUT BE
LOOP UNTIL BE = 1 OR BE = 2 OR BE = 3 OR BE = 4 OR BE = 5
CALL WHICHAN  !THIS SUB DETERMINES WHICH CONDITION IS TO 
                 !BE ALTERED
LOOP UNTIL BE = 5
CALL SUBZERO   !THIS SUB CHECK TO SEE IF A SUBTOPIC
                 !HAS A ZERO RANK
CALL MJZERO    !THIS CHECK TO SEE IF A MAJOR TOPIC HAS A
                 !RANK OF ZERO
CALL READTO   !THIS WRITES THE NEW PARAMETERS TO AN 
               !OUTSIDE FILE
ENDED SUB

SUB WHICHAN    !DETERMINES WHAT THE ADMIN. WANTS TO CHANGE
CLEAR
IF BE = 1 THEN
  CALL CHANRKMJ !CALLED IF THE MAJOR RANKS ARE TO BE 
                 !CHANGED
ELSEIF BE = 2 THEN
  CALL CHANRKST !CALLED IF THE SUBTOPIC RANKS ARE TO 
                 !BE CHANGED
ELSEIF BE = 3 THEN
  CALL CHANLEVE !CALLED IF THE LEVELS OF LEARNING ARE
                 !TO BE CHANGED
ELSEIF BE = 4 THEN
  CALL CHANSCOR !CALLED IF THE PASSING SCORE IS TO BE 
                 !CHANGED
ELSE
END IF
ENDED SUB

SUB CHANRKMJ  !SUB ALLOWS THE ADMIN. TO CHANGE THE MAJOR 
               !TOPIC RANKS.
CALL TOPLIST   !PRINTS THE LIST OF MAJOR TOPICS
CALL AGRANKMJ !ALLOWS THE ADMIN TO ALTER THE MAJOR RANKS
ENDED SUB

SUB TOPLIST    !PRINTS LIST OF MAJOR TOPICS
PRINT
PRINT "  PLEASE ENTER THE RANK FOR EACH TOPIC ."
PRINT
PRINT "  NOTE: 1 IS THE HIGHEST RANKING"
PRINT "EACH RANK CAN BE USED MORE THAN ONCE"
PRINT "A '0' RANK DENOTES TOPICS TO BE DELETED"
PRINT ""
PRINT PRINT "THE TOPICS ARE:"
PRINT PRINT "1) ESTIMATORS"
PRINT PRINT "2) HYPOTHESIS TESTING"
PRINT PRINT "3) REGRESSION"
PRINT PRINT "4) EXPERIMENTAL DESIGN"
PRINT END SUB

SUB AGRANKMJ !ALLOWS ADMIN TO ALTER MAJOR TOPIC RANKS...
!BUT HE MAY IMPUT ONLY CERTAIN VALUES
!(1, 2, 3, OR 4)
DO
  SET CURSOR 12,18
  INPUT MRANK(1)
LOOP UNTIL MRANK(1)=0 OR MRANK(1)=1 OR MRANK(1)=2 OR
  MRANK(1)=3 OR MRANK(1)=4
DO
  SET CURSOR 14,26
  INPUT MRANK(2)
LOOP UNTIL MRANK(2)=0 OR MRANK(2)=1 OR MRANK(2)=2 OR
  MRANK(2)=3 OR MRANK(2)=4
DO
  SET CURSOR 16,18
  INPUT MRANK(3)
LOOP UNTIL MRANK(3)=0 OR MRANK(3)=1 OR MRANK(3)=2 OR
  MRANK(3)=3 OR MRANK(3)=4
DO
  SET CURSOR 18,27
  INPUT MRANK(4)
LOOP UNTIL MRANK(4)=0 OR MRANK(4)=1 OR MRANK(4)=2 OR
  MRANK(4)=3 OR MRANK(4)=4
END SUB

SUB CHANRKST !PRINTS A MENU FOR THE ADMIN. TO CHOOSE
!WHICH GROUP OF SUBTOPICS HE/SHE WISHES
!TO CHANGE.
DO
  DO
    CLEAR
    PRINT
    PRINT "PLEASE SELECT THE NUMBER OF THE OPTION OF YOUR CHOICE."
    PRINT
    PRINT "1) ALTER THE ESTIMATOR RANKINGS."
    PRINT
    PRINT "2) ALTER THE HYPOTHESIS TESTING RANKINGS."
    PRINT
    PRINT "3) ALTER THE REGRESSION RANKINGS."
    PRINT
    PRINT "4) ALTER THE EXPERIMENTAL DESIGN RANKINGS."
    PRINT
    PRINT "5) RETURN TO PREVIOUS MENU."
    PRINT
    INPUT MO
    LOOP UNTIL MO=1 OR MO=2 OR MO=3 OR MO=4 OR MO=5
    CALL WHICHALT
    LOOP UNTIL MO = 5
  END SUB

SUB WHICHALT !DETERMINES WHICH GROUP OF SUBTOPIC RANKINGS IS TO BE ALTERED

  CLEAR
  IF MO = 1 THEN
    CALL CHESRK !ESTIMATOR SUBTOPIC RANKINGS ARE TO BE CHANGED
  ELSEIF MO = 2 THEN
    CALL CHHTRK !HYPOTHESIS TESTING SUBTOPIC RANKINGS ARE TO BE ALTERED
  ELSEIF MO = 3 THEN
    CALL CHRERK !REGRESSION SUBTOPIC RANKINGS ARE TO BE CHANGED
  ELSEIF MO = 4 THEN
    CALL CHEDRK !EXP. DESIGN SUBTOPIC RANKINGS ARE TO BE CHANGED
  ELSE
    END IF
  END SUB

SUB CHESRK !PRINTS THE ESTIMATOR SUBTOPICS AND ALLOWS THE ADMIN TO ALTER THEM BY USING ONLY CERTAIN ALLOWABLE RANKINGS.

  PRINT" THESE ARE THE SUBTOPICS COVERED IN THE MAJOR TOPIC ESTIMATORS."
PRINT "PLEASE RANK THEM IN ORDER OF IMPORTANCE WITH '1' BEING THE MOST"
PRINT "IMPORTANT. EACH NUMBER ONLY ONCE MAY BE USED MORE THAN ONCE. USE '0'
PRINT "TO DENOTE A SUBTOPIC THAT IS TO BE DELETED FROM THE TEST."
PRINT "PROPERTIES OF ESTIMATORS"
PRINT "METHOD OF MOMENTS\MAXIMUM LIKELIHOOD"
PRINT "CONFIDENCE INTERVALS"
DO
  SET CURSOR 6,35
  INPUT S1RANK(1)
LOOP UNTIL S1RANK(1) = 0 OR S1RANK(1) = 1 OR S1RANK(1) = 2 OR S1RANK(1) = 3
DO
  SET CURSOR 8,47
  INPUT S1RANK(2)
LOOP UNTIL S1RANK(2) = 0 OR S1RANK(2) = 1 OR S1RANK(2) = 2 OR S1RANK(2) = 3
DO
  SET CURSOR 10,31
  INPUT S1RANK(3)
LOOP UNTIL S1RANK(3) = 0 OR S1RANK(3) = 1 OR S1RANK(3) = 2 OR S1RANK(3) = 3
PRINT
END SUB

SUB CHMTRK
  ! ALLOWS THE ADMIN TO ALTER THE HYPOTHESIS TESTING SUBTOPIC RANKINGS BY ENTERING ONLY CERTAIN ALLOWABLE VALUES.
PRINT "THESE ARE THE SUBTOPICS COVERED IN THE MAJOR TOPIC HYPOTHESIS TESTING."
PRINT "PLEASE RANK THEM IN ORDER OF IMPORTANCE WITH '1' BEING THE MOST"
PRINT "IMPORTANT. EACH NUMBER MAY BE USED MORE THAN ONCE. USE '0' TO DENOTE"
PRINT "A SUBTOPIC THAT IS TO BE DELETED FROM THE TEST."
PRINT "PROPERTIES OF HYPOTHESIS TESTING"
PRINT "PARAMETRIC TESTS - MEANS"
PRINT "PARAMETRIC TESTS - VARIANCES"
PRINT "NONPARAMETRIC TESTS"
PRINT "TESTS OF GOODNESS OF FIT/INDEPENDENCE"

DO
  SET CURSOR 6,43
  INPUT MJ
LOOP UNTIL MJ=0 OR MJ=1 OR MJ=2 OR MJ=3 OR MJ=4 OR MJ=5
  LET S2RANK(1) = MJ
DO
  SET CURSOR 8,35
  INPUT MJ
LOOP UNTIL MJ=0 OR MJ=1 OR MJ=2 OR MJ=3 OR MJ=4 OR MJ=5
  LET S2RANK(2) = MJ

DO
  SET CURSOR 10,39
  INPUT MJ
LOOP UNTIL MJ=0 OR MJ=1 OR MJ=2 OR MJ=3 OR MJ=4 OR MJ=5
  LET S2RANK(3) = MJ
DO
  SET CURSOR 12,30
  INPUT MJ
LOOP UNTIL MJ=0 OR MJ=1 OR MJ=2 OR MJ=3 OR MJ=4 OR MJ=5
  LET S2RANK(4) = MJ
DO
  SET CURSOR 14,48
  INPUT MJ
LOOP UNTIL MJ=0 OR MJ=1 OR MJ=2 OR MJ=3 OR MJ=4 OR MJ=5
  LET S2RANK(5) = MJ
PRINT END SUB

SUB CHRERK !ALLOWS THE ADMIN TO ALTER THE REGRESSION
!SUBTOPIC RANKINGS BY ENTERING ONLY CERTAIN
!ALLOWABLE VALUES

PRINT"THESE ARE THE SUBTOPICS COVERED IN THE MAJOR TOPIC
REGRESSION."
PRINT"PLEASE RANK THEM IN ORDER OF IMPORTANCE WITH '1' BEING
THE MOST"
PRINT"IMPORTANT. EACH NUMBER MAY BE USED MORE THAN ONCE.
USE '0' TO DENOTE"
PRINT"A SUBTOPIC THAT IS TO BE DELETED FROM THE TEST."
PRINT PRINT "PROPERTIES OF REGRESSION"
PRINT PRINT "DESCRIPTIVE AND INFERENCEAL STATISTICS"
PRINT "DECOMPOSITION AND LEAST SQUARES"
PRINT "ANOVA"

DO
  SET CURSOR 6,35
  INPUT NJ
LOOP UNTIL NJ=0 OR NJ=1 OR NJ=2 OR NJ=3 OR NJ=4
LET S3RANK(1) = NJ
DO
  SET CURSOR 8,49
  INPUT NJ
LOOP UNTIL NJ=0 OR NJ=1 OR NJ=2 OR NJ=3 OR NJ=4
LET S3RANK(2) = NJ
DO
  SET CURSOR 10,42
  INPUT NJ
LOOP UNTIL NJ=0 OR NJ=1 OR NJ=2 OR NJ=3 OR NJ=4
LET S3RANK(3) = NJ
DO
  SET CURSOR 12,16
  INPUT NJ
LOOP UNTIL NJ=0 OR NJ=1 OR NJ=2 OR NJ=3 OR NJ=4
LET S3RANK(4) = NJ

END SUB

SUB CHEDRK
  !ALLOWS THE ADMIN TO ALTER THE EXPERIMENTAL
  !DESIGN SUBTOPIC RANKINGS BY ENTERING CERTAIN
  !ALLOWABLE VALUES.

PRINT "THESE ARE THE SUBTOPICS COVERED IN THE MAJOR TOPIC
  REGRESSION."
PRINT "PLEASE RANK THEM IN ORDER OF IMPORTANCE WITH '1' BEING
  THE MOST"
PRINT "IMPORTANT. EACH NUMBER MAY BE USED MORE THAN ONCE.
  USE '0' TO DENOTE"
PRINT "A SUBTOPIC THAT IS TO BE DELETED FROM THE TEST."
PRINT "SINGLE FACTOR DESIGN"
PRINT "MULTIFACTOR DESIGN"
PRINT "SUM OF SQUARES DECOMPOSITION"
PRINT "ANOVA"

DO
  SET CURSOR 6,31
  INPUT PJ
LOOP UNTIL PJ = 0 OR PJ = 1 OR PJ = 2 OR PJ = 3 OR PJ = 4
LET S4RANK(1) = PJ
DO
  SET CURSOR 8,29
  INPUT PJ
LOOP UNTIL PJ = 0 OR PJ = 1 OR PJ = 2 OR PJ = 3 OR PJ = 4
LET S4RANK(2) = PJ
DO
  SET CURSOR 10,39
  INPUT PJ
LOOP UNTIL PJ = 0 OR PJ = 1 OR PJ = 2 OR PJ = 3 OR PJ = 4
LET S4RANK(3) = PJ
DO
  SET CURSOR 12,16
  INPUT PJ
LOOP UNTIL PJ = 0 OR PJ = 1 OR PJ = 2 OR PJ = 3 OR PJ = 4
LET S4RANK(4) = PJ
PRINT
END SUB

!IF A SUBTOPIC HAS A RANK OF ZERO, THEN THE LEVEL OF
!LEARNING IS AUTOMATICALLY SET TO ZERO IN SUB SUBZERO

SUB SUBZERO

FOR RAI = 1 TO 3
  IF S1RANK(RAI) = 0 OR LEVE1(RAI) = 0 THEN
    LET LEVE1(RAI) = 0
    LET S1RANK(RAI) = 0
  END IF
NEXT RAI

FOR RAI = 1 TO 5
  IF S2RANK(RAI) = 0 OR LEVE2(RAI) = 0 THEN
    LET LEVE2(RAI) = 0
    LET S2RANK(RAI) = 0
  END IF
NEXT RAI

FOR RAI = 1 TO 4
  IF S3RANK(RAI) = 0 OR LEVE3(RAI) = 0 THEN
    LET LEVE3(RAI) = 0
    LET S3RANK(RAI) = 0
  END IF
END IF

IF S4RANK(RAI) = 0 OR LEVE4(RAI) = 0 THEN
  LET LEVE4(RAI) = 0
  LET S4RANK(RAI) = 0
END IF
!If a major topic has a rank of zero then all subtopic rankings and levels of learning for that subtopic are automatically set to zero in MJZERO.

SUB MJZERO
FOR RAI = 1 TO 4
    IF MRANK(RAI) = 0 THEN
        IF RAI = 1 THEN
            FOR RAID = 1 TO 3
                LET S1RANK(RAID) = 0
                LET LEVE1(RAID) = 0
            NEXT RAID
        ELSEIF RAI = 2 THEN
            FOR RAID = 1 TO 5
                LET S2RANK(RAID) = 0
                LET LEVE2(RAID) = 0
            NEXT RAID
        ELSEIF RAI = 3 THEN
            FOR RAID = 1 TO 4
                LET S3RANK(RAID) = 0
                LET LEVE3(RAID) = 0
            NEXT RAID
        ELSEIF RAI = 4 THEN
            FOR RAID = 1 TO 4
                LET S4RANK(RAID) = 0
                LET LEVE4(RAID) = 0
            NEXT RAID
        ELSE
            END IF
        END IF
    END IF
NEXT RAI
END SUB

SUB READTO
!This reads the new rankings, levels of learning and the passing score to be written to outside files, which are then read in by the student version of the test.
OPEN #1: NAME "MJRANK", ACCESS OUTIN, CREATE NEW, OLD, ORGANIZATION TEXT
ERASE #1
FOR PB = 1 TO 4
    PRINT #1: MRANK(PB)
NEXT PB
CLOSE #1

OPEN #11: NAME "SJ1RANK", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
ERASE #11
FOR PB = 1 TO 3
   PRINT #11: S1RANK(PB)
   NEXT PB
CLOSE #11

OPEN #12: NAME "SJ2RANK", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
ERASE #12
FOR PB = 1 TO 5
   PRINT #12: S2RANK(PB)
   NEXT PB
CLOSE #12

OPEN #13: NAME "SJ3RANK", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
ERASE #13
FOR PB = 1 TO 4
   PRINT #13: S3RANK(PB)
   NEXT PB
CLOSE #13

OPEN #14: NAME "SJ4RANK", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
ERASE #14
FOR PB = 1 TO 4
   PRINT #14: S4RANK(PB)
   NEXT PB
CLOSE #14

OPEN #21: NAME "LEV1", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
ERASE #21
FOR PB = 1 TO 3
   PRINT #21: LEV1(PB)
   NEXT PB
CLOSE #21

OPEN #22: NAME "LEV2", ACCESS OUTIN, CREATE NEWOLD,
ORGANIZATION TEXT
ERASE #22
FOR PB = 1 TO 5
   PRINT #22: LEV2(PB)
   NEXT PB
CLOSE #22
OPEN #23: NAME "LEV3", ACCESS OUTIN, CREATE NEWOLD, ORGANIZATION TEXT
ERASE #23
FOR PB = 1 TO 4
    PRINT #23: LEVE3(PB)
NEXT PB
CLOSE #23

OPEN #24: NAME "LEV4", ACCESS OUTIN, CREATE NEWOLD, ORGANIZATION TEXT
ERASE #24
FOR PB = 1 TO 4
    PRINT #24: LEVE4(PB)
NEXT PB
CLOSE #24

OPEN #4: NAME "SCOR", ACCESS OUTIN, CREATE NEWOLD, ORGANIZATION TEXT
ERASE #4
PRINT #4: SCORE
CLOSE #4
END SUB

SUB CHANLEVE !THIS SUB PRINTS A MENU TO ALLOW THE ADMIN
!TO CHOOSE WHICH SUBTOPIC LEVELS OF LEARNING
!THAT HE/SHE WISHES TO ALTER
DO
    PRINT" PLEASE SELECT THE NUMBER OF THE OPTION OF YOUR
    PRINT CHICE:"
    PRINT " 1) ALTER THE ESTIMATOR SUBTOPICS LEVELS OF
    PRINT " 2) ALTER THE HYPOTHESIS TESTING SUBTOPICS
    PRINT " 3) ALTER THE REGRESSION SUBTOPICS LEVELS OF
    PRINT " 4) ALTER THE EXPERIMENTAL DESIGN SUBTOPICS
    PRINT " 5) RETURN TO THE PREVIOUS MENU."
    INPUT BO
LOOP UNTIL BO = 1 OR BO = 2 OR BO = 3 OR BO = 4 OR BO = 5
CALL WHICLEV
LOOP UNTIL BO = 5

END SUB

SUB WHICLEV !DETERMINES WHICH SUBTOPIC LEVEL OF LEARNING !IS TO BE ALTERED
CLEAR
IF BO = 1 THEN
    CALL CHESLE !ALLOWS THE ADMIN TO ALTER ESTIMATOR SUBTOPICS !LEVELS OF LEARNING
ELSEIF BO = 2 THEN
    CALL CHHTLE !ALLOWS THE ADMIN TO ALTER HYPOTHESIS TESTING !SUBTOPIC LEVELS OF LEARNING
ELSEIF BO = 3 THEN
    CALL CHRELE !ALLOWS THE ADMIN TO ALTER REGRESSION SUBTOPICS !LEVELS OF LEARNING
ELSEIF BO = 4 THEN
    CALL CHEDLE !ALLOWS THE ADMIN TO ALTER EXPERIMENTAL DESIGN !SUBTOPICS LEVELS OF LEARNING
ELSE
    END IF
    CLEAR
END IF
END SUB

SUB CHESLE !DISPLAYS A SCREEN THAT ALLOWS THE ADMIN !TO ALTER THE ESTIMATOR SUBTOPICS LEVELS OF !LEARNING BY ENTERING CERTAIN ALLOWABLE VALUES

PRINT " THESE ARE THE SUBTOPICS UNDER ESTIMATORS. AS THEY APPEAR"
PRINT "PLEASE INDICATE THE HIGHEST LEVEL OF LEARNING YOU WISH TO"
PRINT "BE TESTED IN THAT SUBTOPIC. THE OPTIONS AVAILABLE FOR EACH"
PRINT "SUBTOPIC ARE LISTED. '1' REPRESENTS KNOWLEDGE, '2' COMPREHENSION,"
PRINT "AND '3' APPLICATION AND ANALYSIS."
PRINT
PRINT " PROPERTIES OF ESTIMATORS: 1, AND 2"
PRINT
PRINT " METHOD OF MOMENTS\MAXIMUM LIKELIHOOD: 1, AND 3"
PRINT
PRINT " CONFIDENCE INTERVALS: 1, 2 AND 3"
PRINT
DO
    SET CURSOR 7,45
    INPUT TJ
    LOOP UNTIL TJ = 0 OR TJ = 1 OR TJ = 2
    LET LEVEL1(1) = TJ
DO
  SET CURSOR 9,57
  INPUT TJ
LOOP UNTIL TJ = 0 OR TJ = 1 OR TJ = 3
LET LEVE1(2) = TJ
DO
  SET CURSOR 11,43
  INPUT TJ
LOOP UNTIL TJ = 0 OR TJ = 1 OR TJ = 2 OR TJ = 3
LET LEVE1(3) = TJ
END SUB

SUB CHHTLE !DISPLAYS A SCREEN THAT ALLOWS AN ADMIN TO
!CHANGE THE HYPOTHESIS TESTING LEVELS OF
!LEARNING BY ENTERING CERTAIN ALLOWABLE VALUES
PRINT " THESE ARE THE SUBTOPICS UNDER HYPOTHESIS TESTING.
   AS THEY APPEAR"
PRINT "PLEASE INDICATE THE HIGHEST LEVEL OF LEARNING YOU
   WISH TO"
PRINT "BE TESTED IN THAT SUBTOPIC. THE OPTIONS AVAILABLE
   FOR EACH"
PRINT "SUBTOPIC ARE LISTED. '1' REPRESENTS KNOWLEDGE, '2'
   COMPREHENSION,"
PRINT "AND '3' APPLICATION AND ANALYSIS."
PRINT PRINT " PROPERTIES OF HYPOTHESIS TESTING: 1, 2,
   AND 3"
PRINT PRINT " PARAMETRIC TESTS - MEAN: 1, AND 2"
PRINT PRINT " PARAMETRIC TESTS - VARIANCES: 1, AND 2"
PRINT PRINT " NONPARAMETRIC TESTS: 1"
PRINT PRINT " TESTS OF GOODNESS OF FIT\INDEPENDENCE: 1,
   2, AND 3"
PRINT
DO
  SET CURSOR 7,56
  INPUT UJ
LOOP UNTIL UJ = 0 OR UJ = 1 OR UJ = 2 OR UJ = 3
LET LEVE2(1) = UJ
DO
  SET CURSOR 9,44
  INPUT UJ
LOOP UNTIL UJ = 0 OR UJ = 1 OR UJ = 2
LET LEVE2(2) = UJ
DO
SET CURSOR 11,49
INPUT UJ
LOOP UNTIL UJ = 0 OR UJ = 1 OR UJ = 2
LET LEVE2(3) = UJ
DO
  SET CURSOR 13,33
  INPUT UJ
LOOP UNTIL UJ = 0 OR UJ = 1
LET LEVE2(4) = UJ
DO
  SET CURSOR 15,61
  INPUT UJ
LOOP UNTIL UJ = 0 OR UJ = 1 OR UJ = 2 OR UJ = 3
LET LEVE2(5) = UJ
END SUB

SUB CHRELE
!DISPLAYS A SCREEN THAT ALLOWS AN ADMIN TO
!CHANGE THE REGRESSION SUBTOPIC LEVELS OF
!LEARNING BY ENTERING CERTAIN ALLOWABLE VALUES
PRINT " THESE ARE THE SUBTOPICS UNDER REGRESSION. AS THEY
APPEAR"
PRINT "PLEASE INDICATE THE HIGHEST LEVEL OF LEARNING YOU
WISH TO"
PRINT "BE TESTED IN THAT SUBTOPIC. THE OPTIONS AVAILABLE
FOR EACH"
PRINT "SUBTOPIC ARE LISTED. '1' REPRESENTS KNOWLEDGE, '2'
COMPREHENSION,"
PRINT "AND '3' APPLICATION AND ANALYSIS."
PRINT
PRINT " PROPERTIES OF REGRESSION: 1, 2, AND 3"
PRINT
PRINT " DESCRITPTIVE AND INFERENTIAL STATISTICS: 1"
PRINT
PRINT " DECOMPOSITION AND LEAST SQUARES: 1, 2, AND 3"
PRINT
PRINT " ANOVA: 1, 2, AND 3"
PRINT
DO
  SET CURSOR 7,48
  INPUT VJ
LOOP UNTIL VJ = 0 OR VJ = 1 OR VJ = 2 OR VJ = 3
LET LEVE3(1) = VJ
DO
  SET CURSOR 9,52
  INPUT VJ
LOOP UNTIL VJ = 0 OR VJ = 1
LET LEVE3(2) = VJ
DO
  SET CURSOR 11,55
  INPUT VJ
LOOP UNTIL VJ = 0 OR VJ = 1 OR VJ = 2 OR VJ = 3
LET LEVE3(3) = VJ
DO
  SET CURSOR 13,29
  INPUT VJ
LOOP UNTIL VJ = 0 OR VJ = 1 OR VJ = 2 OR VJ = 3
LET LEVE3(4) = VJ
END SUB

SUB CHEDLE !DISPLAYS A SCREEN THAT ALLOWS AN ADMIN TO
!ALTER THE EXPERIMENTAL DESIGN LEVELS OF
!LEARNING BY ENTERING CERTAIN ALLOWABLE VALUES.
PRINT "THESE ARE THE SUBTOPICS UNDER EXPERIMENTAL DESIGN.
AS THEY APPEAR"
PRINT "PLEASE INDICATE THE HIGHEST LEVEL OF LEARNING YOU
WISH TO"
PRINT "BE TESTED IN THAT SUBTOPIC. THE OPTIONS AVAILABLE
FOR EACH"
PRINT "SUBTOPIC ARE LISTED. '1' REPRESENTS KNOWLEDGE, '2'
COMPREHENSION,"
PRINT "AND '3' APPLICATION AND ANALYSIS."
PRINT "SINGLE FACTOR DESIGN: 1, 2, AND 3"
PRINT "MULTIFACTOR DESIGN: 1, 2, AND 3"
PRINT "SUM OF SQUARES DECOMPOSITION: 1, 2, AND 3"
PRINT "ANOVA: 1, 2, AND 3"
DO
  SET CURSOR 7,44
  INPUT WJ
LOOP UNTIL WJ = 0 OR WJ = 1 OR WJ = 2 OR WJ = 3
LET LEVE4(1) = WJ
DO
  SET CURSOR 9,42
  INPUT WJ
LOOP UNTIL WJ = 0 OR WJ = 1 OR WJ = 2 OR WJ = 3
LET LEVE4(2) = WJ
DO
  SET CURSOR 11,52
  INPUT WJ
LOOP UNTIL WJ = 0 OR WJ = 1 OR WJ = 2 OR WJ = 3
LET LEVE4(3) = WJ
DO
    SET CURSOR 13,29
    INPUT WJ
LOOP UNTIL WJ = 0 OR WJ = 1 OR WJ = 2 OR WJ = 3
LET LEVE4(4) = WJ
END SUB

SUB CHANSCOR !THIS DISPLAYS A SCREEN THAT ALLOWS THE ADMIN
    !TO ALTER THE SCORE A STUDENT MUST ACHIEVE TO
    !PASS THE TEST
CLEAR
PRINT "PLEASE ENTER THE PERCENT OF QUESTIONS THAT A
     STUDENT MUST ANSWER"
PRINT "CORRECTLY IN ORDER TO DEMONSTRATE PROFICIENCY IN
     A TOPIC."
PRINT "(50 TO 75 PERCENT IS RECOMMENDED)"
PRINT
INPUT SCORE
END SUB

END
APPENDIX E

QUESTIONBANK PROGRAMS
PROGRAM TEXT1 (RS$)
SET CURSOR 1,1

LET RD$ = RS$[1:2]
LET RN$ = RS$[3:3]
LET RG$ = RS$[4:5]

IF RG$ = "GA" THEN
  LET G = 1
ELSEIF RG$ = "GB" THEN
  LET G = 2
ELSEIF RG$ = "GC" THEN
  LET G = 3
ELSEIF RG$ = "GD" THEN
  LET G = 4
ELSEIF RG$ = "GE" THEN
  LET G = 5
ELSEIF RG$ = "GF" THEN
  LET G = 6
ELSEIF RG$ = "GG" THEN
  LET G = 7
ELSEIF RG$ = "GH" THEN
  LET G = 8
ELSEIF RG$ = "GI" THEN
  LET G = 9
ELSEIF RG$ = "GJ" THEN
  LET G = 10
ELSEIF RG$ = "GK" THEN
  LET G = 11
ELSEIF RG$ = "GL" THEN
  LET G = 12
ELSEIF RG$ = "GM" THEN
  LET G = 13
ELSEIF RG$ = "GN" THEN
  LET G = 14
ELSEIF RG$ = "GO" THEN
  LET G = 15
ELSEIF RG$ = "GP" THEN
  LET G = 16
ELSEIF RG$ = "GQ" THEN
  LET G = 17
ELSEIF RG$ = "GR" THEN
  LET G = 18
ELSEIF RG$ = "GS" THEN
  LET G = 19
ELSEIF RG$ = "GT" THEN
  LET G = 20
ELSEIF RG$ = "GU" THEN
  LET G = 21
ELSEIF RG$ = "GV" THEN
LET G = 22
ELSEIF RG$ = "GW" THEN
LET G = 23
ELSEIF RG$ = "GX" THEN
LET G = 24
ELSEIF RG$ = "GY" THEN
LET G = 25
ELSEIF RG$ = "GZ" THEN
LET G = 26
ELSEIF RG$ = "HA" THEN
LET G = 27
ELSEIF RG$ = "HB" THEN
LET G = 28
ELSEIF RG$ = "HC" THEN
LET G = 29
ELSEIF RG$ = "HD" THEN
LET G = 30
ELSEIF RG$ = "HE" THEN
LET G = 31
ELSEIF RG$ = "HF" THEN
LET G = 32
ELSEIF RG$ = "HG" THEN
LET G = 33
ELSEIF RG$ = "HH" THEN
LET G = 34
ELSEIF RG$ = "HI" THEN
LET G = 35
ELSEIF RG$ = "HJ" THEN
LET G = 36
ELSEIF RG$ = "HK" THEN
LET G = 37
ELSEIF RG$ = "HL" THEN
LET G = 38
ELSEIF RG$ = "HM" THEN
LET G = 39
ELSEIF RG$ = "HN" THEN
LET G = 40
ELSEIF RG$ = "HO" THEN
LET G = 41
ELSEIF RG$ = "HP" THEN
LET G = 42
ELSEIF RG$ = "HQ" THEN
LET G = 43
ELSEIF RG$ = "HR" THEN
LET G = 44
ELSEIF RG$ = "HS" THEN
LET G = 45
ELSEIF RG$ = "HT" THEN
LET G = 46
ELSEIF RG$ = "HU" THEN
LET G = 47
ELSEIF RG$ = "HV" THEN
    LET G = 48
ELSEIF RG$ = "HW" THEN
    LET G = 49
ELSEIF RG$ = "HX" THEN
    LET G = 50
ELSEIF RG$ = "HY" THEN
    LET G = 51
ELSEIF RG$ = "HZ" THEN
    LET G = 52
ELSEIF RG$ = "JA" THEN
    LET G = 53
ELSEIF RG$ = "JB" THEN
    LET G = 54
ELSEIF RG$ = "JC" THEN
    LET G = 55
ELSEIF RG$ = "JD" THEN
    LET G = 56
ELSEIF RG$ = "JE" THEN
    LET G = 57
ELSEIF RG$ = "JF" THEN
    LET G = 58
ELSEIF RG$ = "JG" THEN
    LET G = 59
ELSEIF RG$ = "JH" THEN
    LET G = 60
ELSEIF RG$ = "JJ" THEN
    LET G = 61
ELSEIF RG$ = "JK" THEN
    LET G = 62
ELSEIF RG$ = "JL" THEN
    LET G = 63
ELSEIF RG$ = "JM" THEN
    LET G = 64
ELSEIF RG$ = "JN" THEN
    LET G = 65
ELSE
    END IF

PRINT "QUESTION ";G
PRINT
!PROPERTIES OF ESTIMATORS
IF RD$ = "AA" THEN
    IF RN$ = "Z" THEN
        PRINT "WHEN DERIVING A CONFIDENCE INTERVAL ON THE MEAN OF A NORMALLY"
        PRINT "DISTRIBUTED RANDOM VARIABLE WHOSE VARIANCE IS KNOWN, IT IS NOT"
        PRINT "NECESSARY TO KNOW THE ?"
        PRINT "A) SAMPLE MEAN."
    ELSE
        PRINT "B) STANDARD DEVIATION."
    END IF
ELSE
    PRINT "C) THE OBSERVED MEAN."
ENDIF
PRINT "B) SAMPLE SIZE."
PRINT "C) SAMPLE VARIANCE."
PRINT "D) DEGREE OF CONFIDENCE DESIRED."

ELSEIF RN$ = "Y" THEN
PRINT "THE PURPOSE OF CALCULATING THE MEAN SQUARE ERROR OF A POINT"
PRINT "ESTIMATOR IS TO ?"
PRINT "A) DETERMINE THE BIAS OF THE ESTIMATOR."
PRINT "B) COMPARE THE ESTIMATOR TO OTHER ESTIMATORS."
PRINT "C) CALCULATE THE VARIANCE OF THE ESTIMATOR."
PRINT "D) COMPUTE THE EXPECTED VALUE OF THE ESTIMATOR."

ELSEIF RN$ = "X" THEN
PRINT "IN POINT ESTIMATION WHAT IS MEANT BY CONSISTENCY ?"
PRINT "A) DIFFERENT ESTIMATORS HAVING ABOUT THE SAME NUMERICAL VALUE."
PRINT "B) DIFFERENT ESTIMATORS HAVING ABOUT THE SAME MEAN SQUARE "
PRINT "ERROR."
PRINT "C) THE SAME ESTIMATOR HAVING ABOUT THE SAME NUMERICAL VALUE AS"
PRINT "THE SAMPLE SIZE INCREASES."
PRINT "D) THE SAME ESTIMATOR HAVING ABOUT THE SAME BIAS AS THE SAMPLE"
PRINT "SIZE INCREASES."

ELSEIF RN$ = "W" THEN
PRINT "WHICH OF THE FOLLOWING ESTIMATORS IS BIASED ?"
PRINT "A) SAMPLE MEAN."
PRINT "B) MEDIAN."
PRINT "C) SAMPLE STANDARD DEVIATION."
PRINT "D) SAMPLE VARIANCE."
ELSEIF RN$ = "V" THEN
PRINT "THE PURPOSE OF CONSTRUCTING CONFIDENCE INTERVALS FOR A MEAN"
PRINT "IS TO?"
PRINT "A) ESTIMATE THE SAMPLE MEAN WITH SOME DEGREE OF CONFIDENCE."
PRINT "B) DETERMINE THE VALUE OF THE POPULATION MEAN."
PRINT "C) OBTAIN AN ESTIMATE OF THE SAMPLE MEAN AND VARIANCE."
PRINT "D) ESTIMATE THE POPULATION MEAN WITH SOME DEGREE OF CONFIDENCE."
END IF
END IF

!METHOD OF MOMENTS/MAXIMUM LIKELIHOOD - KNOWLEDGE
IF RD$ = "AB" THEN
IF RN$ = "Z" THEN
PRINT "IN GENERAL, WHICH OF THE FOLLOWING IS NOT A PROPERTY OF MAXIMUM"
PRINT "LIKELIHOOD ESTIMATORS ?"
PRINT "A) CONSISTENT."
PRINT "B) NORMALLY DISTRIBUTED."
PRINT "C) NOT UNIQUE."
PRINT "D) UNBIASED."
ELSEIF RN$ = "Y" THEN
PRINT "WHICH OF THE FOLLOWING IS TRUE OF METHOD OF MOMENT ESTIMATORS?"
PRINT "A) IT USUALLY PROVIDES BETTER ESTIMATORS THAN THE METHOD OF"
PRINT "MAXIMUM LIKELIHOOD."
PRINT "B) IT OCCASIONALLY PROVIDES VERY POOR ESTIMATORS."
PRINT "C) IT ONLY DEALS WITH CONTINUOUS RANDOM VARIABLES."
PRINT "D) IT IS THE BEST METHOD OF PARAMETER ESTIMATION. "
ELSEIF RN$ = "X" THEN
PRINT "THE METHOD OF MAXIMUM LIKELIHOOD GENERALLY ESTIMATES PARAMETER "
PRINT "VALUES BY SOLVING THE ?"
PRINT " A) FIRST PARTIAL DERIVITIVE EQUATION(S)."
PRINT " B) SECOND PARTIAL DERIVITIVE EQUATION(S)."
PRINT " C) SAMPLE MOMENT(S) ABOUT THE ORIGIN." 
PRINT " D) SAMPLE MOMENT(S) ABOUT THE MEAN."
ELSEIF RN$ = "W" THEN
PRINT "WHICH OF THE FOLLOWING METHODS OF POINT ESTIMATION IS BETTER ?"
PRINT " A) METHOD OF MAXIMUM LIKELIHOOD." 
PRINT " B) METHOD OF MOMENTS." 
PRINT " C) BOTH WORK EQUALLY WELL."
ELSEIF RN$ = "V" THEN
PRINT "METHOD OF MOMENTS ESTIMATES PARAMETER VALUES BY SOLVING THE ?"
PRINT " A) FIRST PARTIAL DERIVITIVE EQUATION(S)."
PRINT " B) SECOND PARTIAL DERIVITIVE EQUATION(S)."
PRINT " C) SAMPLE MOMENT(S) ABOUT THE MEAN." 
PRINT " D) SAMPLE MOMENT(S) ABOUT THE ORIGIN."
END IF
END IF
!CONFIDENCE INTERVALS - KNOWLEDGE
IF RD$ = "AC" THEN
  IF RN$ = "Z" THEN
    PRINT "THE GOAL IN CONSTRUCTING A CONFIDENCE INTERVAL IS ?"
    PRINT " A) LONG INTERVAL WITH LOW CONFIDENCE." 
    PRINT " B) LONG INTERVAL WITH HIGH CONFIDENCE." 
    PRINT " C) SHORT INTERVAL WITH LOW CONFIDENCE."
PRINT "D) SHORT INTERVAL WITH HIGH CONFIDENCE."

ELSEIF RN$ = "Y" THEN
    PRINT "WHEN DERIVING A CONFIDENCE INTERVAL ON THE VARIANCE OF A NORMALLY DISTRIBUTED RANDOM VARIABLE, WHICH SAMPLING DISTRIBUTION IS USED?"
    PRINT PRINT "A) Z."
    PRINT PRINT "B) CHI-SQUARE."
    PRINT PRINT "C) t."
    PRINT PRINT "D) F."

ELSEIF RN$ = "X" THEN
    PRINT "WHEN DERIVING A CONFIDENCE INTERVAL ON THE RATIO OF THE VARIANCES OF TWO NORMALLY DISTRIBUTED RANDOM VARIABLES WHICH SAMPLING DISTRIBUTION IS USED?"
    PRINT PRINT "A) Z."
    PRINT PRINT "B) CHI-SQUARE."
    PRINT PRINT "C) t."
    PRINT PRINT "D) F."

ELSEIF RN$ = "W" THEN
    PRINT "WHEN DERIVING A CONFIDENCE INTERVAL ON THE MEAN OF A NORMALLY DISTRIBUTED RANDOM VARIABLE WHOSE VARIANCE IS KNOWN, WHICH SAMPLING DISTRIBUTION IS USED?"
    PRINT PRINT "A) Z."
    PRINT PRINT "B) CHI-SQUARE."
    PRINT PRINT "C) t."
    PRINT PRINT "D) F."

ELSEIF RN$ = "V" THEN
    PRINT "WHEN DERIVING A CONFIDENCE INTERVAL ON THE MEAN OF A NORMALLY DISTRIBUTED RANDOM VARIABLE"
PRINT "DISTRIBUTED RANDOM VARIABLE WHOSE VARIANCE IS UNKNOWN, WHICH"
PRINT "SAMPLING DISTRIBUTION IS USED ?"
PRINT
PRINT " A) Z."
PRINT
PRINT " B) CHI-SQUARE."
PRINT
PRINT " C) t."
PRINT
PRINT " D) F."
END IF
END IF

!PROPERTIES OF HYPOTHESIS TESTING - KNOWLEDGE
IF RD$ = "AD" THEN
  IF RN$ = "Z" THEN
    PRINT "THE ULTIMATE PURPOSE OF HYPOTHESIS TESTING IS TO ?"
    PRINT
    PRINT " A) ACCEPT OR REJECT HYPOTHESES."
    PRINT
    PRINT " B) MAKE DECISIONS."
    PRINT
    PRINT " C) ASSESS THE CHANCES OF MAKING ERRORS."
    PRINT
    PRINT " D) DETERMINE THE CRITICAL VALUES."
  ELSEIF RN$ = "Y" THEN
    PRINT "IN THE HYPOTHESIS TESTING FRAMEWORK, THE PURPOSE OF THE"
    PRINT "CRITICAL VALUE IS TO ?"
    PRINT
    PRINT " A) ESTABLISH THE NULL AND ALTERNATIVE HYPOTHESES."
    PRINT
    PRINT " B) ESTABLISH THE SAMPLE EVIDENCE CONSISTENT WITH THE NULL AND"
    PRINT " ALTERNATIVE HYPOTHESES."
    PRINT
    PRINT " C) EXAMINE THE CONSEQUENCES OF MAKING TYPE I AND TYPE II ERRORS."
    PRINT
    PRINT " D) DETERMINE THE ACTIONS OR DECISIONS THAT WILL BE TAKEN IF THE"
    PRINT " NULL OR ALTERNATIVE HYPOTHESES ARE ACCEPTED."
  ELSEIF RN$ = "X" THEN
    PRINT "A TYPE I ERROR OCCURS IF ?"
    PRINT
A) THE NULL HYPOTHESIS IS ACCEPTED WHEN IT IS FALSE.

B) THE NULL HYPOTHESIS IS ACCEPTED WHEN IT IS TRUE.

C) THE ALTERNATIVE HYPOTHESIS IS REJECTED WHEN IT IS FALSE.

D) THE NULL HYPOTHESIS IS REJECTED WHEN IT IS TRUE.

ELSEIF RN3 = "W" THEN
PRINT "A TYPE I ERROR OCCURS IF ?"
PRINT "A) THE NULL HYPOTHESIS IS ACCEPTED WHEN IT IS FALSE."
PRINT "B) THE NULL HYPOTHESIS IS ACCEPTED WHEN IT IS TRUE."
PRINT "C) THE ALTERNATIVE HYPOTHESIS IS REJECTED WHEN IT IS FALSE."
PRINT "D) THE NULL HYPOTHESIS IS REJECTED WHEN IT IS TRUE."

ELSEIF RN3 = "V" THEN
PRINT "THE NULL AND ALTERNATIVE HYPOTHESES MUST BE ?"
PRINT "A) STATISTICALLY INDEPENDENT."
PRINT "B) MUTALLY EXCLUSIVE."
PRINT "C) STATISTICALLY INDEPENDENT."
PRINT "D) COLLECTIVELY EXHAUSTIVE AND MUTUALLY EXCLUSIVE."

ELSEIF RN3 = "U" THEN
PRINT "BASED UPON PRINCIPLES OF HYPOTHESIS TESTING, WE LEARN THAT"
PRINT "FOR ANY BUSINESS PROBLEM, WE MUST ?"
PRINT "A) DEVELOP HYPOTHESES, MAKE A DECISION, AND THEN COLLECT DATA"
PRINT " TO SUPPORT THE DECISION."
PRINT "B) COLLECT DATA, DEVELOP HYPOTHESES, AND THEN MAKE A DECISION."
C) DEVELOP HYPOTHESES, COLLECT DATA, AND THEN MAKE A DECISION.

D) COLLECT DATA, MAKE A DECISION, AND THEN DEVELOP HYPOTHESES.

END IF

!HYPOTHESIS TESTING (MEANS) - KNOWLEDGE
IF RD$ = "AE" THEN
  IF RN$ = "Z" THEN
    PRINT "THE MEAN OF THE POPULATION DISTRIBUTION IS THE MEAN OF A ?"
    PRINT " A) SINGLE SAMPLE SELECTED FROM THE POPULATION."
    PRINT " B) TOTAL POPULATION OF ELEMENTS."
    PRINT " C) SINGLE SAMPLE OF SIZE N TAKEN FROM A POPULATION."
  ELSEIF RN$ = "Y" THEN
    PRINT "THE SAMPLE MEAN IS THE MEAN OF A ?"
    PRINT " A) SINGLE SAMPLE SELECTED FROM THE POPULATION."
    PRINT " B) TOTAL POPULATION OF ELEMENTS."
    PRINT " C) THE MEAN OF ALL POSSIBLE SAMPLE MEANS OF SIZE N TAKEN FROM A POPULATION."
  ELSEIF RN$ = "X" THEN
    PRINT "LET X BE THE TRAVEL TIME FROM A TO B. X IS NOT NORMALLY DISTRIBUTED. POP. MEAN = 200, POP. VARIANCE = 9. TRANSLATE "
    PRINT "P(X > 209) INTO A Z RANDOM VARIABLE."
    PRINT " A) P(Z > 1)."
    PRINT " B) P(Z > 3)."
    PRINT " C) P(Z > 1/81)."
    PRINT " D) CANNOT BE TRANSLATED."
  ELSEIF RN$ = "W" THEN
    IF RN$ = "X" THEN
      PRINT "LET X BE THE TRAVEL TIME FROM A TO B. X IS NOT NORMALLY DISTRIBUTED. POP. MEAN = 200, POP. VARIANCE = 9. TRANSLATE "
      PRINT "P(X > 209) INTO A Z RANDOM VARIABLE."
      PRINT " A) P(Z > 1)."
      PRINT " B) P(Z > 3)."
      PRINT " C) P(Z > 1/81)."
      PRINT " D) CANNOT BE TRANSLATED."
    ELSEIF RN$ = "Y" THEN
      PRINT "THE SAMPLE MEAN IS THE MEAN OF A ?"
      PRINT " A) SINGLE SAMPLE SELECTED FROM THE POPULATION."
      PRINT " B) TOTAL POPULATION OF ELEMENTS."
      PRINT " C) THE MEAN OF ALL POSSIBLE SAMPLE MEANS OF SIZE N TAKEN FROM A POPULATION."
    ELSEIF RN$ = "Z" THEN
      PRINT "THE MEAN OF THE POPULATION DISTRIBUTION IS THE MEAN OF A ?"
      PRINT " A) SINGLE SAMPLE SELECTED FROM THE POPULATION."
      PRINT " B) TOTAL POPULATION OF ELEMENTS."
      PRINT " C) SINGLE SAMPLE OF SIZE N TAKEN FROM A POPULATION."
    ELSEIF RN$ = "W" THEN
      PRINT "CANNOT BE TRANSLATED."
    ELSE
      PRINT "INVALID INPUT."
PRINT "LET X BE TRAVEL TIME FROM A TO B. X IS NORMALLY DISTRIBUTED."
PRINT "POP. MEAN = 200, POP. VARIANCE = 9. OVER NINE TRIPS, TRANSLATE"
PRINT "P(X > 203) INTO A Z RANDOM VARIABLE?"
PRINT "A) CANNOT BE TRANSLATED."
PRINT "B) P(Z > 1)."
PRINT "C) P(Z > 3)."
PRINT "D) P(Z > 9)."

ELSEIF RN$ = "V" THEN
PRINT "THE TEST OF A HYPOTHESIS ON A PROPORTION IS CONCERNED WITH A"
PRINT "RANDOM VARIABLE THAT FOLLOWS WHICH DISTRIBUTION?"
PRINT "A) BINOMIAL."
PRINT "B) EXPONENTIAL."
PRINT "C) GEOMETRIC."
PRINT "D) NORMAL."
END IF

!HYPOTHESIS TESTING (VARIANCES) - KNOWLEDGE
IF RD$ = "AF" THEN
  IF RN$ = "Z" THEN
    PRINT "THE SAMPLE VARIANCE IS THE VARIANCE FOR?"
    PRINT "A) THE TOTAL POPULATION OF ELEMENTS."
    PRINT "B) A SINGLE SAMPLE FROM A POPULATION."
    PRINT "C) THE VARIANCE FOR ALL POSSIBLE SAMPLE MEANS OF SIZE N TAKEN"
    PRINT "FROM A POPULATION."
  ELSEIF RN$ = "Y" THEN
    PRINT "THE VARIANCE OF A POPULATION DISTRIBUTION IS THE VARIANCE FOR?"
    PRINT "A) THE TOTAL POPULATION OF ELEMENTS."
  END IF
ENDIF
A SINGLE SAMPLE FROM A POPULATION.

A SINGLE ELEMENT OF THE POPULATION.

FROM A POPULATION.

ELSEIF RN$ = "X" THEN

WHEN CONSTRUCTION A HYPOTHESIS TEST ON THE VARIANCE OF A NORMAL DISTRIBUTION, THE TEST ?

A) IS ALWAYS ONE-SIDED WITH THE REJECTION REGION IN THE RIGHT TAIL OF THE DISTRIBUTION.

B) IS ALWAYS ONE-SIDED WITH THE REJECTION REGION IN THE LEFT TAIL OF THE DISTRIBUTION.

C) CAN EITHER BE ONE-SIDED OR TWO SIDED.

D) IS ALWAYS TWO-SIDED.

ELSEIF RN$ = "W" THEN

WHEN CONSTRUCTING A HYPOTHESIS TEST ON THE VARIANCE OF A NORMAL DISTRIBUTION, WHICH TEST STATISTIC IS USED ?

A) Z.

B) CHI-SQUARE.

C) t.

D) F.

ELSEIF RN$ = "V" THEN

WHEN CONSTRUCTING A HYPOTHESIS TEST ON THE VARIANCES OF TWO NORMAL DISTRIBUTIONS, WHICH TEST STATISTIC IS USED ?

A) Z.

B) CHI-SQUARE.

C) T.

D) F.

END IF
![NONPARAMETRIC TESTS - KNOWLEDGE]

IF RD$ = "AG" THEN
  IF RN$ = "Z" THEN
    PRINT "THE ONLY REQUIREMENT FOR RUNNING MOST NONPARAMETRIC TESTS IS "
    PRINT "THAT THE UNDERLYING DISTRIBUTION BE ? "
    PRINT " A) BINOMIAL. "
    PRINT " B) CONTINUOUS. "
    PRINT " C) NORMAL. "
    PRINT " D) RANDOM. "
  ELSEIF RN$ = "Y" THEN
    PRINT "WHICH OF THE FOLLOWING IS NOT A NONPARAMETRIC TEST ? "
    PRINT " A) CHI-SQUARE GOODNESS OF FIT TEST." 
    PRINT " B) SIGN TEST." 
    PRINT " C) WILCOXON SIGNED-RANK TEST. " 
    PRINT " D) WILCOXON TWO-SAMPLE TEST FOR INDEPENDENT SAMPLES."
  ELSEIF RN$ = "X" THEN
    PRINT "WHICH OF THE FOLLOWING IS NOT AN ADVANTAGE OF NONPARAMETRIC TESTS ?"
    PRINT " A) THE COMPUTATION IS VERY EASY." 
    PRINT " B) THEY MAY BE USED FOR RANKED OR QUALITATIVE DATA." 
    PRINT " C) THEY HAVE A SMALLER TYPE II ERROR THAN CORRESPONDING PARAMETRIC TESTS." 
    PRINT " D) THE POPULATION DISTRIBUTION NEED NOT BE NORMAL."
  ELSEIF RN$ = "W" THEN
    PRINT "IN NONPARAMETRIC HYPOTHESIS TESTING WHAT IS A DISADVANTAGE OF "

PRINT "THE SIGN TEST ?"
PRINT " A) THE MAGNITUDE OF THE DIFFERENCES OF THE
PAIRS IS NOT"
PRINT "CONSIDERED."
PRINT " B) THE TEST STATISTIC INVOLVES EXTENSIVE
COMPUTATION."
PRINT " C) IT CAN ONLY BE USED WITH A TWO-SIDED
HYPOTHESIS TEST."
PRINT " D) THE DECISION MAKER HAS NOT CONTROL OVER THE
MAGNITUDE OF "
PRINT " THE TYPE I ERROR."

ELSEIF RN$ = "V" THEN
PRINT "A NONPARAMETRIC TEST THAT DOES NOT REQUIRE THAT
THE OBSERVATIONS"
PRINT "BE PAIRED IS THE ?"
PRINT " A) SIGN TEST."
PRINT " B) WILCOXON SIGNED-RANK TEST."
PRINT " C) WILCOXON TWO-SAMPLE TEST FOR INDEPENDENT
SAMPLES."
PRINT " D) NONE OF THE ABOVE."
END IF

END IF

!GOODNESS OF FIT/INDEPENDENCE - KNOWLEDGE
IF RD$ = "AH" THEN
IF RN$ = "Z" THEN
PRINT "WHICH OF THE FOLLOWING APPLIES TO THE
CHI-SQUARE GOODNESS OF FIT"
PRINT "TEST ?"
PRINT " A) THE DEGREES OF FREEDOM IS THE SAMPLE SIZE
MINUS ONE (N-1)."
PRINT " B) THE SMALLER THE FREQUENCIES OF EACH CLASS
THE MORE ACCURATE"
PRINT " THE RESULTS."
PRINT " C) THE CLASS INTERVALS MUST BE OF EQUAL WIDTH."
PRINT " D) THE ACCURACY IMPROVES AS SAMPLE SIZE
INCREASES.

ELSEIF RN$ = "Y" THEN
PRINT "THE CHI-SQUARE GOODNESS OF FIT TEST COMPARES ?"
PRINT " A) SAMPLE MEAN AND VARIANCE."
PRINT " B) HIGH AND LOW SAMPLE DATA POINTS."
PRINT " C) DIFFERENT SAMPLE MEANS."
PRINT " D) OBSERVED AND EXPECTED FREQUENCIES."

ELSEIF RN$ = "X" THEN
PRINT "IN DETERMINING INDEPENDENCE THE PURPOSE OF A CONTINGENCY TABLE "
PRINT "IS TO DETERMINE IF THE TWO METHODS OF CLASSIFICATION ARE ?"
PRINT " A) COLLECTIVELY EXHAUSTIVE."
PRINT " B) MUTUALLY EXCLUSIVE."
PRINT " C) RANDOM VARIABLES."
PRINT " D) STATISTICALLY INDEPENDENT."

ELSEIF RN$ = "W" THEN
PRINT "THE TEST FOR INDEPENDENCE USING A CONTINGENCY TABLE COMPARES ?"
PRINT " A) ROW AND COLUMN TOTALS."
PRINT " B) HIGH AND LOW SAMPLE TOTALS."
PRINT " C) DIFFERENT SAMPLE MEANS."
PRINT " D) OBSERVED AND EXPECTED FREQUENCIES."

ELSEIF RN$ = "V" THEN
PRINT "GOODNESS OF FIT CAN BE DETERMINED BY ALL OF THE FOLLOWING"
PRINT "EXCEPT?"
PRINT " A) CHI-SQUARE GOODNESS OF FIT TEST."
PRINT " B) SIGN TEST."
PRINT " C) CONSTRUCTING A HISTOGRAM."
PRINT " D) GRAPHICAL METHODS."
END IF
END IF

!PROPERTIES OF REGRESSION - KNOWLEDGE
IF RD$ = "AI" THEN
  IF RN$ = "Z" THEN
    PRINT "AUTOCORRELATION IS A MEASURE OF THE DEGREE TO WHICH ?"
    PRINT " A) THE VALUES OF THE INDEPENDENT VARIABLES ARE RELATED."
    PRINT " B) THE VALUES OF THE INDEPENDENT VARIABLES ARE RELATED TO THE"
    PRINT " DEPENDENT VARIABLE."
    PRINT " C) THE VALUES OF THE DEPENDENT VARIABLES ARE RELATED."
    PRINT " D) THE SAMPLE SLOPE ESTIMATES ARE CORRELATED."
  ELSEIF RN$ = "Y" THEN
    PRINT " y = b(0) + b(1)x"
    PRINT " IS WHICH TYPE OF REGRESSION MODEL ?"
    PRINT " A) SIMPLE LINEAR."
    PRINT " B) MULTIPLE LINEAR."
    PRINT " C) POLYNOMIAL."
    PRINT " D) NONE OF THE ABOVE."
  ELSEIF RN$ = "X" THEN
    PRINT " y = b(0) + b(1)x(1) + b(2)x(2) + b(3)x(3)"
    PRINT " IS WHICH TYPE OF REGRESSION MODEL ?"
    PRINT " A) SIMPLE LINEAR."
    PRINT " B) MULTIPLE LINEAR."
    PRINT " C) POLYNOMIAL."
    PRINT " D) NONE OF THE ABOVE."
ELSEIF RN$ = "W" THEN
  PRINT "  y = b(o) + b(1)x(1) + b(2)x(2) + b(3)x(1)x(2) + b(4)x(1)^2"
  PRINT "IS WHICH TYPE OF REGRESSION MODEL?"
  PRINT "  A) SIMPLE LINEAR."
  PRINT "  B) MULTIPLE LINEAR."
  PRINT "  C) POLYNOMIAL."
  PRINT "  D) NONE OF THE ABOVE."

ELSEIF RN$ = "V" THEN
  PRINT "THE COEFFICIENT OF DETERMINATION (R^2) IS THE AMOUNT OF"
  PRINT "VARIABILITY IN Y?"
  PRINT "  A) CAUSED BY ALL THE VARIABLES EXCLUDED FROM THE STUDY."
  PRINT "  B) EXPLAINED BY THE INDEPENDENT VARIABLES."
  PRINT "  C) CAUSED BY THE INDEPENDENT VARIABLES."
  PRINT "  D) EXPLAINED BY ALL THE VARIABLES EXCLUDED FROM THE STUDY."
END IF

END IF

!DESCRIPTIVE AND INFERENTIAL STATISTICS - KNOWLEDGE
IF RD$ = "AJ" THEN
  IF RN$ = "Z" THEN
    PRINT "A PLOT OF THE INDEPENDENT AND DEPENDENT VARIABLES IS CALLED A?"
    PRINT "  A) FREQUENCY HISTOGRAM."
    PRINT "  B) CONTINGENCY TABLE."
    PRINT "  C) SAMPLING DISTRIBUTION."
    PRINT "  D) SCATTER DIAGRAM."
  ELSEIF RN$ = "Y" THEN
    PRINT "WHICH STATEMENT BEST EXPLAINS REGRESSION ANALYSIS?"
PRINT "A) WHEN X AND Y ARE RANDOM VARIABLES."
PRINT "B) WHEN X AND Y ARE PRESET."
PRINT "C) WHEN X IS PRESET AND Y IS A RANDOM VARIABLE."
PRINT "D) WHEN X IS A RANDOM VARIABLE AND Y IS PRESET."
END IF

ELSEIF RN$ = "X" THEN
PRINT "Y = A + BX IS WHICH KIND OF EXPRESSION ?"
PRINT "A) SAMPLE REGRESSION LINE."
PRINT "B) POPULATION DISTRIBUTION FOR THE SAMPLE SLOPE."
PRINT "C) POPULATION REGRESSION LINE."
PRINT "D) SAMPLE CORRELATION COEFFICIENT EQUATION."
END IF

ELSEIF RN$ = "W" THEN
PRINT "IN REGRESSION ANALYSIS THE SAMPLE INTERCEPT IS ?"
PRINT "A) THE VALUE OF Y WHEN X = X(BAR)."
PRINT "B) THE CHANGE IN Y FOR A ONE UNIT CHANGE IN X."
PRINT "C) THE VALUE OF Y WHEN X = 0."
END IF

ELSEIF RN$ = "V" THEN
PRINT "IN REGRESSION ANALYSIS THE SAMPLE SLOPE IS ?"
PRINT "A) THE VALUE OF Y WHEN X = X(BAR)."
PRINT "B) THE CHANGE IN Y FOR A ONE UNIT CHANGE IN X."
PRINT "C) THE VALUE OF Y WHEN X = 0."
END IF

END IF

END
PROGRAM TEXT2 (RS$)

SET CURSOR 1,1
LET RD$ = RS$[1:2]
LET RN$ = RS$[3:3]
LET RG$ = RS$[4:5]

IF RG$ = "GA" THEN
    LET G = 1
ELSEIF RG$ = "GB" THEN
    LET G = 2
ELSEIF RG$ = "GC" THEN
    LET G = 3
ELSEIF RG$ = "GD" THEN
    LET G = 4
ELSEIF RG$ = "GE" THEN
    LET G = 5
ELSEIF RG$ = "GF" THEN
    LET G = 6
ELSEIF RG$ = "GG" THEN
    LET G = 7
ELSEIF RG$ = "GH" THEN
    LET G = 8
ELSEIF RG$ = "GI" THEN
    LET G = 9
ELSEIF RG$ = "GJ" THEN
    LET G = 10
ELSEIF RG$ = "GK" THEN
    LET G = 11
ELSEIF RG$ = "GL" THEN
    LET G = 12
ELSEIF RG$ = "GM" THEN
    LET G = 13
ELSEIF RG$ = "GN" THEN
    LET G = 14
ELSEIF RG$ = "GO" THEN
    LET G = 15
ELSEIF RG$ = "GP" THEN
    LET G = 16
ELSEIF RG$ = "GQ" THEN
    LET G = 17
ELSEIF RG$ = "GR" THEN
    LET G = 18
ELSEIF RG$ = "GS" THEN
    LET G = 19
ELSEIF RG$ = "GT" THEN
    LET G = 20
ELSEIF RG$ = "GU" THEN
    LET G = 21
ELSEIF RG$ = "GV" THEN
LET G = 22
ELSEIF RG$ = "GW" THEN
  LET G = 23
ELSEIF RG$ = "GX" THEN
  LET G = 24
ELSEIF RG$ = "GY" THEN
  LET G = 25
ELSEIF RG$ = "GZ" THEN
  LET G = 26
ELSEIF RG$ = "HA" THEN
  LET G = 27
ELSEIF RG$ = "HB" THEN
  LET G = 28
ELSEIF RG$ = "HC" THEN
  LET G = 29
ELSEIF RG$ = "HD" THEN
  LET G = 30
ELSEIF RG$ = "HE" THEN
  LET G = 31
ELSEIF RG$ = "HF" THEN
  LET G = 32
ELSEIF RG$ = "HG" THEN
  LET G = 33
ELSEIF RG$ = "HH" THEN
  LET G = 34
ELSEIF RG$ = "HI" THEN
  LET G = 35
ELSEIF RG$ = "HJ" THEN
  LET G = 36
ELSEIF RG$ = "HK" THEN
  LET G = 37
ELSEIF RG$ = "HL" THEN
  LET G = 38
ELSEIF RG$ = "HM" THEN
  LET G = 39
ELSEIF RG$ = "HN" THEN
  LET G = 40
ELSEIF RG$ = "HO" THEN
  LET G = 41
ELSEIF RG$ = "HP" THEN
  LET G = 42
ELSEIF RG$ = "HQ" THEN
  LET G = 43
ELSEIF RG$ = "HR" THEN
  LET G = 44
ELSEIF RG$ = "HS" THEN
  LET G = 45
ELSEIF RG$ = "HT" THEN
  LET G = 46
ELSEIF RG$ = "HU" THEN
  LET G = 47
ELSEIF RG$ = "HV" THEN
    LET G = 48
ELSEIF RG$ = "HW" THEN
    LET G = 49
ELSEIF RG$ = "HX" THEN
    LET G = 50
ELSEIF RG$ = "HY" THEN
    LET G = 51
ELSEIF RG$ = "HZ" THEN
    LET G = 52
ELSEIF RG$ = "JA" THEN
    LET G = 53
ELSEIF RG$ = "JB" THEN
    LET G = 54
ELSEIF RG$ = "JC" THEN
    LET G = 55
ELSEIF RG$ = "JD" THEN
    LET G = 56
ELSEIF RG$ = "JE" THEN
    LET G = 57
ELSEIF RG$ = "JF" THEN
    LET G = 58
ELSEIF RG$ = "JG" THEN
    LET G = 59
ELSEIF RG$ = "JH" THEN
    LET G = 60
ELSEIF RG$ = "JJ" THEN
    LET G = 61
ELSEIF RG$ = "JK" THEN
    LET G = 62
ELSEIF RG$ = "JL" THEN
    LET G = 63
ELSEIF RG$ = "JM" THEN
    LET G = 64
ELSEIF RG$ = "JN" THEN
    LET G = 65
ELSE
    END IF

PRINT "QUESTION ":G
PRINT
!DECOMPOSITION AND LEAST SQUARES - KNOWLEDGE
IF RD$ = "AK" THEN
    IF RN$ = "Z" THEN
        PRINT "IN DECOMPOSITION AND LEAST SQUARES ANALYSIS THE SUM OF THE"
        PRINT "VARIATION CAN BE INTERPRETED AS ?"
        PRINT
        PRINT "A) SS(CHANCE) AND SS(UNEXPLAINED)."
PRINT " B) SS(Regression) and SS(Explained)."
PRINT " C) SS(Total) and SS(Unexplained)."
PRINT " D) SS(Explained) and SS(Chance)."

ELSEIF RN$ = "Y" THEN
PRINT "FILL IN THE BLANK: THE BEST FITTING LINE IS THAT LINE THAT"
PRINT "________________ BETWEEN THE DATA POINTS AND THE LINE."
PRINT " A) MINIMIZES THE SUM OF THE DEVIATIONS."
PRINT " B) MINIMIZES THE SUM OF THE ABSOLUTE DEVIATIONS."
PRINT " C) MAXIMIZES THE CLOSENESS."
PRINT " D) MINIMIZES THE SUM OF THE SQUARED DEVIATIONS."

ELSEIF RN$ = "X" THEN
PRINT "THE AMOUNT OF VARIABILITY THAT IS DUE TO THE INDEPENDENT VARIABLE "
PRINT "IS CALLED THE ?"
PRINT " A) SS(Total)."
PRINT " B) SS(Change)."
PRINT " C) SS(Unexplained)."
PRINT " D) SS(Explained)."

ELSEIF RN$ = "W" THEN
PRINT "THE PROCEDURE USED TO FIND THE LINE SO THAT THE SUM OF SQUARES OF "
PRINT "THE RESIDUAL IS AT A MINIMUM IN REGRESSION ANALYSIS IS THE ?"
PRINT " A) METHOD OF LEAST SQUARES."
PRINT " B) SUM OF SQUARES DECOMPOSITION."
PRINT " C) MEAN SQUARE ERROR EQUATION."
PRINT " D) MINIMUM VARIANCE EQUATION."

ELSEIF RN$ = "V" THEN
PRINT "THE FACT THAT THE SS(Total) = SS(Explained) + SS(Unexplained) "
PRINT "IS AN EXAMPLE OF WHICH OF THE FOLLOWING PRINCIPLES:"
PRINT "A) CENTRAL LIMIT THEOREM."
PRINT "B) INDUCTIVE INference."
PRINT "C) DEDUCTIVE INference."
PRINT "D) DECOMPOSITION."
END IF
END IF

!ANOVA - KNOWLEDGE
IF RD$ = "AL" THEN
  IF RN$ = "Z" THEN
    PRINT "WHEN AN EXPERIMENTER WISHES TO DETERMINE IF A VARIANCE RATIO (CALCULATED " F") IS SIGNIFICANT, HE\SHE WOULD PLAN TO CONSTRUCT A ? "
    PRINT " A) CONFIDENCE INTERVAL."
    PRINT " B) HYPOTHESIS TEST."
    PRINT " C) PREDICTION INTERVAL."
    PRINT " D) SAMPLING DISTRIBUTION FOR THE INDEPENDENT VARIABLE."
  ELSEIF RN$ = "Y" THEN
    PRINT "WHEN CONSTRUCTING AN ANOVA TABLE FOR A SIMPLE LINEAR REGRESSION" MODEL THE NUMBER OF DEGREES OF FREEDOM FOR THE ERROR TERM IS ?"
    PRINT " A) 1."
    PRINT " B) 2."
    PRINT " C) N-1."
    PRINT " D) N-2. "
  ELSEIF RN$ = "X" THEN
    PRINT "WHEN CONSTRUCTING AN ANOVA TABLE FOR A SIMPLE LINEAR REGRESSION" MODEL THE NUMBER OF DEGREES OF FREEDOM FOR THE REGRESSION OR "


PRINT "EXPLAINED TERM IS ?"
PRINT " A) 1."
PRINT " B) 2."
PRINT " C) N-1."
PRINT " D) N-2."

ELSEIF RN$ = "W" THEN
PRINT "WHEN YOU WISH TO DEVELOP AN INTERVAL ESTIMATE OF WHAT Y WILL BE FOR A GIVEN VALUE OF X, YOU SHOULD CONSTRUCT A ?"
PRINT " A) SAMPLING DISTRIBUTION FOR X."
PRINT " B) CONFIDENCE INTERVAL."
PRINT " C) PREDICTION INTERVAL."
PRINT " D) CONFIDENCE OF PREDICTION INTERVAL."

ELSEIF RN$ = "V" THEN
PRINT "THE MEAN SQUARE REGRESSION TERM FOR SIMPLE LINEAR REgression IS EQUAL TO ?"
PRINT " A) SSR."
PRINT " B) SSR/2."
PRINT " C) SSE - SST."
PRINT " D) BOTH A AND C. "
END IF
END IF

!SINGLE FACTOR DESIGN - KNOWLEDGE
IF RD$ = "AM" THEN
IF RN$ = "Z" THEN
PRINT "IN ORDER TO CARRY OUT A LATIN SQUARE EXPERIMENTAL DESIGN THE NUMBER OF TREATMENTS ?"
PRINT " A) MUST BE MORE THAN THE NUMBER OF LEVELS."
PRINT " B) MUST BE LESS THAN THE NUMBER OF LEVELS."
PRINT "C) MUST BE THE SAME AS THE NUMBER OF LEVELS."
PRINT "D) HAS NO RELATIONSHIP TO THE NUMBER OF LEVELS."

ELSEIF RN$ = "Y" THEN
PRINT "WHEN ONLY ONE FACTOR IS THOUGHT TO AFFECT THE EXPERIMENTAL RESPONSE, THE BEST DESIGN IS TO SELECT THE ?"
PRINT "A) FACTORIAL DESIGN."
PRINT "B) RANDOMIZED BLOCK DESIGN."
PRINT "C) LATIN SQUARE DESIGN."
PRINT "D) COMPLETELY RANDOM DESIGN."

ELSEIF RN$ = "X" THEN
PRINT "WHEN AN EXTRANEOUS FACTOR IS THOUGHT TO HAVE AN INFLUENCE ON THE EXPERIMENTAL RESPONSE AND WE WISH TO ELIMINATE ITS IMPACT, THE BEST DESIGN IS A ?"
PRINT "A) RANDOMIZED BLOCK DESIGN."
PRINT "B) MULTIFACTOR DESIGN."
PRINT "C) LATIN SQUARE DESIGN."
PRINT "D) EITHER A OR C."

ELSEIF RN$ = "W" THEN
PRINT "THE PURPOSE UNDERLYING RANDOMIZATION IN EXPERIMENTATION IS "
PRINT "MOST CLOSELY RELATED TO WHICH OF THE FOLLOWING STATEMENTS ?"
PRINT "A) A GOOD DESIGN RULES OUT ALTERNATIVE EXPLANATIONS FOR A SIGNIFICANT VARIANCE RATIO."
PRINT "B) A GOOD DESIGN ATTEMPTS TO MINIMIZE CHANCE VARIANCE."
PRINT "C) AN INDUCTIVE INFERENCE IS WHERE YOU PASS FROM SAMPLE OR "
PRINT "SPECIFIC INFORMATION TO A GENERAL CONCLUSION."
D) THE DECOMPOSITION PRINCIPLE IS THE BASIS FOR THE ANOVA.

ELSEIF RN$ = "V" THEN
PRINT "A RATIONALE FOR SELECTING THE RANDOMIZED BLOCK DESIGN IS MOST"
PRINT "CLOSELY RELATED TO WHICH OF THE FOLLOWING?"
PRINT "A) A GOOD DESIGN RULES OUT ALTERNATIVE EXPLANATIONS FOR A"
PRINT "SIGNIFICANT VARIANCE RATIO."
PRINT "B) A GOOD DESIGN ATTEMPTS TO MINIMIZE CHANCE VARIANCE."
PRINT "C) AN INDUCTIVE INFERENCE IS WHERE YOU PASS FROM SAMPLE OR"
PRINT "SPECIFIC INFORMATION TO A GENERAL CONCLUSION."
PRINT "D) THE DECOMPOSITION PRINCIPLE IS THE BASIS FOR THE ANOVA."
END IF
END IF

MULTIFACTOR DESIGN - KNOWLEDGE
IF RD$ = "AN" THEN
IF RN$ = "Z" THEN
PRINT "IF YOUR HYPOTHESIS FOR A FACTORIAL DESIGN DOES NOT PREDICT AN"
PRINT "INTERACTION, BUT YOU DISCOVER AN INTERACTION AFTER RUNNING THE"
PRINT "EXPERIMENT, WHICH IS NOT A METHOD TO CORRECTLY INTERPRETING THE"
PRINT "INFORMATION?"
PRINT "A) ORTHOGONAL CONSTRAINTS."
PRINT "B) NEWMAN-KEULS TEST."
PRINT "C) GRAPHING RESULTS."
PRINT "D) SCHEFFE'S TEST."
ELSEIF RN$ = "Y" THEN
PRINT "WHICH OF THE FOLLOWING IS NOT AN ADVANTAGE OF FACTORIAL DESIGN?"
PRINT "A) WITH ONE OBSERVATION PER CELL THE
INTERACTION AND ERROR TERMS ARE
PRINT "DISTINGUISHABLE (NOT CONFOUNDED)."
PRINT "B) WITH ONE OBSERVATION PER CELL ANY
INTERACTION CAN BE DETECTED."
PRINT "C) BOTH EFFECTS ARE COMPUTED USING ALL OF THE
DATA."
PRINT "D) IT IS VERY EFFICIENT."
ELSEIF RN$ = "X" THEN
PRINT "A FACTORIAL EXPERIMENT WITH ONE OBSERVATION PER
CELL RESEMBLES"
PRINT "WHICH OF THE FOLLOWING EXPERIMENTAL DESIGNS ?"
PRINT "A) COMPLETELY RANDOM."
PRINT "B) RANDOM BLOCK."
PRINT "C) MATCHED PAIR."
PRINT "D) LATIN SQUARE."
ELSEIF RN$ = "W" THEN
PRINT "WHEN IN A FACTORIAL EXPERIMENT THE MEAN RESPONSE
IN A CELL"
PRINT "CANNOT BE PREDICTED BY THE RESPONSES IN THE
OTHER CELLS, THIS"
PRINT "SUGGESTS THAT ?"
PRINT "A) THE SUM OF SQUARES ERROR WILL BE LARGE."
PRINT "B) THERE IS AN INTERACTION EFFECT PRESENT."
PRINT "C) ONE OF THE MAIN EFFECTS IS SIGNIFICANT."
PRINT "D) THE WRONG DESIGN WAS SELECTED."
ELSEIF RN$ = "V" THEN
PRINT "WHEN AN INTERACTION EFFECT IS THOUGHT TO EXIST
THE"
PRINT "APPROPRIATE EXPERIMENTAL DESIGN IS A ?"
PRINT "A) COMPLETELY RANDOM DESIGN."
PRINT "B) MATCHED PAIR DESIGN."
PRINT "C) FACTORIAL DESIGN."
PRINT "D) RANDOMIZED BLOCK DESIGN."
END IF
END IF

!SUM OF SQUARES DECOMPOSITION - KNOWLEDGE
IF RD$ = "AO" THEN
  IF RN$ = "Z" THEN
    PRINT "WHAT IS MEAN BY SUM OF SQUARES ?"
    PRINT
    PRINT "A) DEVIATIONS OF SAMPLE MEANS FROM THEIR POPULATION MEAN."
    PRINT
    PRINT "B) DEVIATIONS OF SAMPLE MEANS FROM OTHER SAMPLE MEANS."
    PRINT
    PRINT "C) DEVIATIONS OF SAMPLE VALUES FROM THEIR SAMPLE MEAN."
    PRINT
    PRINT "D) DEVIATIONS OF SAMPLE VALUES FROM THEIR POPULATION MEAN."
  ELSEIF RN$ = "Y" THEN
    PRINT "FOR A ONE-WAY ANOVA THE SUM OF SQUARES (ERROR) IS FOUND BY ?"
    PRINT
    PRINT "A) SUM OF SQUARES (BETWEEN TREATMENTS) MINUS SUM OF SQUARES"
    PRINT "(TOTAL)."
    PRINT
    PRINT "B) SUM OF SQUARES (WITHIN TREATMENTS) MINUS SUM OF SQUARES"
    PRINT "(TOTAL)."
    PRINT
    PRINT "C) SUM OF SQUARES (TOTAL) MINUS SUM OF SQUARES (WITHIN"
    PRINT "TREATMENTS)."
    PRINT
    PRINT "D) SUM OF SQUARES (TOTAL) MINUS SUM OF SQUARES (BETWEEN "
    PRINT "TREATMENTS)."
  ELSEIF RN$ = "X" THEN
    PRINT "THE SUM OF SQUARES BETWEEN TREATMENTS IS ?"
    PRINT
    PRINT "A) THE VARIABILITY IN THE RESPONSES DUE TO ALL OTHER FACTORS NOT"
    PRINT "BEING CONTROLLED IN THE EXPERIMENT."
    PRINT
    PRINT "B) THE VARIABILITY IN THE RESPONSES DUE TO THE
FACTOR THAT IS"
PRINT "BEING INVESTIGATED."
PRINT
PRINT " C) THE VARIABILITY FROM ALL POSSIBLE SOURCES
OF VARIATION."

ELSEIF RN$ = "W" THEN
PRINT "THE SUM OF SQUARES WITHIN TREATMENTS IS DUE TO ?"
PRINT
PRINT " A) THE VARIABILITY FROM ALL POSSIBLE SOURCES OF
VARIATION."
PRINT
PRINT " B) THE VARIABILITY IN THE RESPONSES DUE TO ALL
OTHER FACTORS NOT"
PRINT "BEING CONTROLLED IN THE EXPERIMENT."
PRINT
PRINT " C) THE VARIABILITY IN THE RESPONSES DUE TO THE
FACTOR THAT IS"
PRINT "BEING INVESTIGATED."

ELSEIF RN$ = "V" THEN
PRINT "$S(BETWEEN) + SS(WITHIN) = SS(TOTAL) IS MOST
CLOSELY RELATED"
PRINT "TO WHICH OF THE FOLLOWING STATEMENTS ?"
PRINT
PRINT " A) A GOOD DESIGN RULES OUT ALTERNATIVE
EXPLANATIONS FOR A"
PRINT "SIGNIFICANT VARIANCE RATIO."
PRINT
PRINT " B) A GOOD DESIGN ATTEMPTS TO MINIMIZE CHANCE
VARIANCE."
PRINT
PRINT " C) AN INDUCTIVE INFERENCE IS WHERE YOU PASS FROM
SAMPLE OR"
PRINT "SPECIFIC INFORMATION TO A GENERAL CONCLUSION."
PRINT
PRINT " D) THE DECOMPOSITION PRINCIPLE IS THE BASIS FOR
THE ANOVA."

END IF
END IF

!ANOVA - KNOWLEDGE
IF RD$ = "AP" THEN
IF RN$ = "Z" THEN
PRINT "WHEN USING AN ANOVA TABLE THE REJECTION REGION
IS USUALLY THE ?"
PRINT
PRINT " A) LOWER TAIL OF THE CHI-SQUARE DISTRIBUTION."
PRINT
PRINT " B) UPPER TAIL OF THE CHI-SQUARE DISTRIBUTION."
PRINT "C) LOWER TAIL OF THE F DISTRIBUTION."
PRINT "D) UPPER TAIL OF THE F DISTRIBUTION."

ELSEIF RN$ = "Y" THEN
PRINT "WHICH OF THE FOLLOWING IS NOT AN ASSUMPTION
TO BE MADE REGARDING"
PRINT "ANOVA TECHNIQUES?"
PRINT "A) THE PROCESS IS REPEATABLE."
PRINT "B) THE ERROR VARIANCE WITHIN ALL LEVELS OF
THE FACTOR ARE "
PRINT "HOMOGENEOUS."
PRINT "C) EACH CELL MUST HAVE AT LEAST ONE VALUE."
PRINT "D) THE POPULATION BEING SAMPLED IS NORMAL."

ELSEIF RN$ = "X" THEN
PRINT "OTHER THINGS BEING EQUAL, IF THE VARIATION IN
THE RESPONSES "
PRINT "UNDER EACH TREATMENT IS REDUCED?"
PRINT "A) THE VARIANCE RATIO (CALCULATED F) WILL BE
LARGER."
PRINT "B) THE VARIANCE RATIO (CALCULATED F) WILL BE
SMALLER."
PRINT "C) THE VARIANCE RATIO (CALCULATED F) WILL NOT
BE AFFECTED."
PRINT "D) THE VARIANCE RATIO (CALCULATED F) MAY BE
LARGER OR"
PRINT "SMALLER."

ELSEIF RN$ = "W" THEN
PRINT "IN THE ANOVA, WE DRAW AN INDUCTIVE INFEERENCE
WHEN WE?"
PRINT "A) DECIDE ON THE MAXIMUM PROBABILITY OF MAKING
A TYPE I ERROR."
PRINT "B) DECOMPOSE THE SUM OF SQUARES TOTAL."
PRINT "C) COMPUTE THE VARIANCE RATIO."
D) COMPARE THE VARIANCE RATIO TO THE TABLED F-VALUE.

ELSEIF RN$ = "V" THEN
PRINT "ASSUMING THAT THE NULL HYPOTHESIS THAT ALL THE POPULATION MEANS ARE EQUAL IS CORRECT, TAKE REPEATED SAMPLES FROM THE POPULATION AND COMPUTE THE VARIANCE RATIO. IF WE PLOT THE DISTRIBUTION OF THESE VARIANCE RATIOS THE DISTRIBUTION WOULD BE ?"
PRINT " A) T-DISTRIBUTED."
PRINT " B) Z-DISTRIBUTED."
PRINT " C) F-DISTRIBUTED."
PRINT " D) BINOMIALLY DISTRIBUTED."
END IF
END IF

! PROPERTIES OF ESTIMATORS - COMPREHENSION
IF RD$ = "BA" THEN
ELSEIF RN$ = "Z" THEN
PRINT "WHICH OF THE FOLLOWING IS USUALLY THE MINIMUM VARIANCE UNBIASED ESTIMATOR OF \( \mu \) FOR THE NORMAL DISTRIBUTION WHERE THE VARIANCE IS KNOWN ?"
PRINT " A) MEAN."
PRINT " B) A SINGLE OBSERVATION \( X_i \) , FROM A SAMPLE \( X , X , ... , X \)."
PRINT " C) MEDIAN."
PRINT " D) MODE."
END IF
PRINT " C) A LARGE SAMPLE SIZE."
PRINT " D) THAT IT BE UNBIASED."

ELSEIF RN$ = "X" THEN
PRINT "A BIASED ESTIMATOR IS PREFERABLE TO AN UNBIASED ONE WHEN THE ?"
PRINT " A) SAMPLE SIZE IS LARGE ( N > 30 )."
PRINT " B) MEAN SQUARE ERROR OF THE BIASED ESTIMATOR IS LESS THAN THE "
PRINT " MEAN SQUARE ERROR OF THE UNBIASED ESTIMATOR."
PRINT " C) VARIANCE OF THE BIASED ESTIMATOR IS LARGE."
PRINT " D) VARIANCE OF THE UNBIASED ESTIMATOR IS LARGE."

ELSEIF RN$ = "W" THEN
PRINT "FOR A BIASED ESTIMATOR THE MEAN SQUARE ERROR IS COMPOSED OF THE ?"
PRINT " A) VARIANCE OF THE ESTIMATOR."
PRINT " B) VARIANCE PLUS THE BIAS OF THE ESTIMATOR."
PRINT " C) VARIANCE PLUS THE SQUARED BIAS OF THE ESTIMATOR."
PRINT " D) BIAS OF THE ESTIMATOR."

ELSEIF RN$ = "V" THEN
PRINT "YOU ARE GIVEN THAT THE VARIANCE OF A POINT ESTIMATOR IS 8 AND ITS"
PRINT "BIAS IS 4. WHAT IS THE MEAN SQUARE ERROR OF THE ESTIMATOR ?"
PRINT " A) 2."
PRINT " B) 12."
PRINT " C) 24."
PRINT " D) 32."
END IF
END IF
CONFIDENCE INTERVALS - COMPREHENSION

IF RD$ = "BB" THEN
  IF RN$ = "Z" THEN
    PRINT "CONVERTING A 90 PERCENT CONFIDENCE INTERVAL TO A 95 PERCENT"
    PRINT "CONFIDENCE INTERVAL ?"
    PRINT " A) DECREASES THE LENGTH OF THE INTERVAL."
    PRINT " B) INCREASES THE LENGTH OF THE INTERVAL."
    PRINT " C) HAS NO EFFECT ON THE LENGTH OF THE INTERVAL."
    PRINT " D) NEITHER DECREASES OR INCREASES THE LENGTH OF THE INTERVAL."
  ELSEIF RN$ = "Y" THEN
    PRINT "INTERPRET THE FOLLOWING 90% CONFIDENCE INTERVAL FOR THE MEAN"
    PRINT " ( 200 HOURS, 220 HOURS )"
    PRINT " A) WE ARE 90% CONFIDENT THAT ANY SAMPLE MEAN BASED UPON"
    PRINT "OBSERVATIONS FROM THE POPULATION WILL LIE BETWEEN 200 HOURS AND"
    PRINT "220 HOURS."
    PRINT " B) WE ARE 90% CONFIDENT THAT THE POPULATION MEAN WILL EQUAL 210"
    PRINT "HOURS - THE MIDPOINT OF THE INTERVAL."
    PRINT " C) WE ARE 90% CONFIDENT THAT THE POPULATION MEAN WILL LIE"
    PRINT "BETWEEN 200 HOURS AND 220 HOURS."
  ELSEIF RN$ = "X" THEN
    PRINT "WE HAVE CONSTRUCTED A 95% CONFIDENCE INTERVAL FOR THE MEAN"
    PRINT "INCOME FOR A NEIGHBORHOOD. THE CONFIDENCE INTERVAL IS ( $7020, "
    PRINT "$7170 ). IN ORDER TO BE ELIGIBLE FOR GOVERNMENT AID, A "
    PRINT "NEIGHBORHOOD MUST HAVE AN AVERAGE INCOME OF $7000 OR LESS. BASED"
    PRINT "UPON THE CONFIDENCE INTERVAL WE CAN CONCLUDE THAT THE "
    PRINT "NEIGHBORHOOD IS ?"
PRINT "A) DEFINITELY NOT ELIGIBLE FOR AID."
PRINT "B) PROBABLY NOT ELIGIBLE FOR AID."
PRINT "C) PROBABLY ELIGIBLE FOR AID."
PRINT "D) DEFINITELY ELIGIBLE FOR AID."

ELSEIF RN$ = "W" THEN
PRINT "THERE ARE TWO WAYS TO REDUCE THE WIDTH OF A CONFIDENCE INTERVAL. THESE ARE?"
PRINT "A) INCREASE THE SAMPLE SIZE: INCREASE THE DEGREE OF CONFIDENCE."
PRINT "B) DECREASE THE SAMPLE SIZE; INCREASE THE DEGREE OF CONFIDENCE."
PRINT "C) INCREASE THE SAMPLE SIZE; DECREASE THE DEGREE OF CONFIDENCE."
PRINT "D) DECREASE THE SAMPLE SIZE; DECREASE THE DEGREE OF CONFIDENCE."

ELSEIF RN$ = "V" THEN
PRINT "WHEN THE T-DISTRIBUTION IS USED TO CONSTRUCT A CONFIDENCE INTERVAL, THE WIDTH OF THE INTERVAL WILL BE?"
PRINT "A) THE SAME AS WHEN THE Z-TABLE IS USED."
PRINT "B) SMALLER THAN WHEN THE Z-TABLE IS USED."
PRINT "C) LARGER THAN WHEN THE Z-TABLE IS USED."
END IF
END IF

!PROPERTIES OF HYPOTHESIS TESTING - COMPREHENSION
IF RD$ = "BC" THEN
IF RN$ = "Z" THEN
PRINT "YOU ARE TESTING A NEW BRAKE SYSTEM (NBS) AND WILL SWITCH TO"
PRINT "IT IF IT STOPS A CAR GOING 35 MILES PER HOUR IN LESS THE 65 FEET."
PRINT "THE H(O), H(A) ARE POP. MEAN (NBS) >= 65 FEET, POP. MEAN < 65"
PRINT "FEET. IN ENGLISH , THE TYPE I ERROR WOULD BE MADE IF YOU?"
ELSEIF RN$ = "Y" THEN
PRINT "IN A JURY TRIAL IN THE UNITED STATES, THE NULL HYPOTHESIS "
PRINT "THAT THE JURY OPERATES UNDER IS THE INDIVIDUAL "
PRINT 
PRINT " A) MAY BE GUILTY." 
PRINT 
PRINT " B) IS INNOCENT." 
PRINT 
PRINT " C) MAY BE INNOCENT." 
PRINT 
PRINT " D) IS GUILTY." 
ELSEIF RN$ = "X" THEN
PRINT "THE CONCEPT OF A REJECTION VALUE IS TO THE HYPOTHESIS TESTING "
PRINT "FRAMEWORK AS WHICH ONE OF THE FOLLOWING PRINCIPLES IS TO THE "
PRINT "SCIENTIFIC METHOD ? "
PRINT 
PRINT " A) DEVELOP HYPOTHESES BEFORE COLLECTING DATA." 
PRINT 
PRINT " B) DIFFERENTIATE FACTS FROM VALUES FROM OPINIONS." 
PRINT 
PRINT " C) CHOOSE THE HYPOTHESIS THAT HAS THE PREPONDERANCE OF EVIDENCE." 
PRINT 
PRINT " D) RUN CONTROLLED EXPERIMENTATION WHENEVER POSSIBLE TO TEST " 
PRINT " HYPOTHESES." 
ELSEIF RN$ = "W" THEN
PRINT " H(0): POP. MEAN ( = $200 " 
PRINT " H(A): POP. MEAN > $200 __"
MAXIMUM ACCEPTABLE RISK OF A TYPE I ERROR IS 0.01. SUPPOSE $X = $201.6. WHAT IS THE PROBABILITY OF NOW MAKING A TYPE I ERROR?

A) 0.01.
B) CANNOT COMPUTE WITHOUT ADDITIONAL INFORMATION.
C) ZERO.
D) 0.99.

ELSEIF RN$ = "V" THEN
PRINT "H(0): POP. MEAN (NEW BRAKE SYSTEM) $\leq 65 FEET"
PRINT "H(A): POP. MEAN (NEW BRAKE SYSTEM) $\geq 65 FEET"
PRINT "P(\alpha) = 0.05, N = 36, POP. VARIANCE = 144 FEET."
PRINT "SET UP THE REJECTION VALUE FOR THIS PROBLEM?"
PRINT "A) REJECTION VALUE = 65 - 1.645 \times 2."
PRINT "B) REJECTION VALUE = 65 - 1.96 \times 2."
PRINT "C) REJECTION VALUE = 65 + 1.645 \times 2."
PRINT "D) REJECTION VALUE = 65 + 1.96 \times 2."
END IF

!HYPOTHESIS TESTING (MEANS) - COMPREHENSION
IF RD$ = "BD" THEN
IF RN$ = "Z" THEN
PRINT "IN DEVELOPING THE REJECTION REGION VALUES FOR THE FOLLOWING"
PRINT "HYPOTHESIS, SUPPOSE YOU NEED TO USE THE Z-DISTRIBUTION"
PRINT "H(0): POP. MEAN = 100"
PRINT "H(A): POP. MEAN $\neq 100"
PRINT "\alpha = 0.05, N = 10"
PRINT "WHAT IS THE CORRECT Z DISTRIBUTION VALUE?"
PRINT "A) Z = 1.645."
PRINT "B) Z = 1.96."
PRINT " C) Z = 2.228."
PRINT
PRINT " D) Z = 2.262."

ELSEIF RN$ = "Y" THEN
PRINT "THE PRESENT MACHINERY PRODUCES 140 UNITS PER HOUR. IN ORDER"
PRINT "TO JUSTIFY THE NEW MACHINERY IT MUST PRODUCE MORE THAN 150 UNITS"
PRINT "PER HOUR. THE PROPER NULL AND ALTERNATIVE HYPOTHESES ARE: ?"
PRINT
PRINT " A) H(0): POP. MEAN \leq 140 H(A): POP. MEAN \geq 140."
PRINT
PRINT " B) H(0): POP. MEAN \geq 150 H(A): POP. MEAN \leq 150."
PRINT
PRINT " C) H(0): POP. MEAN \leq 150 H(A): POP. MEAN \geq 150."
PRINT
PRINT " D) H(0): POP. MEAN \leq 140 H(A): POP. MEAN \geq 140."

ELSEIF RN$ = "X" THEN
PRINT "SUPPOSE WE HAVE A POPULATION WITH MEAN = 1000. WE TAKE ONE"
PRINT "SAMPLE OF SIZE 1 FROM THIS POPULATION. THEN WE TAKE ONE SAMPLE"
PRINT "OF SIZE 50 FROM THIS POPULATION. THE LATTER'S MEAN WILL PROBABLY"
PRINT "FALL CLOSER TO 1000 THAN THE FORMER SAMPLE OF SIZE ONE. THIS"
PRINT "DEMONSTRATES WHICH OF THE FOLLOWING PRINCIPLES?: ?"
PRINT
PRINT " A) CENTRAL LIMIT THEOREM."
PRINT
PRINT " B) MEAN OF POPULATION DISTRIBUTION AND SAMPLING DISTRIBUTION ARE"
PRINT " THE SAME."
PRINT
PRINT " C) VARIANCE OF SAMPLING DISTRIBUTION IS MUCH LESS THAN VARIANCE"
PRINT " OF THE POPULATION."
PRINT
PRINT " D) INDUCTIVE INFERENCE."

ELSEIF RN$ = "W" THEN
PRINT "SUPPOSE THAT YOU WANT TO DECIDE WHICH OF TWO EQUALLY PRICED LIGHT"
PRINT "BULBS LASTS LONGER. YOU CHOOSE A RANDOM SAMPLE OF 100 LIGHT 
PRINT "BULBS OF EACH BRAND AND FIND THAT BRAND A HAS A SAMPLE MEAN OF"
PRINT "1180 HOURS AND SAMPLE STANDARD DEVIATION OF 120 HOURS, AND THAT"
PRINT "BRAND B HAS SAMPLE MEAN OF 1160 HOURS AND SAMPLE STANDARD "
PRINT "DEVIATION OF 40 HOURS. THE PROPER NULL AND ALTERNATIVE 
PRINT "HYPOTHESES WOULD BE ?"
PRINT " A) H(0):POP.MEAN(A)=POP.MEAN(B); H(A):POP.MEAN(A)<>POP.MEAN(B)."
PRINT " B) H(0):POP.MEAN(A)=POP.MEAN(B); H(A):POP.MEAN(A)>POP.MEAN(B)."
PRINT " C) H(0):POP.MEAN(A)=POP.MEAN(B); H(A):POP.MEAN(A)<POP.MEAN(B)."
PRINT " D) H(0):POP.MEAN(A)= 1180; H(A):POP.MEAN(A)> 1180."

ELSEIF RN$ = "V" THEN
PRINT "PAST EXPERIENCE HAS SHOWN THAT THE SCORES OF STUDENTS WHO TAKE A"
PRINT "CERTAIN MATHEMATICS TEST ARE NORMALLY DISTRIBUTED WITH MEAN 75 
PRINT "AND VARIANCE 36. THE MATH DEPARTMENT WISHES TO DETERMINE IF THIS"
PRINT "YEARS GROUP OF STUDENTS IS TYPICAL. THEIR MEAN SCORE IS 82. THE "
PRINT "PROPER NULL AND ALTERNATIVE HYPOTHESES WOULD BE ?"
PRINT " A) H(0): POP. MEAN = 75 H(A): POP. MEAN > 75."
PRINT " B) H(0): POP. MEAN = 75 H(A): POP. MEAN < 75."
PRINT " C) H(0): POP. MEAN = 75 H(A): POP. MEAN <> 75."
PRINT " D) H(0): POP. MEAN = 82 H(A): POP. MEAN > 82."
END IF
END IF
END
PROGRAM TEXT3 (RS$)

SET CURSOR 1,1
LET RD$ = RS$[1:2]
LET RN$ = RS$[3:3]
LET RG$ = RS$[4:5]

IF RG$ = "GA" THEN
   LET G = 1
ELSEIF RG$ = "GB" THEN
   LET G = 2
ELSEIF RG$ = "GC" THEN
   LET G = 3
ELSEIF RG$ = "GD" THEN
   LET G = 4
ELSEIF RG$ = "GE" THEN
   LET G = 5
ELSEIF RG$ = "GF" THEN
   LET G = 6
ELSEIF RG$ = "GG" THEN
   LET G = 7
ELSEIF RG$ = "GH" THEN
   LET G = 8
ELSEIF RG$ = "GI" THEN
   LET G = 9
ELSEIF RG$ = "GJ" THEN
   LET G = 10
ELSEIF RG$ = "GK" THEN
   LET G = 11
ELSEIF RG$ = "GL" THEN
   LET G = 12
ELSEIF RG$ = "GM" THEN
   LET G = 13
ELSEIF RG$ = "GN" THEN
   LET G = 14
ELSEIF RG$ = "GO" THEN
   LET G = 15
ELSEIF RG$ = "GP" THEN
   LET G = 16
ELSEIF RG$ = "GQ" THEN
   LET G = 17
ELSEIF RG$ = "GR" THEN
   LET G = 18
ELSEIF RG$ = "GS" THEN
   LET G = 19
ELSEIF RG$ = "GT" THEN
   LET G = 20
ELSEIF RG$ = "GU" THEN
   LET G = 21
ELSEIF RG$ = "GV" THEN


LET G = 22
ELSEIF RG$ = "GW" THEN
  LET G = 23
ELSEIF RG$ = "GX" THEN
  LET G = 24
ELSEIF RG$ = "GY" THEN
  LET G = 25
ELSEIF RG$ = "GZ" THEN
  LET G = 26
ELSEIF RG$ = "HA" THEN
  LET G = 27
ELSEIF RG$ = "HB" THEN
  LET G = 28
ELSEIF RG$ = "HC" THEN
  LET G = 29
ELSEIF RG$ = "HD" THEN
  LET G = 30
ELSEIF RG$ = "HE" THEN
  LET G = 31
ELSEIF RG$ = "HF" THEN
  LET G = 32
ELSEIF RG$ = "HG" THEN
  LET G = 33
ELSEIF RG$ = "HH" THEN
  LET G = 34
ELSEIF RG$ = "HI" THEN
  LET G = 35
ELSEIF RG$ = "HJ" THEN
  LET G = 36
ELSEIF RG$ = "HK" THEN
  LET G = 37
ELSEIF RG$ = "HL" THEN
  LET G = 38
ELSEIF RG$ = "HM" THEN
  LET G = 39
ELSEIF RG$ = "HN" THEN
  LET G = 40
ELSEIF RG$ = "HO" THEN
  LET G = 41
ELSEIF RG$ = "HP" THEN
  LET G = 42
ELSEIF RG$ = "HQ" THEN
  LET G = 43
ELSEIF RG$ = "HR" THEN
  LET G = 44
ELSEIF RG$ = "HS" THEN
  LET G = 45
ELSEIF RG$ = "HT" THEN
  LET G = 46
ELSEIF RG$ = "HU" THEN
  LET G = 47
ELSEIF RG$ = "HV" THEN
  LET G = 48
ELSEIF RG$ = "HW" THEN
  LET G = 49
ELSEIF RG$ = "HX" THEN
  LET G = 50
ELSEIF RG$ = "HY" THEN
  LET G = 51
ELSEIF RG$ = "HZ" THEN
  LET G = 52
ELSEIF RG$ = "JA" THEN
  LET G = 53
ELSEIF RG$ = "JB" THEN
  LET G = 54
ELSEIF RG$ = "JC" THEN
  LET G = 55
ELSEIF RG$ = "JD" THEN
  LET G = 56
ELSEIF RG$ = "JE" THEN
  LET G = 57
ELSEIF RG$ = "JF" THEN
  LET G = 58
ELSEIF RG$ = "JG" THEN
  LET G = 59
ELSEIF RG$ = "JH" THEN
  LET G = 60
ELSEIF RG$ = "JJ" THEN
  LET G = 61
ELSEIF RG$ = "JK" THEN
  LET G = 62
ELSEIF RG$ = "JL" THEN
  LET G = 63
ELSEIF RG$ = "JM" THEN
  LET G = 64
ELSEIF RG$ = "JN" THEN
  LET G = 65
ELSE
END IF

PRINT "QUESTION ";G

PRINT
!HYPOTHESIS TESTING (VARIANCES) - COMPREHENSION
IF RD$ = "BE" THEN
  IF RN$ = "Z" THEN
    PRINT "LET D BE THE DIFFERENCE IN TWO SAMPLE MEANS."
    PRINT "THE VARIANCE OF"
    PRINT "THE SAMPLING DISTRIBUTION OF D IS ?"
  PRINT
PRINT " A) POP. VARIANCE(1) + POP. VARIANCE(2)."
PRINT " B) (POP. VARIANCE(1)/N1) - (POP. VARIANCE(2)/N2)."
PRINT " C) (POP. VARIANCE(1)/N1) + (POP. VARIANCE(2)/N2)."
PRINT " D) POP. VARIANCE(1) - POP. VARIANCE(2)."

ELSEIF RN$ = "Y" THEN
PRINT "WHEN PERFORMING A HYPOTHESIS TESTS ON THE VARIANCE OF A NORMAL "
PRINT "DISTRIBUTION THE CHI-SQUARE STATISTIC IS CALCULATED USING ALL OF"
PRINT "THE FOLLOWING PARAMETERS EXCEPT ?"
PRINT " A) HYPOTHESIZED POPULATION VARIANCE."
PRINT " B) SAMPLE VARIANCE."
PRINT " C) SAMPLE MEAN."
PRINT " D) SAMPLE SIZE."

ELSEIF RN$ = "X" THEN
PRINT "THE MAKERS OF A CERTAIN BRAND OF CAR MUFFLER CLAIM THAT THE LIFE"
PRINT "OF THE MUFFLER HAS A VARIANCE OF 0.8 YEARS. A RANDOM SAMPLE OF "
PRINT "16 MUFFLERS HAD A MEAN LIFE OF 10 YEARS WITH A VARIANCE OF 1 "
PRINT "YEAR. WHAT WOULD BE THE NULL AND ALTERNATIVE HYPOTHESES FOR THE"
PRINT "TEST TO DETERMINE IF THE MUFFLER MANUFACTURER COULD PROVE THAT "
PRINT "THE VARIANCE DOES NOT EXCEED HIS CLAIM ?"
PRINT " A) H(0): POP. VARIANCE >= 1
H(A): POP. VARIANCE < 1"
PRINT " B) H(0): POP. VARIANCE <= 1
H(A): POP. VARIANCE > 1 "
PRINT " C) H(0): POP. VARIANCE >= 0.8
H(A): POP. VARIANCE < 0.8"
PRINT " D) H(0): POP. VARIANCE <= 0.8
H(A): POP. VARIANCE > 0.8 "
ELSEIF RN$ = "W" THEN
   PRINT "WHEN CONSTRUCTING A HYPOTHESIS TEST ON THE
   VARIANCES OF TWO"
   PRINT "NORMAL DISTRIBUTIONS, THE DEGREES OF FREEDOM
   ASSOCIATED WITH THE"
   PRINT "TEST STATISTIC IS ?"
   PRINT "(NOTE N1 AND N2 ARE THE FIRST AND SECOND SAMPLE
   SIZES,"
   PRINT "RESPECTIVELY)"
   PRINT " A) N1 + N2 - 1." 
   PRINT " B) N1 - 1, N2 - 1 (N1 <> N2). "
   PRINT " C) N1 - 1."
   PRINT " D) N2 - 1, N1 - 1 (N1 <> N2)."

ELSEIF RN$ = "V" THEN
   PRINT "WHEN CONSTRUCTING A HYPOTHESIS TEST ON THE
   VARIANCES OF TWO "
   PRINT "NORMAL DISTRIBUTIONS THE TEST STATISTIC, F, IS
   CALCULATED BY ?"
   PRINT "(NOTE S1 AND S2 ARE THE FIRST AND SECOND SAMPLE
   VARIANCES,"
   PRINT "RESPECTIVELY)"
   PRINT " A) S1^2 + S2^2 ."
   PRINT " B) S1^2 - S2^2 ." 
   PRINT " C) S1^2 X S2^2 ."
   PRINT " D) S1^2 / S2^2 ."
END IF
END IF

!GOODNESS OF FIT/ INDEPENDENCE - COMPREHENSION
IF RD$ = "BF" THEN
   IF RN$ = "Z" THEN
      PRINT "USING THE CHI-SQUARE GOODNESS OF FIT TEST WE
      ARE TRYING TO DETERMINE"
      PRINT "IF A SAMPLE DISTRIBUTION IS POISSON. THE RESULTS
      ARE"
      PRINT " X 0 1 2 3 4 5"
      PRINT "OR MORE"
      PRINT "OBSERVED 107 64 25 3 1 0"
PRINT "EXPECTED 109 66 20 4 1 0"
PRINT "WE CAN CONCLUDE THAT?"
PRINT " A) DEFINITELY POISSON."
PRINT " B) QUITE LIKELY POISSON."
PRINT " C) MOST LIKELY NOT POISSON."
PRINT " D) DEFINITELY NOT POISSON."

ELSEIF RN$ = "Y" THEN
PRINT "WE ARE INTERESTED IN APPLYING THE CHI-SQUARE GOODNESS OF FIT TEST TO"
PRINT "A SAMPLE TO DETERMINE IF THE DATA IS NORMAL AND HAS MEAN EQUAL TO"
PRINT "100. THE TEST STATISTIC FALLS IN THE REJECTION REGION."
PRINT "WE CAN CONCLUDE THAT?"
PRINT " A) THE MEAN IS NOT 100 OR THE DISTRIBUTION IS NOT NORMAL."
PRINT " B) THE MEAN IS NOT 100."
PRINT " C) THE DISTRIBUTION IS NOT NORMAL."
PRINT " D) FURTHER TESTING IS REQUIRED BEFORE ANY DECISIONS CAN BE MADE."

ELSEIF RN$ = "X" THEN
PRINT "IN CONSTRUCTING A CONTINGENCY TABLE TO DETERMINE INDEPENDENCE THE "
PRINT "DEGREES OF FREEDOM IS DETERMINED BY?"
PRINT " A) THE TOTAL NUMBER INVOLVED IN THE RANDOM SAMPLE MINUS THE NUMBER"
PRINT " OF ESTIMATED PARAMETERS."
PRINT " B) THE TOTAL NUMBER INVOLVED IN THE RANDOM SAMPLE MINUS ONE."
PRINT " C) THE NUMBER OF ROWS MINUS ONE, TIMES THE NUMBER OF COLUMNS MINUS"
PRINT " ONE."
PRINT " D) THE NUMBER OF ROWS MINUS ONE, PLUS THE NUMBER OF COLUMNS MINUS"
PRINT " ONE."

ELSEIF RN$ = "W" THEN
AFTER CARRYING OUT THE CHI-SQUARE GOODNESS OF
FIT TEST TO DETERMINE
IF A DISTRIBUTION IS NORMAL, WE CALCULATE THE
CHI-SQUARE TEST
STATISTIC TO BE 10.04 WHILE THE CORRESPONDING
VALUE FROM THE TABLE IS 9.21. WE CAN CONCLUDE THAT THE DISTRIBUTION IS ?
A) DEFINITELY NORMAL.
B) QUITE LIKELY NORMAL.
C) PROBABLY NOT NORMAL.
D) DEFINITELY NOT NORMAL.

ELSEIF RN$ = "V" THEN
WHEN CONDUCTING A TEST FOR INDEPENDENCE IF THE
COMPUTED CHI-SQUARE TEST STATISTIC IS 8.5 AND THE VALUE
TAKEN FROM THE TABLE IS 5.991 WE ?
A) ACCEPT THE HYPOTHESIS AND CONCLUDE THE CRITERIA ARE
INDEPENDENT.
B) ACCEPT THE HYPOTHESIS AND CONCLUDE THE CRITERIA ARE NOT
INDEPENDENT.
C) REJECT THE HYPOTHESIS AND CONCLUDE THE CRITERIA ARE
INDEPENDENT.
D) REJECT THE HYPOTHESIS AND CONCLUDE THE CRITERIA ARE NOT
INDEPENDENT.
END IF
END IF

PROPERTY OF REGRESSION - COMPREHENSION
IF RD$ = "BG" THEN
IF RN$ = "Z" THEN
AFTER COMPLETING A SIMPLE LINEAR REGRESSION STUDY THE CORRELATION
COEFFICIENT (r) IS COMPUTED TO BE -1. FROM THIS WE CAN CONCLUDE
THAT ?
PRINT "A) SSE = 0 AND THERE IS NO RELATIONSHIP BETWEEN THE DEPENDENT"
PRINT "AND INDEPENDENT VARIABLES."
PRINT "B) SSR = 0 AND THERE IS NO RELATIONSHIP BETWEEN THE DEPENDENT"
PRINT "AND INDEPENDENT VARIABLES."
PRINT "C) SSE = 0 AND THERE IS A RELATIONSHIP BETWEEN THE DEPENDENT"
PRINT "AND INDEPENDENT VARIABLES."
PRINT "D) SSR = 0 AND THERE IS A RELATIONSHIP BETWEEN THE DEPENDENT"
PRINT "AND INDEPENDENT VARIABLES."

ELSEIF RN$ = "Y" THEN
PRINT "AFTER COMPLETING A SIMPLE LINEAR REGRESSION ANALYSIS YOU COMPUTE"
PRINT "2"
PRINT "THE COEFFICIENT OF MULTIPLE DETERMINATION (R²)
AND FIND IT TO BE"
PRINT "1. YOU CAN CONCLUDE THAT THE DATA IS ?"
PRINT "A) DEFINITELY LINEAR."
PRINT "B) DEFINITELY NOT LINEAR."
PRINT "C) PROBABLY CURVILINEAR."
PRINT "D) DEFINITELY CURVILINEAR."

ELSEIF RN$ = "X" THEN
PRINT "IN A POLYNOMIAL REGRESSION ANALYSIS AS THE MULTIPLE CORRELATION "
PRINT "COEFFICIENT (R) APPROACHES 1 YOU CAN CONCLUDE THAT THE DATA IS ?"
PRINT "A) LINEAR."
PRINT "B) MULTIPLE LINEAR."
PRINT "C) EXPLAINED BY THE MODEL."
PRINT "D) NOT EXPLAINED BY THE MODEL."

ELSEIF RN$ = "W" THEN
PRINT "BELOW IS A CORRELATION MATRIX"
PRINT " 1 0.88 -0.11"
Print "WHICH OF THE FOLLOWING IS TRUE?"
Print "A) THE INDEPENDENT VARIABLES ARE NOT CLOSELY RELATED BECAUSE R13"
Print "IS SMALL."
Print "B) THE INDEPENDENT VARIABLES ARE CLOSELY RELATED BECAUSE R12 IS"
Print "VERY LARGE."
Print "C) THE INDEPENDENT VARIABLES ARE CLOSELY RELATED BECAUSE R23"
Print "IS RELATIVELY SMALL."
Print "D) THE INDEPENDENT VARIABLES ARE NOT CLOSELY RELATED BECAUSE THE"
Print "AVERAGE OF R12 AND R13 IS MUCH LARGER THAN R23."
Elseif RN$ = "V" then
Print "WHEN THE D(SQUARED) IS NOT ZERO, THIS MEANS"
Print "THAT OTHER VARIABLES (BEYOND THE PRESENT INDEPENDENT VARIABLES) AFFECT THE"
Print "DEPENDENT VARIABLE. GIVEN THIS, THE D(SQUARED) IS EQUIVALENT TO?"
Print "A) SS(TOTAL)."
Print "B) SS(EXPLAINED)."
Print "C) SS(BLOCK)."
Print "D) SS(UNEXPLAINED)."
End If
End If

! Decomposition and Least Squares - Comprehension
If RD$ = "BH" then
  If RN$ = "Z" then
    Print "IN PERFORMING REGRESSION ANALYSIS SS(REGRESSION) IS CALCULATED TO"
    Print "BE 12 AND SS(TOTAL) TO BE 18. WHAT IS THE SS (CHANCE) ?"
    Print "A) 2/3."
    Print "B) 6."
  End if
End if
PRINT " C) 12."
PRINT " D) 30."

ELSEIF RN$ = "Y" THEN
  PRINT "IF YOU SELECT EIGHT INDEPENDENT VARIABLES TO BUILD A REGRESSION"
  PRINT "MODEL HOW MANY LEAST SQUARES EQUATIONS WILL NEED TO BE SOLVED?"
  PRINT " A) 4."
  PRINT " B) 6."
  PRINT " C) 9."
  PRINT " D) 12."
ELSEIF RN$ = "X" THEN
  PRINT "Y ARE - 5
  PRINT "4
  PRINT "3
  PRINT "2
  PRINT "1
  PRINT "X
  PRINT "A) 15 = 5A + 15B AND 35 = 15A + 55B"
  PRINT "B) 15 = 5A + 15B AND 225 = 15A + 90B"
  PRINT "C) 15 = 5A + 15B AND 225 = 15A + 225B"
  PRINT "D) 15 = 5A + 15B AND 35 = 15A + 225B"
ELSEIF RN$ = "W" THEN
  PRINT "EXPERIMENTAL DESIGN AND REGRESSION ANALYSIS ARE SIMILAR"
  PRINT "TECHNIQUES. THE SIMILARITY IS ESTABLISHED BY THE FOLLOWING"
  PRINT "ANALOGY:"" SS(BETWEEN TREATMENTS) IS TO SS(WITHIN TREATMENTS) AS?
  PRINT "A) SS(EXPLAINED) IS TO SS(TOTAL)."
  PRINT "B) SS(EXPLAINED) IS TO SS(UNEXPLAINED)."
  PRINT "C) SS(TOTAL) IS TO SS(EXPLAINED)."
PRINT "D) SS(Total) is to SS(Unexplained)."

ELSEIF RN$ = "V" THEN
  PRINT "IF YOU SELECT FIVE INDEPENDENT VARIABLES TO BUILD A"
  PRINT "REGRESSION MODEL HOW MANY LEAST SQUARES EQUATIONS WILL NEED TO BE"
  PRINT "SOLVED ?"
  PRINT "A) 4."
  PRINT "B) 6."
  PRINT "C) 2."
  PRINT "D) 5."
END IF
END IF

!ANOVA - COMPREHENSION
IF RD$ = "BI" THEN
  IF RN$ = "Z" THEN
    PRINT "Y = -70 - 4X"
    PRINT "FOR X = 10 , THE PREDICTED VALUE OF Y IS ?"
    PRINT "A) -740."
    PRINT "B) 660."
    PRINT "C) 30."
    PRINT "D) -110."
  ELSEIF RN$ = "Y" THEN
    PRINT "WHEN THE VARIANCE RATIO (CALCULATED F VALUE) IS SIGNIFICANT,"
    PRINT "THIS IS EQUIVALENT TO ?"
    PRINT "A) A CONFIDENCE INTERVAL FOR BETA (*) INCLUDING THE VALUE OF "
    PRINT "ZERO."
    PRINT "B) A CONFIDENCE INTERVAL FOR ALPHA (*) NOT INCLUDING THE VALUE "
    PRINT "OF ZERO."
    PRINT "C) A CONFIDENCE INTERVAL FOR ALPHA INCLUDING THE VALUE OF ZERO."
  END IF
D) A CONFIDENCE INTERVAL FOR BETA NOT INCLUDING THE VALUE OF ZERO.

* ALPHA = POPULATION INTERCEPT.
BETA = POPULATION SLOPE.

ELSEIF RN$ = "X" THEN
IN REGRESSION ANALYSIS WE ARE INTERESTED IN DRAWING INFERENCES TO?
A) ALPHA (*) BECAUSE WE NEED TO KNOW THE VALUE OF Y WHEN X = 0.
B) BETA (*) BECAUSE WE NEED TO MINIMIZE THE CHANCE OF TYPE II ERROR.
C) ALPHA BECAUSE WE NEED TO MINIMIZE THE CHANCE OF TYPE I ERROR.
D) BETA BECAUSE THE SLOPE IS A MEASURE OF THE RELATIONSHIP.

* ALPHA = POPULATION INTERCEPT.
BETA = POPULATION SLOPE.

ELSEIF RN$ = "W" THEN
TWO WAYS TO REDUCE THE WIDTH OF A PREDICTION INTERVAL ARE TO?
A) DECREASE THE SAMPLE SIZE AND INCREASE THE PREDICTION LEVEL.
B) INCREASE BOTH THE SAMPLE SIZE AND THE PREDICTION LEVEL.
C) INCREASE THE SAMPLE SIZE AND DECREASE THE PREDICTION LEVEL.
D) DECREASE BOTH THE SAMPLE SIZE AND THE PREDICTION LEVEL.

ELSEIF RN$ = "V" THEN
BELOW IS A 95% PREDICTION INTERVAL FOR X = 50
" 155 +- 26"
PRINT " THE INTERPRETATION IS ?"
PRINT
PRINT " A) WE ARE 95% CONFIDENT THAT THE TRUE MEAN OF Y FOR X = 50 IS "
PRINT "BETWEEN 129 AND 181."
PRINT
PRINT " B) WE ARE 95% CONFIDENT THAT AN OBSERVED VALUE OF Y FOR X = 50 IS "
PRINT "BETWEEN 129 AND 181."
PRINT
PRINT " C) WE ARE 95% CONFIDENT THAT X WILL EQUAL 50."
END IF
END IF

!SINGLE FACTOR DESIGN - COMPREHENSION
IF RD$ = "BJ" THEN
  IF RN$ = "Z" THEN
    PRINT "IN RANDOMIZED COMPLETE BLOCK DESIGN, THE ULTIMATE PURPOSE OF"
    PRINT "BLOCKING IS TO ?"
    PRINT
    PRINT " A) ELIMINATE TREATMENT VARIATION FROM ERROR VARIATION."
    PRINT
    PRINT " B) CONVERT A TWO-WAY ANOVA INTO A ONE-WAY ANOVA."
    PRINT
    PRINT " C) ISOLATE ERROR THAT MAY HAVE AN ATTRIBUTABLE CAUSE."
    PRINT
    PRINT " D) ENSURE THE DESIGN DOES NOT INTRODUCE OUTSIDE FACTORS."
  ELSEIF RN$ = "Y" THEN
    PRINT "GIVEN THE FOLLOWING INFORMATION WHERE FOUR DIFFERENT FERTILIZERS" (A, B, C, D) ARE BING TESTED ON FOUR DIFFERENT TYPES OF CROPS (I, "
    PRINT "II, III, IV) WITH EACH LEVEL REPRESENTING A DIFFERENT TIME OF DAY"
    PRINT "THE FERTILIZER IS SPREAD. WHAT TYPE OF DESIGN IS BEING USED ?"
    PRINT " CROP"
    PRINT "LEVEL  I II III IV"
    PRINT "  1 A B C D"
    PRINT "  2 C A D C"
    PRINT "  3 B D A B"
    PRINT "  4 D C B A"
    PRINT
    PRINT " A) RANDOM BLOCK."
PRINT "B) LATIN SQUARE."
PRINT "C) FACTORIAL."
PRINT "D) COMPLETELY RANDOM."

ELSEIF RN$ = "X" THEN
PRINT "GIVEN THE FOLLOWING INFORMATION WHERE FOUR
DIFFERENT FERTILIZERS"
PRINT "(A, B, C, D) ARE BEING TESTED ON FOUR
DIFFERENT CROPS (I, II, III, "
PRINT "IV) WITH EACH LEVEL REPRESENTING THE TIME OF
DAY THE FERTILIZER IS"
PRINT "SPREAD. WHAT TYPE OF DESIGN IS BEING USED ?"
PRINT "CROP"
PRINT "LEVEL I II III IV"
PRINT "1 B C D A"
PRINT "2 D B A C"
PRINT "3 A D C B"
PRINT "4 C A B D"
PRINT "A) RANDOM BLOCK."
PRINT "B) LATIN-SQUARE."
PRINT "C) FACTORIAL."
PRINT "D) COMPLETELY RANDOM."

ELSEIF RN$ = "W" THEN
PRINT "GIVEN THE FOLLOWING INFORMATION WHERE FOUR
DIFFERENT FERTILIZERS"
PRINT "A, B, C, D) ARE BEING TESTED ON FOUR DIFFERENT
CROPS (I, II, III, "
PRINT "IV) WITH EACH LEVEL REPRESENTING THE TIME OF
DAY THE FERTILIZER IS"
PRINT "SPREAD. WHAT TYPE OF DESIGN IS BEING USED ?"
PRINT "CROP"
PRINT "LEVEL I II III IV"
PRINT "1 A C D A"
PRINT "2 C B A D"
PRINT "3 D C B C"
PRINT "4 B D B A"
PRINT "A) RANDOM BLOCK."
PRINT "B) LATIN-SQUARE."
PRINT "C) FACTORIAL."
PRINT "D) COMPLETELY RANDOM."

ELSEIF RN$ = "V" THEN
PRINT "IN USING A LATIN SQUARE EXPERIMENTAL DESIGN IN
TESTING FOUR"
PRINT "FERTILIZERS (A, B. C, D) ON FOUR DIFFERENT CROPS
(I, II, III, IV)"
PRINT "WITH THE LEVELS REPRESENTING THE TIME OF DAY THE
FERTILIZER IS "
PRINT "SPREAD, WHICH OF THE FOLLOWING IS NOT A FACTOR
IN COMPUTING THE SUM"
PRINT "OF SQUARES (ERROR) IN A LATIN SQUARE
EXPERIMENTAL DESIGN ?"
PRINT
PRINT " A) WEATHER."
PRINT
PRINT " B) LEVELS."
PRINT
PRINT " C) TREATMENTS."
PRINT
PRINT " D) CROPS."
END IF
END IF

!MULTIFACTOR DESIGN - COMPREHENSION
IF RD$ = "BK" THEN
IF RN$ = "Z" THEN
PRINT "AS THE NUMBER OF FACTORS IN A FACTORIAL
EXPERIMENT INCREASES THE"
PRINT "CHANCES OF INTERACTION BETWEEN ALL OF THE
FACTORS ?"
PRINT
PRINT " A) DOES NOT DEPEND ON THE NUMBER OF FACTORS."
PRINT
PRINT " B) REMAINS THE SAME."
PRINT
PRINT " C) INCREASES."
PRINT
PRINT " D) DECREASES."
ELSEIF RN$ = "Y" THEN
PRINT "IN A 3 BY 2 FACTORIAL EXPERIMENT WITH 3
OBSERVATIONS PER CELL, WHAT"
PRINT "IS THE TOTAL NUMBER OF DEGREES OF FREEDOM ?"
PRINT
PRINT " A) 8."
PRINT
PRINT " B) 15."
PRINT
PRINT " C) 17."
PRINT
PRINT " D) 26."
ELSEIF RN$ = "X" THEN
PRINT "IN A 3 X 4 FACTORIAL EXPERIMENT THERE ARE HOW
MANY DIFFERENT "
PRINT "EXPERIMENTAL CONDITIONS ?"
PRINT
PRINT "A) 3."
PRINT "B) 4."
PRINT "C) 7."
PRINT "D) 12."
ELSEIF RN$ = "W" THEN
PRINT "A 2 BY 2 BY 2 FACTORIAL EXPERIMENT WITH FOUR OBSERVATIONS PER CELL"
PRINT "HAS HOW MANY DEGREES OF FREEDOM ?"
PRINT "A) 11."
PRINT "B) 17."
PRINT "C) 23."
PRINT "D) 31."
ELSEIF RN$ = "V" THEN
PRINT "FOR A THREE FACTOR (A, B, C) FACTORIAL DESIGN, THE"
PRINT "DECOMPOSITION WOULD INCLUDE WHICH INTERACTION TERMS ?"
PRINT "A) AB."
PRINT "B) AB, AC, BC."
PRINT "C) AB, AC, BC, ABC."
PRINT "D) AB, AC, BC, ERROR."
END IF
END IF
!SUM OF SQUARES - COMPREHENSION
IF RD$ = "BL" THEN
IF RN$ = "Z" THEN
PRINT "WE HAVE FOUR TREATMENTS EACH HAVING 3 OBSERVATIONS. THE DEGREES OF"
PRINT "FREEDOM BETWEEN TREATMENTS IS ?"
PRINT "A) 2."
PRINT "B) 3."
PRINT "C) 4."
PRINT " D) 11."

ELSEIF RN$ = "Y" THEN
  PRINT "WHEN 20 OBSERVATIONS ARE RANDOMLY ASSIGNED
  ONE OF FOUR TREATMENT"
  PRINT "CATEGORIES WHAT WILL MOST LIKELY RESULT ?"
  PRINT " A) HIGH SUM OF SQUARES (BETWEEN TREATMENTS),
  HIGH SUM OF SQUARES"
  PRINT " (WITHIN TREATMENTS)."
  PRINT " B) HIGH SUM OF SQUARES (BETWEEN TREATMENTS),
  LOW SUM OF SQUARES"
  PRINT " (WITHIN TREATMENTS)."
  PRINT " C) LOW SUM OF SQUARES (BETWEEN TREATMENTS),
  LOW SUM OF SQUARES"
  PRINT " (WITHIN TREATMENTS)."
  PRINT " D) LOW SUM OF SQUARES (BETWEEN TREATMENTS),
  HIGH SUM OF SQUARES"
  PRINT " (WITHIN TREATMENTS)."

ELSEIF RN$ = "X" THEN
  PRINT "WE HAVE FOUR TREATMENTS EACH HAVING 10
  OBSERVATIONS. THE"
  PRINT "DEGREES OF FREEDOM WITHIN TREATMENTS IS ?"
  PRINT " A) 36."
  PRINT " B) 27."
  PRINT " C) 9."
  PRINT " D) 29."

ELSEIF RN$ = "W" THEN
  PRINT "AN ANALYST HAS JUST COMPLETED THE DECOMPOSITION.
  IN ORDINARY"
  PRINT "ENGLISH WHAT HAS HE/SHE JUST DONE ?"
  PRINT " A) DETERMINED THE APPROPRIATE DEGREES OF
  FREEDOM FOR EACH"
  PRINT "COMPONENT."
  PRINT " B) MADE AN INDUCTIVE INFERENCE AS TO WHETHER OR
  NOT TO ACCEPT"
  PRINT "THE NULL HYPOTHESIS."
  PRINT " C) BROKEN DOWN AND ASSIGNED THE TOTAL
VARIABILITY TO BETWEEN AND"
PRINT "WITHIN VARIATION."
PRINT " D) COMPUTED THE VARIANCE RATIO AND COMPARED IT TO THE TABLE F-
PRINT "VALUE."
ELSEIF RN$ = "V" THEN
PRINT "YOU ARE RUNNING A TEST ON THE EFFECT OF TIRE PRESSURE"
PRINT "(TREATMENT) ON MILES PER GALLON. YOU SEPARATE THE FOUR TIRE"
PRINT "PRESSURES (TREATMENT LEVELS) AS FAR AS IT IS PRACTICAL; E.G.;"
PRINT "T1 = 10 POUNDS, T2 = 20 POUNDS, T3 = 30 POUNDS, T4 = 40 POUNDS."
PRINT "WHICH OF THE FOLLOWING EFFECTS IS MOST PROBABLE?"
PRINT " A) INCREASE SS( ERROR)."
PRINT " B) DECREASE SS(BETWEEN)."
PRINT " C) INCREASE SS(BETWEEN)."
PRINT " D) DECREASE SS( ERROR)."
END IF
ELSEIF RN$ = "Y" THEN
!ANOVA - COMPREHENSION
IF RD$ = "BM" THEN
IF RN$ = "Z" THEN
PRINT "ONCE A TWO-WAY ANOVA TABLE SHOWS THAT A SIGNIFICANT INTERACTION HAS" PRINT " TAKEN PLACE ?"
PRINT " A) OTHER TESTING METHODS CAN BE USED TO DETERMINE EXACT" PRINT " INTERACTION."
PRINT " B) THE EXACT INTERACTION CAN BE INTERPRETED FROM THE TABLE."
PRINT " C) THE EXPERIMENTER USUALLY IS NOT INTERESTED IN DETERMINING EXACT" PRINT " INTERACTION."
PRINT " D) GRAPHICAL METHODS MOST ACCURATELY DEPICT EXACT INTERACTION."
ELSEIF RN$ = "Y" THEN
PRINT "WHICH OF THE FOLLOWING IS NOT A REASON TO USE ANOVA TESTING OVER"
PRINT "USING MULTIPLE t TESTS?"
PRINT "A) EVEN AFTER A FEW TESTS WITH A 5 PERCENT CRITICAL VALUE THE "
PRINT "CHANCES OF REJECTING INCORRECTLY BECOMES QUITE LARGE USING"
PRINT "THE t TESTS."
PRINT "B) MORE DATA IS REQUIRED FOR THE t TEST."
PRINT "C) ANOVA IS MORE ACCURATE."
PRINT "D) THE t TESTS ARE TIME CONSUMING."

ELSEIF RN$ = "X" THEN
PRINT "IN A SINGLE FACTOR EXPERIMENT THERE IS A DIFFERENCE IN MEANS. IT "
PRINT "WOULD BE EXPECTED THAT THE MEAN SQUARE IS "
PRINT "THAN IF THERE WERE NO DIFFERENCE IN MEANS."
PRINT "A) HIGHER FOR WITHIN TREATMENTS."
PRINT "B) LOWER FOR BETWEEN TREATMENTS."
PRINT "C) HIGHER FOR BETWEEN TREATMENTS."
PRINT "D) BOTH A AND B."

ELSEIF RN$ = "W" THEN
PRINT "AN EXPERIMENT CONSISTS OF FIVE TREATMENTS EACH WITH FIVE "
PRINT "OBSERVATIONS. AT A MAXIMUM ACCEPTABLE RISK OF MAKING A TYPE I "
PRINT "ERROR OF 0.05, THE APPROPRIATE VALUE FOR TESTING THE VARIANCE "
PRINT "RATIO IS?"
PRINT "A) F(.975,4,16)."
PRINT "B) F(.95, 4, 20)."
PRINT "C) F(.975, 4, 24)."
PRINT "D) F(.95, 4, 16)."

ELSEIF RN$ = "V" THEN
PRINT "THE REGION OF REJECTION FOR THE VARIANCE RATIO
IS IN THE UPPER TAIL OF THE F-DISTRIBUTION. WHICH STATEMENT IS CORRECT?

A) THE VARIANCE RATIO CAN BE NEGATIVE BECAUSE VARIANCES CAN BE NEGATIVE.

B) LOW VARIANCE RATIOS WOULD MEAN THAT YOU PROBABLY RAN THE EXPERIMENT IMPROPERLY AND SHOULD PROBABLY RERUN IT.

C) LOW VARIANCE RATIOS ARE CONSISTENT WITH THE NULL HYPOTHESIS AND THUS YOU WANT TO ACCEPT, NOT REJECT, THE NULL HYPOTHESIS.

D) WHEN THE VARIANCE RATIO IS SMALL, IT BECOMES UNSTABLE AND IS NOT A MEANINGFUL INDICATOR OF THE EFFECT OF THE TREATMENT.

END IF

METHOD OF MOMENTS/MAXIMUM LIKELIHOOD - ANALYSIS/APPLICATION

IF RD$ = "CA" THEN
IF RN$ = "Z" THEN
PRINT "IT IS NOT POSSIBLE TO USE CALCULUS IN THE METHOD OF MAXIMUM LIKELIHOOD WHEN?"
PRINT "A) IT IS ALWAYS POSSIBLE TO USE CALCULUS."
PRINT "B) THE DISTRIBUTION IS NOT NORMAL."
PRINT "C) ASYMPTOTIC PROPERTIES ARE PRESENT."
PRINT "D) THE SLOPE IS NEVER ZERO."
ELSEIF RN$ = "Y" THEN
PRINT "USING THE METHOD OF MAXIMUM LIKELIHOOD FIND y SUCH THAT"
PRINT "-4y 12" e * y
PRINT "IS MAXIMIZED. (HINT: USE THE CHAIN RULE)"
PRINT " A) 2."
PRINT " B) 3."
PRINT " C) 11/2."
PRINT " D) 48."

ELSEIF RN$ = "X" THEN
PRINT "GIVEN THE FOLLOWING BERNOULLI FUNCTION WHAT IS THE MAXIMUM"
PRINT "LIKELIHOOD ESTIMATOR OF p, THE PROBABILITY OF SUCCESSFUL"
PRINT "OPERATION ?"
PRINT
PRINT " L(P) = p (1 - p)"^2
PRINT " A) 1/3."
PRINT " B) 2/3."
PRINT " C) 3/4."
PRINT " D) 1."

ELSEIF RN$ = "W" THEN
PRINT "GIVEN THE FOLLOWING BERNOULLI FUNCTION WHAT IS THE MAXIMUM"
PRINT "LIKELIHOOD ESTIMATOR OF p, THE PROBABILITY OF SUCCESSFUL"
PRINT "OPERATION ?"
PRINT
PRINT " L(P) = p (1 - p)"^2
PRINT " A) 1/2."
PRINT " B) 2/3."
PRINT " C) 3/4."
PRINT " D) 1."

ELSEIF RN$ = "V" THEN
PRINT "GIVEN THE FOLLOWING BERNOULLI FUNCTION WHAT IS THE MAXIMUM"
PRINT "LIKELIHOOD ESTIMATOR OF p, THE PROBABILITY OF SUCCESSFUL"
PRINT "OPERATION ?"
PRINT "
PRINT "
PRINT "
PRINT "A) 1/3."
PRINT "B) 1/2."
PRINT "C) 3/4."
PRINT "D) 1."
END IF
END IF

END
PROGRAM TEXT4 (RS$)

SET CURSOR 1,1
LET RD$ = RS$[1:2]
LET RN$ = RS$[3:3]
LET RG$ = RS$[4:5]

IF RG$ = "GA" THEN
  LET G = 1
ELSEIF RG$ = "GB" THEN
  LET G = 2
ELSEIF RG$ = "GC" THEN
  LET G = 3
ELSEIF RG$ = "GD" THEN
  LET G = 4
ELSEIF RG$ = "GE" THEN
  LET G = 5
ELSEIF RG$ = "GF" THEN
  LET G = 6
ELSEIF RG$ = "GG" THEN
  LET G = 7
ELSEIF RG$ = "GH" THEN
  LET G = 8
ELSEIF RG$ = "GI" THEN
  LET G = 9
ELSEIF RG$ = "GJ" THEN
  LET G = 10
ELSEIF RG$ = "GK" THEN
  LET G = 11
ELSEIF RG$ = "GL" THEN
  LET G = 12
ELSEIF RG$ = "GM" THEN
  LET G = 13
ELSEIF RG$ = "GN" THEN
  LET G = 14
ELSEIF RG$ = "GO" THEN
  LET G = 15
ELSEIF RG$ = "GP" THEN
  LET G = 16
ELSEIF RG$ = "GQ" THEN
  LET G = 17
ELSEIF RG$ = "GR" THEN
  LET G = 18
ELSEIF RG$ = "GS" THEN
  LET G = 19
ELSEIF RG$ = "GT" THEN
  LET G = 20
ELSEIF RG$ = "GU" THEN
  LET G = 21
ELSEIF RG$ = "GV" THEN


LET G = 22
ELSEIF RG$ = "GW" THEN
    LET G = 23
ELSEIF RG$ = "GX" THEN
    LET G = 24
ELSEIF RG$ = "GY" THEN
    LET G = 25
ELSEIF RG$ = "GZ" THEN
    LET G = 26
ELSEIF RG$ = "HA" THEN
    LET G = 27
ELSEIF RG$ = "HB" THEN
    LET G = 28
ELSEIF RG$ = "HC" THEN
    LET G = 29
ELSEIF RG$ = "HD" THEN
    LET G = 30
ELSEIF RG$ = "HE" THEN
    LET G = 31
ELSEIF RG$ = "HF" THEN
    LET G = 32
ELSEIF RG$ = "HG" THEN
    LET G = 33
ELSEIF RG$ = "HH" THEN
    LET G = 34
ELSEIF RG$ = "HI" THEN
    LET G = 35
ELSEIF RG$ = "HJ" THEN
    LET G = 36
ELSEIF RG$ = "HK" THEN
    LET G = 37
ELSEIF RG$ = "HL" THEN
    LET G = 38
ELSEIF RG$ = "HM" THEN
    LET G = 39
ELSEIF RG$ = "HN" THEN
    LET G = 40
ELSEIF RG$ = "HO" THEN
    LET G = 41
ELSEIF RG$ = "HP" THEN
    LET G = 42
ELSEIF RG$ = "HQ" THEN
    LET G = 43
ELSEIF RG$ = "HR" THEN
    LET G = 44
ELSEIF RG$ = "HS" THEN
    LET G = 45
ELSEIF RG$ = "HT" THEN
    LET G = 46
ELSEIF RG$ = "HU" THEN
    LET G = 47
ELSEIF RG$ = "HV" THEN
  LET G = 48
ELSEIF RG$ = "HW" THEN
  LET G = 49
ELSEIF RG$ = "HX" THEN
  LET G = 50
ELSEIF RG$ = "HY" THEN
  LET G = 51
ELSEIF RG$ = "HZ" THEN
  LET G = 52
ELSEIF RG$ = "JA" THEN
  LET G = 53
ELSEIF RG$ = "JB" THEN
  LET G = 54
ELSEIF RG$ = "JC" THEN
  LET G = 55
ELSEIF RG$ = "JD" THEN
  LET G = 56
ELSEIF RG$ = "JE" THEN
  LET G = 57
ELSEIF RG$ = "JF" THEN
  LET G = 58
ELSEIF RG$ = "JG" THEN
  LET G = 59
ELSEIF RG$ = "JH" THEN
  LET G = 60
ELSEIF RG$ = "JJ" THEN
  LET G = 61
ELSEIF RG$ = "JK" THEN
  LET G = 62
ELSEIF RG$ = "JL" THEN
  LET G = 63
ELSEIF RG$ = "JM" THEN
  LET G = 64
ELSEIF RG$ = "JN" THEN
  LET G = 65
ELSE
  END IF

PRINT "QUESTION ";G
PRINT

!CONFIDENCE INTERVALS - APPLICATION/ANALYSIS
IF RD$ = "CB" THEN
  IF RN$ = "2" THEN
    PRINT "WHEN THE SAMPLE SIZE IS SMALL ( N < 30 ) AND 
    THE POPULATION "
  ELSE
    PRINT 
  END IF
END IF
PRINT "VARIANCE IS KNOWN, FROM WHICH DISTRIBUTION WILL THE DEGREE OF"
PRINT "CONFIDENCE FACTOR BE SELECTED IN CONSTRUCTING A CONFIDENCE"
PRINT "INTERVAL FOR THE POPULATION MEAN ?"
PRINT "A) BINOMIAL DISTRIBUTION."
PRINT "B) Z-DISTRIBUTION."
PRINT "C) T-DISTRIBUTION."
PRINT "D) EITHER THE Z OR T DISTRIBUTIONS."

ELSEIF RN$ = "Y" THEN
PRINT "WHAT PROCEDURE(S) DO YOU HAVE TO DETERMINE IF POP. MEAN(1)"
PRINT "NOT = POP. MEAN(2) ?"
PRINT "A) CONSTRUCT TWO CONFIDENCE INTERVALS AND DETERMINE IF THEY"
PRINT "INTERSECT."
PRINT "B) CONSTRUCT A CONFIDENCE INTERVAL FOR POP. MEAN(1) -"
PRINT "POP. MEAN(2)."
PRINT "C) UTILIZE HYPOTHESIS TESTING FRAMEWORK."
PRINT "D) USE PROCEDURE (B) OR (C) SHOWN ABOVE."

ELSEIF RN$ = "X" THEN
PRINT "WHEN WE WISH TO ESTIMATE POPULATION PARAMETERS WE OFTEN "
PRINT "CONSTRUCT CONFIDENCE INTERVALS (CI). WHICH OF THE FOLLOWING IS"
PRINT "AN IMPLICIT ASSUMPTION IN CONSTRUCTING CI'S ?"
PRINT "A) THE DISTRIBUTION OF THE POPULATION IS NORMAL."
PRINT "B) THE SAMPLE STATISTIC IS BASED ON AT LEAST 30 OBSERVATIONS."
PRINT "C) THE SAMPLE FROM WHICH THE SAMPLE STATISTIC IS COMPUTED IS "
PRINT "REPRESENTATIVE OF THE POPULATION."
PRINT "D) THE VALUE OF THE SAMPLE STATISTIC WILL BE CLOSE TO THE VALUE"
PRINT "OF THE POPULATION PARAMETER."

ELSEIF RN$ = "W" THEN
PRINT "A BUSINESS ANALYST ARGUES THAT IF YOU WISH TO REDUCE THE WIDTH "
PRINT "OF A CONFIDENCE INTERVAL, ONE WAY IS TO REDUCE THE SIZE OF"
PRINT "THE POPULATION VARIANCE. WHICH ANALYSIS IS CORRECT?"
PRINT
PRINT "A) INVALID ARGUMENT: WE GENERALLY CANNOT CONTROL THE MAGNITUDE"
PRINT "OF THE POPULATION VARIANCE."
PRINT
PRINT "B) VALID ARGUMENT: CLEARLY AS POP. VARIANCE BECOMES SMALLER, THE"
PRINT "WIDTH OF THE CONFIDENCE INTERVAL SHRINKS."
PRINT
PRINT "C) INVALID ARGUMENT: FOR POP. VARIANCE TO BECOME SMALLER THE"
PRINT "SAMPLE SIZE MUST DECREASE. THESE FORCES COUNTERACT ONE ANOTHER"
PRINT "AND THE WIDTH OF THE INTERVAL REMAINS UNCHANGED."
PRINT
PRINT "D) VALID ARGUMENT: AS 'N' INCREASES, THE POP. VARIANCE "
PRINT "DECREASES. THE NET EFFECT IS A NARROWER INTERVAL."

ELSEIF RN$ = "V" THEN
PRINT "A BUSINESS ANALYST ARGUES THAT A 99% CONFIDENCE INTERVAL IS"
PRINT "PREFERABLE TO A 95% INTERVAL. WHICH ANALYSIS IS CORRECT?"
PRINT
PRINT "A) THE ANALYST IS CORRECT BECAUSE 99% CONFIDENCE IS BETTER THAN"
PRINT "95% CONFIDENCE."
PRINT
PRINT "B) THE ANALYST IS INCORRECT BECAUSE WIDER INTERVALS PROVIDE LESS"
PRINT "MEANINGFUL INFORMATION."
PRINT
PRINT "C) THE ANALYST IS CORRECT BECAUSE THE CHANCE OF COMMITTING"
PRINT "TYPE I ERROR IS SMALLER FOR A 99% INTERVAL."
PRINT
PRINT "D) THE ANALYST IS INCORRECT BECAUSE SMALLER INTERVALS PROVIDE"
PRINT "LESS MEANINGFUL INFORMATION."
!PROPERTIES OF HYPOTHESIS TESTING - APPLICATION/ANALYSIS

IF RD$ = "CC" THEN
  IF RN$ = "Z" THEN
    PRINT "H(0): POPULATION MEAN BRAKING DISTANCE FOR A NEW BRAKE IS NO"
    PRINT "BETTER THAN THE PRESENT BRAKE."
    PRINT "H(A): NEW BRAKE HAS A SHORTER BRAKING DISTANCE THAN THE PRESENT BRAKE."
    PRINT "WHICH OF THE FOLLOWING ARE SOME ECONOMIC CONSEQUENCES OF MAKING A"
    PRINT "TYPE I ERROR?"
    PRINT "A) COSTS ASSOCIATED WITH CLASS ACTION SUITS FOR FALSE"
    PRINT "ADVERTISING CLAIMS REGARDING THE BRAKE SYSTEM."
    PRINT "B) THERE ARE NO ECONOMIC COSTS."
    PRINT "C) THE RESEARCH AND DEVELOPMENT COSTS ASSOCIATED WITH THE NEW"
    PRINT "PRODUCT."
    PRINT "D) COSTS ASSOCIATED WITH YOUR FAILURE TO SWITCH OVER TO A"
    PRINT "SUPERIOR NEW BRAKE SYSTEM."
  ELSEIF RN$ = "Y" THEN
    PRINT "H(0): POPULATION MEAN PRODUCTIVITY OF NEW MACHINE NO BETTER"
    PRINT "THAN THE PRESENT EQUIPMENT."
    PRINT "H(A): POPULATION MEAN PRODUCTIVITY OF NEW MACHINE IS SUPERIOR."
    PRINT "WHICH OF THE FOLLOWING ARE SOME ECONOMIC CONSEQUENCES OF MAKING A"
    PRINT "TYPE I ERROR?"
    PRINT "A) ALL COSTS ASSOCIATED WITH SWITCHING OVER TO A NEW MACHINE THAT"
    PRINT "IS NOT SUPERIOR TO WHAT YOU ALREADY POSSESS."
    PRINT "B) LOSS ASSOCIATED WITH THE FAILURE TO INSTALL MORE COST-"
    PRINT "EFFICIENT EQUIPMENT."
    PRINT "C) SWITCHOVER COSTS THAT ARE EVENTUALLY RECOUPED DUE TO SUPERIOR"
    PRINT "PERFORMANCE OF A NEW MACHINE."
PRINT
PRINT "D) THERE ARE NO ECONOMIC COSTS."

ELSEIF RN$ = "X" THEN
PRINT "THE ORGANIZING PRINCIPLES BEHIND HYPOTHESIS CONSTRUCTION ARE:"
PRINT
PRINT "A) THE NULL HYPOTHESIS IS ALWAYS THE STATUS QUO HYPOTHESIS AND"
PRINT "THE NULL AND ALTERNATIVE HYPOTHESES MUST BE MUTUALLY EXCLUSIVE"
PRINT "AND EXHAUSTIVE."
PRINT
PRINT "B) THE NULL HYPOTHESIS IS ALWAYS THE STATUS QUO HYPOTHESIS AND"
PRINT "THE SAMPLE STATISTIC X(BAR) MUST BE KNOWN."
PRINT
PRINT "C) THE POPULATION MEAN MUST BE UNKNOWN AND THE ALTERNATIVE"
PRINT "HYPOTHESIS IS THE STATUS QUO HYPOTHESIS."
PRINT
PRINT "D) THE NULL AND ALTERNATIVE HYPOTHESES ARE MUTUALLY EXCLUSIVE"
PRINT "AND EXHAUSTIVE AND THE SUM OF THE PROBABILITIES OF MAKING TYPE I"
PRINT "AND TYPE II ERRORS MUST EQUAL 1.0."

ELSEIF RN$ = "W" THEN
PRINT "AS YOU REDUCE THE CHANCE OF MAKING A TYPE I ERROR, THE CHANCE"
PRINT "OF MAKING A TYPE II ERROR ?"
PRINT
PRINT "A) WILL NOT BE AFFECTED BECAUSE THE TWO ERRORS ARE CONCEPTUALLY"
PRINT "DIFFERENT."
PRINT
PRINT "B) WILL INCREASE BECAUSE THE SUM OF THE PROBABILITIES IS 1.0."
PRINT
PRINT "C) WILL ALSO DECREASE DUE TO THE DECREASE IN THE SIZE OF THE"
PRINT "REJECTION REGION."
PRINT
PRINT "D) WILL INCREASE BECAUSE OF THE LARGER REGION OF ACCEPTANCE THAT"
PRINT "RESULTS FROM THE REDUCTION IN THE TYPE I ERROR."

ELSEIF RN$ = "V" THEN
PRINT "WE KNOW THAT THE PLACEMENT OF THE REJECTION REGION IS ALWAYS "
PRINT "CONSISTENT WITH THE ALTERNATIVE HYPOTHESIS.
   FOR EXAMPLE, CASE I"
PRINT "--H(A): < IS ASSOCIATED WITH A LOWER TAIL TEST.
CASE II"
PRINT "--H(A): > IS ASSOCIATED WITH AN UPPER TAIL TEST
   BUT WHY IS THIS SO?"
PRINT
PRINT "A) THERE IS NO LOGICAL REASON; WE SIMPLY FOLLOW
   THE RULES SHOWN"
PRINT " IN THE ABOVE CASES."
PRINT
PRINT "B) USING CASE I TO ILLUSTRATE, AS X(BAR) BECOMES
   SMALLER, AT SOME "
PRINT " POINT IN THE LOWER TAIL YOU SHOULD REJECT
   THE H(0) IN FAVOR OF "
PRINT " H(A)."
PRINT
PRINT "C) USING CASE I TO ILLUSTRATE, AS POP. MEAN
   BECOMES SMALLER, AT "
PRINT " SOME POINT IN THE LOWER TAIL YOU SHOULD REJECT
   THE H(0) IN FAVOR"
PRINT " OF H(A)."
PRINT
PRINT "D) THE TOTAL AREA UNDER THE SAMPLING
   DISTRIBUTION MUST EQUAL"
PRINT " ONE."

ELSEIF RN$ = "U" THEN
PRINT "WHICH OF THE FOLLOWING STATEMENTS CAPTURES THE
   CONCEPT OF A"
PRINT "REJECTION REGION IN HYPOTHESIS TESTING ?"
PRINT
PRINT "A) WHEN IN DOUBT, ALWAYS TAKE A LARGER SAMPLE."
PRINT
PRINT "B) DEDUCTIVE REASONING IS OFTEN FAULTY."
PRINT
PRINT "C) THE WHOLE IS GREATER THAN THE SUM OF ITS
   PARTS."
PRINT
PRINT "D) YOU MUST FIND A PERSON GUILTY BEYOND A
   SHADOW OF A DOUBT."

ELSEIF RN$ = "T" THEN
PRINT "IN A LOWER TAIL TEST, THE LOGICAL REASON THAT
   THE REJECTION"
PRINT "REGION IS IN THE LOWER TAIL IS ?"
PRINT
PRINT "A) BECAUSE THE INEQUALITY IN THE ALTERNATIVE
   HYPOTHESIS"
PRINT " DETERMINES WHERE THE REJECTION REGION IS. "
PRINT "B) BECAUSE THE INEQUALITY IN THE ALTERNATIVE HYPOTHESIS" DETERMINES WHERE THE ACCEPTANCE REGION IS."
PRINT "C) BECAUSE YOU WOULD WANT TO REJECT THE H(0) ONLY FOR SAMPLE" EVIDENCE X(BAR) THAT IS FAR BELOW THE MEAN."
PRINT "D) THAT SINCE THE Z AND T DISTRIBUTIONS ARE SYMMETRIC, THE" REGION CAN BE IN THE LOWER TAIL."
ELSEIF RN$ = "S" THEN PRINT "THE ORGANIZING PRINCIPLE BEHIND HYPOTHESIS TESTING IS BEST" CAPTURED BY WHICH OF THE FOLLOWING STATEMENTS ?"
PRINT "A) WE MUST ALWAYS LET THE DATA SPEAK FOR ITSELF."
PRINT "B) IT IS BETTER TO KNOW THE RISKS AND TAKE AN ACTION THAN TO" WAIT FOR CERTAINTY."
PRINT "C) A GOOD ACTION THAT CAN BE IMPLEMENTED IS BETTER THAN THE BEST" ACTION THAT CANNOT BE IMPLEMENTED."
PRINT "D) ONE PICTURE IS WORTH 10,000 WORDS."
END IF
END IF

!GOODNESS OF FIT/INDEPENDENCE - APPLICATION/ANALYSIS IF RD$ = "CD" THEN IF RN$ = "Z" THEN PRINT "GIVEN THE FOLLOWING OBSERVED DATA IN A CONTINGENCY TABLE, ASSUMING " NO INTERACTION WHAT IS THE EXPECTED VALUE OF ROW1, COLUMN 1 ?"
PRINT "EYE COLOR BROWN BLOND TOTAL"
PRINT "BLUE 12 8 20"
PRINT "GREEN 7 3 10"
PRINT "HAZEL 1 9 10"
PRINT "TOTAL 20 20 40"
PRINT "A) 40/6."
PRINT "B) 8."
PRINT "C) 10."
PRINT "D) 12."

ELSEIF RN$ = "Y" THEN
PRINT "WHEN CONSTRUCTING A CHI-SQUARE GOODNESS OF FIT TEST WE FIND THE "
PRINT "OBSERVED FREQUENCY OF A CLASS IS 6 AND THE EXPECTED FREQUENCY IS 8."
PRINT "WHAT VALUE DOES THIS ADD WHEN COMPUTING THE CHI-SQUARE TEST "
PRINT "STATISTIC?"
PRINT "A) 1/4."
PRINT "B) 1/2."
PRINT "C) 2/3."
PRINT "D) 2."

ELSEIF RN$ = "X" THEN
PRINT "WHEN CONSTRUCTING A GOODNESS OF FIT TEST WE ARE GIVEN THE FOLLOWING"
PRINT "CLASS INTERVALS"
PRINT "CLASS 1 2 3 4 5 6 7"
PRINT "FREQUENCY 1 1 4 6 3 1 1"
PRINT "WHAT IS THE MAXIMUM NUMBER OF INTERVALS ALLOWED TO CONDUCT THE "
PRINT "TEST ACCURATELY?"
PRINT "A) 2."
PRINT "B) 3."
PRINT "C) 4."
PRINT "D) 5."

ELSEIF RN$ = "W" THEN
PRINT "ASSUME A RANDOM SAMPLE FROM A NORMAL DISTRIBUTION IS PLOTTED ON "
PRINT "NORMAL PROBABILITY PAPER AND A STRAIGHT LINE DRAWN TO CONNECT THE"
PRINT "POINTS. GIVEN THAT THE"
PRINT "34TH PERCENTILE = 3"
ELSEIF RN$ = "V" THEN
  PRINT "WHEN CONSTRUCTING A CHI-SQUARE GOODNESS OF FIT TEST WE FIND THE "
  PRINT "OBSERVED FREQUENCY OF A CLASS IS 12 AND THE EXPECTED FREQUENCY IS "
  PRINT "8. WHAT VALUE DOES THIS ADD WHEN COMPUTING THE CHI-SQUARE TEST "
  PRINT "STATISTIC ?"
  PRINT
  PRINT " A) 1/4."
  PRINT " B) 1/2."
  PRINT " C) 2/3."
  PRINT " D) 2."
END IF
END IF

!PROPERTIES OF REGRESSION - APPLICATION/ANALYSIS
IF RD$ = "CE" THEN
  IF RN$ = "Z" THEN
    PRINT "WHEN THE CORRELATION COEFFICIENT FOR A SIMPLE LINEAR REGRESSION "
    PRINT "MODEL IS 0, THE VALUE OF BETA (";CHR$(225);") IN THE REGRESSION EQUATION "
    PRINT
    PRINT " A) EQUALS 0."
    PRINT " B) EQUALS 1."
    PRINT " C) EQUALS -1."
    PRINT " D) CANNOT BE DETERMINED WITH THIS INFORMATION."
  ELSEIF RN$ = "Y" THEN
    PRINT "YOU HAVE JUST FOUND A SIGNIFICANT RELATIONSHIP BETWEEN TWO "
  END IF
END IF
PRINT "VARIABLES IN A REGRESSION STUDY. YOU CAN CONCLUDE THAT ?"

PRINT "A) THE INDEPENDENT AND DEPENDENT VARIABLES ARE RELATED TO ONE"
PRINT "ANOTHER."
PRINT "B) THE INDEPENDENT VARIABLE IS NOT A CAUSE OF THE DEPENDENT"
PRINT "VARIABLE."
PRINT "C) THE DEPENDENT VARIABLE IS A CAUSE OF THE INDEPENDENT"
PRINT "VARIABLE."
PRINT "D) SOME FORM OF CAUSALITY HAS BEEN ESTABLISHED."

ELSEIF RN$ = "X" THEN
PRINT "WE KNOW THAT R(SQUARED) ALONE CANNOT BE USED TO DETERMINE IF "
PRINT "TWO VARIABLES ARE STATISTICALLY RELATED. THIS IS BECAUSE ?"
PRINT "A) YOU ALSO NEED TO KNOW THE MAGNITUDE OF THE SAMPLE SLOPE."
PRINT "B) R(SQUARED) DOES NOT ACCOUNT FOR SAMPLE SIZE AND IS NOT AN "
PRINT "INFERENTIAL STATISTIC."
PRINT "C) THE SS(UNEXPLAINED) IS OMITTED FROM THE R(SQUARED)"
PRINT "CALCULATION."
PRINT "D) R(SQUARED) CAN ONLY TAKE ON VALUES FROM 0 TO 100% WHILE THE"
PRINT "VARIANCE RATIO CAN ASSUME ANY POSITIVE VALUE."

ELSEIF RN$ = "W" THEN
PRINT "AS YOU INCREASE THE NUMBER OF INDEPENDENT VARIABLES, THE"
PRINT "CHANCE OF THE INDEPENDENT VARIABLES BEING RELATED ?"
PRINT "A) DECREASES BECAUSE THE DEGREES OF FREEDOM (UNEXPLAINED) "
PRINT "INCREASES."
PRINT "B) INCREASES BECAUSE THERE ARE MORE INDEPENDENT VARIABLES."
PRINT
PRINT "C) INCREASES BECAUSE THE COEFFICIENT OF
VARIATION INCREASES."
PRINT
PRINT "D) DECREASES DUE TO THE POTENTIAL REDUCTION IN
THE VARIANCE"
PRINT "(UNEXPLAINED) TERM."
ELSEIF RN$ = "V" THEN
PRINT "WHEN THE CORRELATION COEFFICIENT FOR A SIMPLE
LINEAR REGRESSION"
PRINT "MODEL IS 0, WE CAN CONCLUDE THAT THE TWO
VARIABLES ?"
PRINT
PRINT "A) HAVE NO LINEAR RELATIONSHIP."
PRINT
PRINT "B) HAVE A LINEAR RELATIONSHIP."
PRINT
PRINT "C) MAY BE RELATED BUT NOT LINEARLY."
PRINT
PRINT "D) BOTH A AND C."
END IF
END IF

!DECOMPOSITION AND LEAST SQUARES - APPLICATION/ANALYSIS
IF RD$ = "CF" THEN
IF RN$ = "Z" THEN
PRINT "IN RECONSTRUCTING THE ANOVA TABLE FOR A SIMPLE
LINEAR REGRESSION"
PRINT "MODEL WE ARE GIVEN THE FOLLOWING INFORMATION:"
PRINT
PRINT "N = 5, SSE = 12 SSR = 6"
PRINT
PRINT "THE VARIANCE RATIO OR F CALCULATED IS COMPUTED
TO BE ?"
PRINT
PRINT "A) 2/3."
PRINT
PRINT "B) 3/2."
PRINT
PRINT "C) 2."
PRINT
PRINT "D) 3."
ELSEIF RN$ = "Y" THEN
PRINT "IN RECONSTRUCTING THE ANOVA TABLE FOR A SIMPLE
LINEAR"
PRINT "REGRESSION MODEL GIVEN THE FOLLOWING INFORMATION:"
PRINT
PRINT "COMPUTED F STATISTIC (VARIANCE RATIO) = 4, N = 4,"
SSE = 2"

PRINT "THE SSR MUST HAVE BEEN COMPUTED TO BE ?"
PRINT " A) 1."
PRINT " B) 2."
PRINT " C) 4."
PRINT " D) 8."

ELSEIF RN$ = "X" THEN
PRINT "IF YOU INCREASE THE SIZE OF THE SAMPLE FOR YOUR REGRESSION"
PRINT "STUDY, WHICH OF THE FOLLOWING CONDITIONS USUALLY OCCURS ?"
PRINT " A) INCREASE THE VARIANCE RATIO."
PRINT " B) DECREASE THE WIDTH OF THE PREDICTION INTERVAL."
PRINT " C) INCREASE THE DEGREES OF FREEDOM FOR CHANCE OR UNEXPLAINED VARIATION."
PRINT " D) BOTH B AND C."

ELSEIF RN$ = "W" THEN
PRINT "YOU HAVE SET UP THE LEAST SQUARES EQUATIONS AND HAVE SOLVED "
PRINT "FOR THE SAMPLE INTERCEPT. ONCE THIS IS KNOWN ALL YOU HAVE TO DO "
PRINT "TO DETERMINE THE SAMPLE SLOPE IS TO PLUG THE VALUE OF THE "
PRINT "INTERCEPT BACK INTO ANY ONE OF THE EQUATIONS. THIS DEMONSTRATES"
PRINT " THE ?"
PRINT " A) DECOMPOSITION PRINCIPLE."
PRINT " B) DEGREES OF FREEDOM PRINCIPLE."
PRINT " C) INDUCTIVE INFERENCE PRINCIPLE."
PRINT " D) SCIENTIFIC METHOD PRINCIPLE."

ELSEIF RN$ = "V" THEN
PRINT "IF YOU DIVIDE THE VALUES OF THE INDEPENDENT AND
DEPENDENT
PRINT "VARIABLES BY A FACTOR OF 10, YOU WILL?"
PRINT
PRINT "A) REDUCE THE VALUES OF THE SAMPLE SLOPE AND
INTERCEPT BY A"
PRINT "FACTOR OF 10."
PRINT
PRINT "B) REDUCE THE VALUE OF THE SAMPLE INTERCEPT
ONLY BY A FACTOR OF"
PRINT "10."
PRINT
PRINT "C) REDUCE THE VALUE OF THE SAMPLE SLOPE ONLY
BY A FACTOR OF 10."
PRINT
PRINT "D) NOT REDUCE THE VALUES OF THE SAMPLE SLOPE
OR INTERCEPT."
END IF
END IF

!ANOVA - APPLICATION/ ANALYSIS
IF RD$ = "CG" THEN
  IF RN$ = "Z" THEN
    PRINT "IF THE VARIANCE RATIO (CALCULATED F VALUE) IS
    NOT SIGNIFICANT"
    PRINT "THEN IT FOLLOWS LOGICALLY THAT?"
    PRINT
    PRINT "A) CONFIDENCE INTERVALS FOR THE POPULATION
    SLOPE AND INTERCEPT"
    PRINT "MUST INCLUDE ZERO."
    PRINT
    PRINT "B) A CONFIDENCE INTERVAL ON THE POPULATION
    INTERCEPT MUST NOT"
    PRINT "INCLUDE ZERO."
    PRINT
    PRINT "C) A CONFIDENCE INTERVAL ON THE POPULATION
    SLOPE MUST INCLUDE"
    PRINT "ZERO."
    PRINT
    PRINT "D) A CONFIDENCE INTERVAL ON THE POPULATION
    SLOPE MUST NOT"
    PRINT "INCLUDE ZERO."
  ELSEIF RN$ = "Y" THEN
    PRINT "WHEN THE COEFFICIENT OF DETERMINATION APPROACHES
    0.90?"
    PRINT
    PRINT "A) THERE IS NO NEED TO COMPUTE THE VARIANCE
    RATIO (CALCULATED F"
    PRINT "VALUE)."
    PRINT
PRINT "B) THE VARIANCE RATIO BECOMES SMALLER."
PRINT "C) THE VARIANCE RATIO BECOMES LARGER."
PRINT "D) THE PROBABILITY OF COMMITTING A TYPE I ERROR BECOMES 0.10."

ELSEIF RN$ = "X" THEN
PRINT "WHEN THE COEFFICIENT OF DETERMINATION IS VERY LOW THE"
PRINT "INTERPRETATION IS THAT?"
PRINT "A) THE INDEPENDENT VARIABLE'S RELATIONSHIP WITH"
PRINT "OTHER VARIABLES"
PRINT "IS PROBABLY NOT SIGNIFICANT AND OTHER POTENTIAL INDEPENDENT VARIABLES"
PRINT "ARE UNLIKELY TO AFFECT THE DEPENDENT VARIABLE."
PRINT "B) THE INDEPENDENT VARIABLE'S RELATIONSHIP TO"
PRINT "OTHER VARIABLES"
PRINT "IS PROBABLY SIGNIFICANT AND THERE ARE MANY OTHER POTENTIAL INDEPENDENT"
PRINT "VARIABLES THAT AFFECT THE DEPENDENT VARIABLE."
PRINT "C) THE INDEPENDENT VARIABLE'S RELATIONSHIP TO"
PRINT "OTHER VARIABLES IS"
PRINT "PROBABLY NOT SIGNIFICANT AND THERE ARE MANY OTHER POTENTIAL INDEPENDENT"
PRINT "VARIABLES THAT AFFECT THE DEPENDENT VARIABLE."

ELSEIF RN$ = "W" THEN
PRINT "AFTER WE HAVE COMPUTED THE SAMPLE SLOPE, WE THEN USE AN ANOVA"
PRINT "TABLE TO DETERMINE IF THE INDEPENDENT AND DEPENDENT VARIABLES ARE"
PRINT "RELATED. WHY IS THIS NECESSARY?"
PRINT "A) WE NEED TO DETERMINE THE MAGNITUDE OF THE SAMPLE SLOPE."
PRINT "B) WE NEED TO RECOGNIZE THAT THE SLOPE IS DERIVED FROM A SAMPLE"
PRINT "OF THE DATA AND THE SLOPE ALONE DOES NOT GIVE ANY INDICATION OF THE."
PRINT "VARIABILITY ABOUT THE REGRESSION LINE."
PRINT "C) WE HAVE NOT YET CALCULATED THE VALUE OF THE COEFFICIENT OF"
PRINT "DETERMINATION."
PRINT "D) WE HAVE TO VERIFY THAT OUR SAMPLE SLOPE
    CALCULATIONS ARE, IN "
PRINT "FACT, CORRECT."

ELSEIF RN$ = "V" THEN
    PRINT "IF THE VARIANCE RATIO (CALCULATED F VALUE) IS
    SIGNIFICANT "
    PRINT "THEN IT FOLLOWS LOGICALLY THAT ?"
PRINT
PRINT "A) CONFIDENCE INTERVALS FOR THE POPULATION
    SLOPE AND INTERCEPT "
PRINT "MUST INCLUDE ZERO."
PRINT
PRINT "B) A CONFIDENCE INTERVAL ON THE POPULATION
    INTERCEPT MUST NOT "
PRINT "INCLUDE ZERO."
PRINT
PRINT "C) A CONFIDENCE INTERVAL ON THE POPULATION
    SLOPE MUST INCLUDE "
PRINT "ZERO."
PRINT
PRINT "D) A CONFIDENCE INTERVAL ON THE POPULATION
    SLOPE MUST NOT "
PRINT "INCLUDE ZERO."
END IF
END IF

!SINGLE FACTOR DESIGN - APPLICATION/ANALYSIS
IF RD$ = "CH" THEN
    IF RN$ = "Z" THEN
        PRINT "GIVEN THAT WE ARE USING A RANDOMIZED BLOCK
            DESIGN TO TEST THE"
        PRINT "HYPOTHESIS "
        PRINT
        PRINT " H(0) = u = u = u = u . "
        PRINT " 1  2  3  4"
        PRINT
        PRINT "THE CALCULATED F STATISTIC = 10.04 WHICH IS
            SIGNIFICANTLY LARGER"
        PRINT "THAN THE CORRESPONDING REJECTION VALUE, EVEN AT
            THE ONE PERCENT"
        PRINT "LEVEL. WE CONCLUDE THAT ?"
        PRINT
        PRINT "A) NONE OF THE MEANS ARE EQUAL."
        PRINT "B) AT LEAST TWO OF THE MEANS DIFFER."
        PRINT "C) EACH MEAN MAY EQUAL ONE BUT NO MORE THAN
            ONE OTHER MEAN."
        PRINT "D) ALL OF THE MEANS ARE EQUAL."
    ELSEIF RN$ = "Y" THEN
PRINT "BELOW IS REPEATED MEASURES DESIGN. EACH SUBJECT RECEIVES EACH"
PRINT "TREATMENT (NOT ALL AT ONE TIME). WHICH IS THE CORRECT DECOMPOSITION?"
PRINT 
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<td>S4</td>
<td>X41</td>
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<td>X43</td>
</tr>
</tbody>
</table>
PRINT "A) TREATMENT 1, TREATMENT 2, TREATMENT 3, ERROR/WITHIN."
PRINT "B) TREATMENT, SUBJECTS, TREATMENT-SUBJECT INTERACTION."
PRINT "C) TREATMENTS, ERROR/WITHIN."
PRINT "D) TREATMENTS, SUBJECTS, ERROR/WITHIN."
ELSEIF RN$ = "X" THEN
PRINT "WHICH OF THE FOLLOWING STATEMENTS CAPTURES THE UNDERLYING"
PRINT "ORGANIZING PRINCIPLE IN EXPERIMENTAL DESIGN?"
PRINT "A) CONDUCT COST-BENEFIT TRADEOFFS."
PRINT "B) MAKE INCREMENTAL IMPROVEMENTS."
PRINT "C) KNOW YOUR LIMITATIONS."
PRINT "D) RESOLVE UNCERTAINTY."
ELSEIF RN$ = "W" THEN
PRINT "THE FUNDAMENTAL ASSUMPTION BEHIND THE RANDOMIZED BLOCK DESIGN "
PRINT "IS THAT BY BLOCKING?"
PRINT "A) YOU WILL REDUCE SS(ERROR) AND THEREBY INCREASE THE VARIANCE"
PRINT "RATIO FOR THE TREATMENT EFFECT."
PRINT "B) YOU CAN INCREASE THE VARIANCE RATIO FOR THE TREATMENT EFFECT"
PRINT "IF THE REDUCTION IN SUM OF SQUARE (ERROR)."
PRINT "C) YOU CAN INCREASE THE VARIANCE RATIO FOR THE TREATMENT EFFECT"
PRINT "IF THE REDUCTION IN SUM OF SQUARE (ERROR) MORE
THAN OFFSETS THE "
PRINT "GAIN IN THE ERROR DEGREES OF FREEDOM."
PRINT " D) YOU WILL INCREASE THE SUM OF
PRINT "SQUARE(TREATMENT) AND THEREBY"
PRINT "INCREASE THE VARIANCE RATIO FOR THE TREATMENT
PRINT "EFFECT."
ELSEIF RN$ = "V" THEN
PRINT "GIVEN THAT WE ARE USING A RANDOMIZED BLOCK
PRINT "DESIGN TO TEST THE"
PRINT "HYPOTHESIS "
PRINT "H(0) = u = u = u = u ."
PRINT "1 2 3 4"
PRINT "THE CALCULATED F STATISTIC = 3.32 WHICH IS
PRINT "SIGNIFICANTLY SMALLER" PRINT "THAN THE CORRESPONDING REJECTION VALUE, EVEN AT
PRINT "THE FIVE PERCENT"
PRINT "LEVEL. WE CONCLUDE THAT ?"
PRINT " A) NONE OF THE MEANS ARE EQUAL."
PRINT " B) AT LEAST TWO OF THE MEANS DIFFER."
PRINT " C) EACH MEAN MAY EQUAL ONE BUT NO MORE THAN
PRINT "ONE OTHER MEAN."
PRINT " D) ALL OF THE MEANS ARE EQUAL."
END IF
!MULTIFACTOR DESIGN - APPLICATION/ANALYSIS
ELSEIF RN$ = "CI" THEN
IF RN$ = "Z" THEN
PRINT "GIVEN A 2 BY 3 FACTORIAL DESIGN WITH 3
PRINT "OBSERVATIONS PER CELL, WHAT"
PRINT "IS THE DEGREES OF FREEDOM ASSOCIATED WITH THE
PRINT "ERROR TERM ?"
PRINT " A) 6."
PRINT " B) 12."
PRINT " C) 14."
PRINT " D) 17."
ELSEIF RN$ = "Y" THEN
PRINT "YOU DESIGN A 4-FACTOR FACTORIAL EXPERIMENT.
PRINT "HOW MANY"
PRINT "INTERACTION EFFECTS OR TERMS WILL THERE BE IN THE
DECOMPOSITION?"
PRINT
PRINT "A) 11."
PRINT
PRINT "B) 4."
PRINT
PRINT "C) 10."
PRINT
PRINT "D) 22."

ELSEIF RN$ = "X" THEN
PRINT "BELOW IS A LAYOUT OF A BLOCKED FACTORIAL DESIGN"
PRINT
PRINT "A1 42"
PRINT "A2 81 82 81 82"
PRINT "B1 B2 B1 B2"
PRINT "BLOCK 1"
PRINT "BLOCK 2"
PRINT "BLOCK 3"
PRINT
PRINT "WHICH OF THE FOLLOWING DECOMPOSITIONS IS
CORRECT?"
PRINT
PRINT "A) A, B, BLOCKS, BLOCKS * A INTERACTION."
PRINT "B) BLOCKS, A, B, AB INTERACTION"
PRINT "C) BLOCKS, A, B, AB, ERROR."
PRINT "D) A, B, AB, ERROR."

ELSEIF RN$ = "W" THEN
PRINT "ACCORDING TO CURRENT MANAGEMENT THEORY, THE
BEST STYLE OF"
PRINT "LEADERSHIP TO USE IN A GIVEN SITUATION DEPENDS
UPON THE"
PRINT "CHARACTERISTICS OF THE PROBLEMS CONFRONTING THE
FIRM. IF YOU"
PRINT "WISH TO TEST THIS HYPOTHESIS, THE BEST
EXPERIMENTAL DESIGN IS A?"
PRINT
PRINT "A) ONE FACTOR COMPLETELY RANDOM DESIGN."
PRINT
PRINT "B) FACTORIAL DESIGN."
PRINT
PRINT "C) RANDOMIZED BLOCK DESIGN."
PRINT
PRINT "D) LATIN SQUARE DESIGN."

ELSEIF RN$ = "V" THEN
PRINT "IF YOU CHOSE A RANDOMIZED BLOCK DESIGN AND AN
INTERACTION IS"
PRINT "TRULY PRESENT, THE VARIABILITY DUE TO THE INTERACTION EFFECT"
PRINT "WILL?"
PRINT "A) HAVE NO EFFECT ON THE DECOMPOSITION FOR THE DESIGN."
PRINT "B) FLOW INTO THE SS(BLOCK) TERM THUS INDICATING THE PRESENCE OF"
PRINT "AN INTERACTION."
PRINT "C) FLOW INTO THE SS(ERROR) TERM THUS MAKING IT MORE DIFFICULT TO"
PRINT "REJECT THE NULL FOR THE TREATMENT EFFECT."
PRINT "D) BE DISTRIBUTED AMONG ALL THE SOURCES OF VARIATIONS AND THUS"
PRINT "WILL HAVE NO SERIOUS NEGATIVE EFFECT."
END IF

!SUM OF SQUARES DECOMPOSITION - APPLICATION/ANALYSIS
IF RD$ = "CJ" THEN
  IF RN$ = "Z" THEN
    PRINT "FOR A ONE-WAY ANOVA TABLE GIVEN THAT SUM OF SQUARES(ERROR)"
    PRINT "EQUALS 3.0 AND SUM OF SQUARES(TOTAL) EQUALS 10.0, WHAT IS THE"
    PRINT "SUM OF SQUARES(BETWEEN)?"
    PRINT "A) 10/3."
    PRINT "B) 7."
    PRINT "C) 13."
    PRINT "D) 30."
  ELSEIF RN$ = "Y" THEN
    PRINT "IN ORDER TO ESTIMATE THE SUM OF SQUARES DUE TO CHANGE, THERE"
    PRINT "MUST BE?"
    PRINT "A) AT LEAST 30 OBSERVATIONS WITHIN THE EXPERIMENT."
    PRINT "B) AT LEAST ONE OBSERVATION IN EACH EXPERIMENTAL CELL."
    PRINT "C) AN EQUAL NUMBER OF OBSERVATIONS IN EACH CELL."
PRINT "D) AT LEAST TWO OBSERVATIONS IN EACH CELL."

ELSEIF RN$ = "X" THEN
PRINT "BELOW IS SHOWN A PARTIAL ANOVA TABLE?"
PRINT "SOURCE DEGREES OF FREEDOM"
PRINT "A 1"
PRINT "B 2"
PRINT "AB 6"
PRINT "ERROR 48"
PRINT "FOR WHICH DESIGN IS THE ANOVA CORRECT?"
PRINT "A) 2 X 3 X 6 WITH 2 OBSERVATIONS PER CELL."
PRINT "B) 2 X 3 X 3 WITH 3 OBSERVATIONS PER CELL."
PRINT "C) 2 X 3 X 2 WITH 2 OBSERVATIONS PER CELL."
PRINT "D) 2 X 3 X 4 WITH 3 OBSERVATIONS PER CELL."

ELSEIF RN$ = "W" THEN
PRINT "BELOW IS SHOWN A PARTIAL ANOVA TABLE?"
PRINT "SOURCE DEGREES OF FREEDOM"
PRINT "A 1"
PRINT "B 2"
PRINT "AB 6"
PRINT "ERROR 12"
PRINT "FOR WHICH DESIGN IS THE ANOVA CORRECT?"
PRINT "A) 2 X 3 X 6 WITH 2 OBSERVATIONS PER CELL."
PRINT "B) 2 X 3 X 3 WITH 3 OBSERVATIONS PER CELL."
PRINT "C) 2 X 3 X 2 WITH 2 OBSERVATIONS PER CELL."
PRINT "D) 2 X 3 X 4 WITH 3 OBSERVATIONS PER CELL."

ELSEIF RN$ = "V" THEN
PRINT "BELOW ARE TWO DATA SETS. WITHOUT DOING THE
FORMAL"
PRINT "DECOMPOSITION, WHICH, IF ANY, WILL ULTIMATELY
LEAD TO A REJECTION"
PRINT "OF THE NULL HYPOTHESIS WHICH SAYS THE TREATMENTS
ARE EQUAL?"
PRINT "DATA SET 1 DATA SET 2"
PRINT "T1 T2 T3 T1 T2 T3"
PRINT "1 6 9 3 9 6"
PRINT "2 5 7 2 6 2"
PRINT "2 5 8 9 8 9"
PRINT "  2   4   8   8   2   3 "
PRINT "  3   5   8   4   5   12"
PRINT
PRINT "  A) BOTH DATA SETS."
PRINT "  B) DATA SET 1."
PRINT "  C) DATA SET 2."
PRINT "  D) NEITHER DATA SET.  
END IF
END IF

!ANOVA - APPLICATION/ANALYSIS
IF RD$ = "CK" THEN
  IF RN$ = "Z" THEN
    PRINT "SUPPOSE THE REJECTION VALUE , FOR ALPHA = 0.05, IS 10.13."
    PRINT "FURTHER SUPPOSE THAT THE VARIANCE RATIO = 200. WE CAN ?"
    PRINT
    PRINT "  A) REJECT THE NULL WITH ABSOLUTE CERTAINTY."
    PRINT
    PRINT "  B) REJECT THE NULL WITH WITH LESS THAN A 5/100 CHANCE OF MAKING A TYPE I ERROR."
    PRINT "  C) REJECT THE NULL WITH A 5/100 CHANCE OF MAKING A TYPE I ERROR."
    PRINT
    PRINT "  D) REJECT THE NULL WITH MORE THAN A 5/100 CHANCE OF MAKING A TYPE I ERROR."
  ELSEIF RN$ = "Y" THEN
    PRINT "GIVEN NO A-PRIORI TESTING, YOU SHOULD CONDUCT A POST ANOVA "
    PRINT "ANALYSIS ?"
    PRINT
    PRINT "  A) ONLY WHEN THE VARIANCE RATIO FOR AN EFFECT IS NOT SIGNIFICANT."
    PRINT
    PRINT "  B) EVERY TIME TO DOUBLE CHECK THE ACCURACY OF THE ANOVA TABLE."
    PRINT
    PRINT "  C) WHEN THE VARIANCE RATIO FOR AN EFFECT IS SIGNIFICANT AND"
    PRINT "THERE WERE MORE THAN TWO LEVELS FOR A TREATMENT."
    PRINT
    PRINT "  D) WHEN THE VARIANCE RATIO FOR AN EFFECT IS SIGNIFICANT AND"
    PRINT "THERE ARE ONLY TWO LEVELS FOR A TREATMENT."
ELSEIF RN$ = "X" THEN
PRINT "SUPPOSE THE REJECTION VALUE , FOR
ALPHA = 0.05, IS 10.13."
PRINT "FURTHER SUPPOSE THAT THE VARIANCE RATIO =
10.05. WE CAN ?"
PRINT PRINT " A) ACCEPT THE NULL WITH ABSOLUTE CERTAINTY."
PRINT PRINT " B) ACCEPT THE NULL WITH WITH LESS THAN A 5/100
CHANCE OF MAKING A" TYPE I ERROR."
PRINT PRINT " C) ACCEPT THE NULL WITH A 5/100 CHANCE OF
MAKING A TYPE I ERROR."
PRINT PRINT " D) ACCEPT THE NULL WITH MORE THAN A 5/100
CHANCE OF MAKING A" TYPE I ERROR."
ELSEIF RN$ = "W" THEN
PRINT THE VARIANCE RATIO IS FOUND TO BE SIGNIFICANT.
THEN IF YOU "
PRINT "CONSTRUCTED CONFIDENCE INTERVALS FOR ALL PAIRS
OF TREATMENT " MEANS ?"
PRINT PRINT " A) NONE OF THE CONFIDENCE INTERVALS WILL INCLUDE
ZERO."
PRINT PRINT " B) ALL OF THE CONFIDENCE INTERVALS WILL INCLUDE
ZERO."
PRINT PRINT " C) AT LEAST ONE OF THE INTERVALS MUST NOT
INCLUDE ZERO."
PRINT PRINT " D) AT LEAST ONE OF THE INTERVALS MUST INCLUDE
ZERO."
ELSEIF RN$ = "V" THEN
PRINT "THE VARIANCE RATIO IS FOUND NOT TO BE
SIGNIFICANT. THEN IF "
PRINT "YOU CONSTRUCTED CONFIDENCE INTERVALS FOR ALL
PAIRS OF TREATMENT " MEANS ?"
PRINT PRINT " A) NONE OF THE CONFIDENCE INTERVALS WILL
INCLUDE ZERO."
PRINT PRINT " B) ALL OF THE CONFIDENCE INTERVALS WILL
INCLUDE ZERO."
PRINT
PRINT " C) AT LEAST ONE OF THE INTERVALS MUST NOT INCLUDE ZERO."
PRINT
PRINT " D) AT LEAST ONE OF THE INTERVALS MUST INCLUDE ZERO."
END IF
END IF
END
APPENDIX F

PROGRAMMED INSTRUCTION PROGRAMS
PROGRAM PI (HELP$)

!PROGRAMMED INSTRUCTION
! ASCII CODES FOR CHARACTERS

LET A$ = CHR$(224)
LET B$ = CHR$(225)
LET C$ = CHR$(228)
LET D$ = CHR$(229)
LET E$ = CHR$(230)
LET F$ = CHR$(231)
LET G$ = CHR$(233)
LET H$ = CHR$(236)
LET I$ = CHR$(238)
LET J$ = CHR$(251)
LET K$ = CHR$(235)
LET L$ = CHR$(241)
LET M$ = CHR$(242)
LET N$ = CHR$(243)
LET O$ = CHR$(244)
LET P$ = CHR$(245)
LET Q$ = CHR$(232)
LET R$ = CHR$(179)

SUB ANSWER
DO
  DO
    SET CURSOR 21,1
    PRINT "PLEASE ENTER THE LETTER OF YOUR RESPONSE. ";
    INPUT CHOICE$
    IF CHOICE$ = "a" THEN
      LET CHOICE$ = "A"
    ELSEIF CHOICE$ = "b" THEN
      LET CHOICE$ = "B"
    ELSEIF CHOICE$ = "c" THEN
      LET CHOICE$ = "C"
    ELSEIF CHOICE$ = "d" THEN
      LET CHOICE$ = "D"
    ELSE
      END IF
    END IF
  LOOP UNTIL CHOICE$ = "A" OR CHOICE$ = "B" OR CHOICE$ = "C" OR CHOICE$ = "D"
  PRINT "ENTER '1' IF THIS IS THE ANSWER YOU DESIRE OR '2' TO RE-ENTER YOUR ANSWER. ";
  INPUT CONFIRM
  LOOP UNTIL CONFIRM = 1

  IF CHOICE$ = CR$ THEN
    PRINT "YOU HAVE SELECTED THE CORRECT RESPONSE."
ELSE
    PRINT "THE CORRECT RESPONSE IS ";CR$;"." END IF CALL MOVER END SUB

SUB MOVER

DO
    SET CURSOR 25,1
    IF MARKER > 1 THEN
        PRINT "PLEASE ENTER '1' TO CONTINUE OR '2' TO REVIEW. ";
    ELSE
        PRINT "PLEASE ENTER '1' TO CONTINUE. ";
    END IF
    INPUT PLACE
LOOP UNTIL PLACE = 1 OR PLACE = 2

IF PLACE = 1 THEN
    LET MARKER = MARKER + 1
ELSEIF PLACE = 2 THEN
    LET MARKER = MARKER - 1
END IF

IF MARKER < 1 THEN
    LET MARKER = 1
END IF

END SUB


SUB ESTIMATE

DO
    CLEAR
    IF MARKER = 1 THEN
        CALL EPAGE1
    ELSEIF MARKER = 2 THEN
        CALL EPAGE2
    ELSEIF MARKER = 3 THEN
        CALL EPAGE3
    ELSEIF MARKER = 4 THEN
        CALL EPAGE4
    ELSEIF MARKER = 5 THEN
        CALL EPAGE5
    ELSEIF MARKER = 6 THEN
        CALL EPAGE6
ELSEIF MARKER = 7 THEN
    CALL EPAGE7
ELSEIF MARKER = 8 THEN
    CALL EPAGE8
ELSEIF MARKER = 9 THEN
    CALL EPAGE9
ELSEIF MARKER = 10 THEN
    CALL EPAGE10
ELSEIF MARKER = 11 THEN
    CALL EPAGE11
ELSEIF MARKER = 12 THEN
    CALL EPAGE12
ELSEIF MARKER = 13 THEN
    CALL EPAGE13
ELSEIF MARKER = 14 THEN
    CALL EPAGE14
ELSEIF MARKER = 15 THEN
    CALL EPAGE15
ELSEIF MARKER = 16 THEN
    STOP
ELSE
    PRINT "MARKER OUT OF BOUNDS."
END IF

LOOP UNTIL MARKER = 16
STOP

END SUB

SUB EPAGE1

PRINT "ESTIMATORS"
PRINT "AN ESTIMATE OF A POPULATION PARAMETER MAY BE"
PRINT "GIVEN AS A POINT ESTIMATE"
PRINT "OR AN INTERVAL ESTIMATE (CONFIDENCE INTERVAL). A"
PRINT "POINT ESTIMATE OF A POPULATION PARAMETER IS A SINGLE NUMERICAL VALUE OF A"
PRINT "STATISTIC THAT CORRESPONDS"
PRINT "TO THAT PARAMETER."
PRINT "IF THE EXPECTED VALUE OF THE ESTIMATOR IS THE"
PRINT "SAME AS THE VALUE OF THE"
PRINT "POPULATION PARAMETER THEN THE ESTIMATOR IS SAID TO BE UNBIASED. A BIASED"
PRINT "ESTIMATOR HAS AN EXPECTED VALUE THAT IS DIFFERENT FROM THE POPULATION PARAMETER."
PRINT "A METHOD OF COMPARING ESTIMATORS IS BE COMPUTING THEIR MEAN SQUARE"
PRINT "ERRORS (MSE). GENERALLY UNBIASED ESTIMATORS ARE BETTER THAN BIASED ONES."
Sometimes, however, biased estimators are preferred if the variance can be reduced by introducing a relatively small amount of bias, therefore lowering the MSE.

One of the best methods of obtaining a point estimator is the method of maximum likelihood. Suppose that 'X' is a random variable with probability distribution \( f(x; \theta) \), where \( \theta \) is a single unknown parameter. Let \( x(1), x(2), \ldots, x(n) \) be the observed values in the random sample of size \( n \). Then the likelihood function of the sample is

\[
L(\theta) = f(x(1); \theta) f(x(2); \theta) \ldots f(x(n); \theta)
\]

Note that the likelihood function is now a function of only the unknown parameter \( \theta \). The maximum likelihood estimator of \( \theta \) that maximizes the likelihood function \( L(\theta) \). Essentially, the maximum likelihood estimator is the value of \( \theta \) that maximizes the probability of occurrence of the sample results.

Except when the slope of the function is never equal to zero, calculus methods can be used to find the maximum likelihood estimator. The method.
OF MAXIMUM LIKELIHOOD CAN BE USED IN SITUATIONS WHERE THERE ARE SEVERAL
UNKNOWN PARAMETERS SAY ;G$;"(1), ";G$;"(2), ..., ";G$;"(k) TO ESTIMATE. IN SUCH CASES, THE
LIKELIHOOD FUNCTION IS A FUNCTION OF THE k UNKNOWN PARAMETERS" ;G$;"(1),";G$;"(2),...";G$;"(k"
AND THE MAXIMUM ESTIMATORS {";G$;"(i)} WOULD BE FOUND BE EQATING THE k FIRST" PARTIAL DERIVITIVES EQUAL TO ZERO AND SOLVING THE RESULTING SYSTEM OF" EQUATIONS."
MAXIMUM LIKELIHOOD ESTIMATORS ARE NOT NECESSARILY UNBIASED, BUT MAY BE" EASILY MODIFIED TO MAKE IT SO. SPECIFICALLY THEY ARE ASYMPTOTICALLY, NORMALLY" DISTRIBUTED, AND UNBIASED."

EXAMPLE #1

GIVEN THE FOLLOWING BERNOULLI FUNCTION WHAT IS THE MAXIMUM LIKELIHOOD ESTIMATOR OF p, THE PROBABILITY OF SUCCESSFUL OPERATION?

WE WISH TO FIND THAT VALUE OF p WHICH MAXIMIZES THE EQUATION, THE LIKELIHOOD OF THIS PARTICULAR SEQUENCE. DIFFERENTIATING THIS WITH RESPECT TO p AND SETTING THE DERIVITIVE EQUAL TO ZERO:

L(p) = p (p - 1)^2

L(p) = (p^3) - (2p^2) + p
L'(p) = (3p^2) - 4p + 1 = 0

USING THE QUADRATIC FORMULA TO SOLVE WE FIND THAT p EQUALS 1 OR 1/3.

THE VALUE p = 1 WHEN SUBSTITUTED INTO THE ORIGINAL EQUATION YIELDS
L(p) = 0. HENCE THE LIKELIHOOD IS MAXIMIZED WHEN p = 1/3. THIS IS
THE MAXIMUM LIKELIHOOD ESTIMATE OF \( p \).

ANOTHER METHOD OF OBTAINING A POINT ESTIMATOR IS THE METHOD OF MOMENTS.

Suppose that \( x \) is either a continuous random variable with probability density \( f(x;G_1, G_2, \ldots, G_k) \) or a discrete random variable with the distribution \( p(x;G_1, G_2, \ldots, G_k) \) characterized by \( k \) unknown parameters.

Let \( x(1), x(2), \ldots, x(n) \) be a random sample of size \( n \) from \( x \), and define

\[
\text{Method of Moments - Continued}
\]

The first \( k \) population moments about the origin are

\[
E(x^t) = \int x^t f(x;G_1, G_2, \ldots, G_k) \, dx
\]

\[
E(x^t) = \int x^t p(x;G_1, G_2, \ldots, G_k) \, dx
\]
PRINT " \( t = 1,2,\ldots,k \) \ x \ \text{DISCRETE}"

PRINT "THE POPULATION MOMENTS \{u'(t)\} WILL, IN GENERAL, \ \text{BE FUNCTIONS OF THE} \ k \ \text{UNKNOWN}\"

PRINT "PARAMETERS \{\text{";G$\;"}(i)\}. EQUATING SAMPLE MOMENTS AND POPULATION MOMENTS WILL YIELD"

PRINT "k SIMULTANEOUS EQUATIONS IN k UNKNOWNS (THE \{\text{";G$\;"}(i)\}); THAT IS"

PRINT " \( u'(t) = m'(t) \quad t = 1,2,\ldots,k. \)"

CALL MOVER

END SUB

!EST - 7

SUB EPAGE7

PRINT "EXAMPLE #2"

PRINT "LET \( X(1),\ldots,X(n) \) BE A RANDOM SAMPLE FROM A POISSON DISTRIBUTION WITH"

PRINT "PARAMETER \";Q$\;\". ESTIMATE \";Q$\;\"."

PRINT "THE RANDOM VARIABLE IS SAID TO BE POISSON DISTRIBUTED IF IT HAS THE"

PRINT "PROBABILITY DENSITY FUNCTION "

PRINT " \( f(x) = (\{e^{-\";Q$\;\"}\} \times \{\";Q$\;\"^{x}\}) / x! \)
\( x = 0,1,\ldots. \)"

PRINT "EXAMINING THIS EQUATION WE SEE THAT \";E$\;\" IS THE ONLY PARAMETER TO BE"

PRINT "ESTIMATED. HENCE THERE IS ONLY ONE METHOD OF MOMENTS EQUATION,"

PRINT "M'(1) = U'(1) = E(X)."

PRINT "BUT THE EXPECTED VALUE OF THE RANDOM VARIABLE \( X \) HAVING A POISSON DIS-

PRINT "TRIBUTION IS \";Q$\;\". HENCE THE ESTIMATOR OF \";E$\;\" IS THE FIRST SAMPLE"

PRINT "MOMENT ABOUT THE ORIGIN."

PRINT " \( 1 \quad n \)"

PRINT "M = \[ X(i) = x. THIS IS THE EQUATION FOR THE SAMPLE \]
FOR THE SAMPLE"

PRINT "n \quad i=1 "

PRINT "MEAN"
THE MOST IMPORTANT CRITERION IN SELECTING A POINT ESTIMATOR IS ITS?

A) BIASEDNESS.
B) CONSISTENCY.
C) MEAN SQUARE ERROR.
D) UNBIASEDNESS.

THE SECOND TYPE OF PARAMETER ESTIMATION INVOLVES CONSTRUCTION AN INTERVAL ESTIMATE (CONFIDENCE INTERVAL). IN MANY SITUATIONS, A POINT ESTIMATE DOES NOT PROVIDE ENOUGH INFORMATION ABOUT THE PARAMETER OF INTEREST. FOR EXAMPLE, IF WE ARE INTERESTED IN ESTIMATING THE MEAN COMPRESSION STRENGTH OF CONCRETE, A SINGLE NUMBER MAY NOT BE VERY MEANINGFUL. AN INTERVAL ESTIMATE OF THE FORM L ;N$;E$;N$; U MIGHT BE MORE USEFUL. THE END POINTS OF THIS INTERVAL WILL BE RANDOM VARIABLES, SINCE THEY ARE FUNCTIONS OF SAMPLE DATA.

IN GENERAL, TO CONSTRUCT AN INTERVAL ESTIMATOR OF THE UNKNOWN PARAMETER, WE MUST FIND TWO STATISTICS L AND U SUCH THAT

P{ L ;N$; ";G$; ";N$; U} = 1 - ";A$; .
L and U are called the lower and upper confidence limits, respectively.

The statistics L and U are determined by the unknown parameters G$ and A$, such that

\[ P\left(\frac{G$ \left(1-\frac{1}{2}\right)}{N$} \right) = 1 - \frac{1}{2} \]

Substituting, the confidence interval can be constructed as

\[ P\left(\frac{Z(1-\frac{1}{2}) \cdot N$}{G$} \right) = 1 - \frac{1}{2} \]

Since Z is symmetric, \( Z(1-\frac{1}{2}) = -Z(\frac{1}{2}) \).

The distribution of the Z statistic is

\[ \bar{X} \quad \mu \]

\[ Z = \frac{\bar{X} - \mu}{\sigma} \]

The Z statistic is distributed as k normal.
SUBSTITUTING FOR $Z$ AND $Z(1-\alpha)/2$ YIELDS

$$\bar{X} - \alpha$$

$$P(-Z(\alpha/2)/\sqrt{n} < \frac{\bar{X} - \mu}{\sigma/\sqrt{n}} < Z(\alpha/2)/\sqrt{n}) = 1 - \alpha.$$ 

SOLVING FOR THE POPULATION MEAN, $\mu$, GIVES

$$\bar{X} - \frac{Z(\alpha/2)}{\sqrt{n}} \leq \mu \leq \bar{X} + \frac{Z(\alpha/2)}{\sqrt{n}}.$$ 

THE RESULTING CONFIDENCE INTERVAL IS

$$[\bar{X} - \frac{Z(\alpha/2)}{\sqrt{n}}, \bar{X} + \frac{Z(\alpha/2)}{\sqrt{n}}].$$

CONFIDENCE INTERVALS FOR OTHER PARAMETERS ARE SIMILARLY DERIVED.

CONFIDENCE INTERVALS - CONTINUED

OTHER CASES THAT INVOLVE THE CONSTRUCTION OF CONFIDENCE INTERVALS INCLUDE

1) DIFFERENCES IN TWO MEANS, VARIANCES KNOWN.
2) MEAN OF A NORMAL DISTRIBUTION, VARIANCE UNKNOWN.
3) DIFFERENCES IN MEANS OF TWO NORMAL DISTRIBUTIONS, VARIANCES EQUAL BUT UNKNOWN.
4) VARIANCE OF A NORMAL DISTRIBUTION.
5) RATIO OF THE VARIANCES OF TWO NORMAL DISTRIBUTIONS.
6) PROPORTION OR PARAMETER OF A BINOMIAL DISTRIBUTION, $p$.
7) DIFFERENCES IN TWO PROPORTIONS OR TWO BINOMIAL PARAMETERS.

IN THE CASES WHERE A CONFIDENCE INTERVAL IS CONSTRUCTED ON ONE OR TWO MEANS WHERE THE VARIANCE IS KNOWN OR IN THE CASE OF CONSTRUCTING CONFIDENCE
PRINT "INTERVALS ON PROPORTIONS, Z IS THE TEST STATISTIC
USED. t IS THE TEST"
PRINT "STATISTIC USED WHEN CONSTRUCTING A CONFIDENCE ON A
MEAN(S) OF A NORMAL"
PRINT "DISTRIBUTION(S) WHEN THE VARIANCE(S) IS UNKNOWN.
WHEN CONSTRUCTING A CON-
PRINT "FIDENCE INTERVAL ON ONE UNKNOWN VARIANCE OF A NORMAL
DISTRIBUTION THE CHI-
PRINT "SQUARE TEST STATISTIC IS USED. F IS THE TEST
STATISTIC FOR CONSTRUCTING"
PRINT "CONFIDENCE INTERVALS ON THE RATIO OF THE VARIANCES
OF TWO NORMAL DISTRIBUTIONS."
PRINT
END SUB
!EST - 13
SUB EPAGE13
PRINT "EXAMPLE #3"
PRINT "THE WEIGHTS OF SEVEN SIMILAR CONTAINERS OF SULFURIC
ACID ARE 9.8, 10.2,"
PRINT "10.4, 9.8, 10.0, 10.2, AND 9.6 OUNCES. FIND A 95%
CONFIDENCE INTERVAL FOR"
PRINT "THE MEAN OF ALL SUCH CONTAINERS, ASSUMING AN
APPROXIMATE NORMAL DISTRIBUTION."
PRINT "THE SAMPLE MEAN AND STANDARD DEVIATION FOR THE GIVEN
DATA ARE"
PRINT "x = 10.0 AND s = 0.283."
PRINT "USING A t TABLE WE FIND THAT t(0.025) = 2.447 FOR
v = 6 DEGREES OF FREEDOM."
PRINT "HENCE THE 95% CONFIDENCE INTERVAL FOR ";E$;" IS"
PRINT "10.0-(2.447)(0.283/7^{1/2})";E$;"(10.0+(2.447)(0.283/7^{1/2}))",
PRINT "WHICH REDUCES TO"
PRINT "9.74 < ";E$;" < 10.26"
CALL MOVER
AN AMMUNITION MANUFACTURER IS INVESTIGATING THE MUZZLE VELOCITY OF TWO DIFFERENT TYPES OF RIFLE AMMUNITION. THE MANUFACTURER ASSUMES THAT MUZZLE VELOCITY IS APPROXIMATELY NORMALLY DISTRIBUTED AND THAT THE STANDARD DEVIATIONS OF THE MUZZLE VELOCITY FOR AMMUNITION TYPES 1 AND 2 ARE $D_1 = 1.10$ M/S AND $D_2 = 1.50$ M/S, RESPECTIVELY. RANDOM SAMPLES OF 10 TYPE 1 SHELLS AND 20 TYPE 2 SHELLS ARE SELECTED, AND THESE SHELLS ARE FIRED IN RANDOM ORDER FROM A TEST RIFLE. THE OBSERVED SAMPLE MEANS ARE $x_1 = 500$ M/S AND $x_2 = 494$ M/S, RESPECTIVELY. A 90% TWO SIDED CONFIDENCE INTERVAL ON THE DIFFERENCE IN MEAN MUZZLE VELOCITIES $E_1 - E_2$ IS USED

$\frac{1}{n_1} + \frac{1}{n_2}$ $\overline{x}_1 - \overline{x}_2 \pm Z(\frac{1}{2}) \sqrt{\frac{D_1^2}{n_1} + \frac{D_2^2}{n_2}}$

1.21 2.25

500-494-1.6([-][-]^{1/2})$ \leq E_1 - E_2 \leq 500-494+1.6([-][-]^{1/2})$

5.21 \leq E_1 - E_2 \leq 6.79/

WE ARE 90 PERCENT CONFIDENT THAT THE MEAN MUZZLE VELOCITY OF TYPE 1 EXCEEDS THAT OF TYPE 2 BY BETWEEN 5.21 AND 6.79 M/S.
!EST - 15

SUB EPAGE15

LET CR$ = "C"
PRINT "QUESTION #2"
PRINT
PRINT "WHEN THE SAMPLE SIZE IS SMALL (n < 30) AND THE"
PRINT "POPULATION VARIANCE IS"
PRINT "UNKNOWN, FROM WHICH DISTRIBUTION WILL THE DEGREE OF"
PRINT "CONFIDENCE"
PRINT "FACTOR BE SELECTED IN CONSTRUCTING A CONFIDENCE"
PRINT "INTERVAL FOR THE"
PRINT "POPULATION MEAN ?"
PRINT
PRINT " A) BINOMIAL."
PRINT
PRINT " B) Z."
PRINT
PRINT " C) t."
PRINT
PRINT " D) EITHER Z OR t."
PRINT
CALL ANSWER

END SUB

SUB HYPOTEST

DO
    CLEAR
    IF MARKER = 1 THEN
        CALL HPAGE1
    ELSEIF MARKER = 2 THEN
        CALL HPAGE2
    ELSEIF MARKER = 3 THEN
        CALL HPAGE3
    ELSEIF MARKER = 4 THEN
        CALL HPAGE4
    ELSEIF MARKER = 5 THEN
        CALL HPAGE5
    ELSEIF MARKER = 6 THEN
        CALL HPAGE6
    ELSEIF MARKER = 7 THEN
        CALL HPAGE7
    ELSEIF MARKER = 8 THEN
        CALL HPAGE8
    ELSEIF MARKER = 9 THEN
        CALL HPAGE9

END DO
ELSEIF MARKER = 10 THEN
    CALL HPAGE10
ELSEIF MARKER = 11 THEN
    CALL HPAGE11
ELSEIF MARKER = 12 THEN
    CALL HPAGE12
ELSEIF MARKER = 13 THEN
    CALL HPAGE13
ELSEIF MARKER = 14 THEN
    CALL HPAGE14
ELSEIF MARKER = 15 THEN
    CALL HPAGE15
ELSEIF MARKER = 16 THEN
    CALL HPAGE16
ELSEIF MARKER = 17 THEN
    CALL HPAGE17
ELSEIF MARKER = 18 THEN
    CALL HPAGE18
ELSEIF MARKER = 19 THEN
    CALL HPAGE19
ELSEIF MARKER = 20 THEN
    CALL HPAGE20
ELSEIF MARKER = 21 THEN
    STOP
    ELSE
    PRINT "HPAGE MARKER OUT OF BOUNDS"
END IF
END SUB

SUB HPAGE1
PRINT "HYPOTHESIS TESTING"
PRINT "A STATISTICAL HYPOTHESIS IS AN ASSUMPTION OR STATEMENT, WHICH MAY OR"
PRINT "MAY NOT BE TRUE, CONCERNING ONE OR MORE POPULATIONS. THE TRUTH OR FALSITY"
PRINT "OF A STATISTICAL HYPOTHESIS IS NEVER KNOWN WITH CERTAINTY UNLESS THE ENTIRE"
PRINT "POPULATION IS EXAMINED, WHICH IS IMPRACTICAL IN MOST SITUATIONS. INSTEAD"
PRINT "A RANDOM SAMPLE IS TAKEN FROM THE POPULATION OF INTEREST AND THE INFORMATION CONTAINED IN THIS SAMPLE IS USED TO DECIDE WHETHER THE HYPOTHESIS IS"
PRINT "LIKELY TO BE TRUE OR FALSE. EVIDENCE FROM THE SAMPLE THAT IS INCONSISTENT"
"WITH THE STATED HYPOTHESIS LEADS TO A REJECTION OF
THE HYPOTHESIS, WHEREAS"
"EVIDENCE SUPPORTING THE HYPOTHESIS LEADS TO ITS
ACCEPTANCE. MOST STATISTICAL"
"TESTS ARE PARAMETRIC; THEY ASSUME THAT THE
OBSERVATIONS ARE TAKEN FROM A"
"POPULATION WITH A KNOWN DISTRIBUTION. NONPARAMETRIC
TESTS DO NOT REQUIRE"
"ANY DISTRIBUTIONAL ASSUMPTIONS REGARDING THE
UNDERLYING POPULATION."

CALL MOVER

END SUB

SUB HPAGE2

PRINT "HYPOTHESES THAT WE FORMULATE WITH THE HOPE OF
REJECTING ARE CALLED"
PRINT "NULL HYPOTHESES AND ARE DENOTED BY H(0). USUALLY,
BUT NOT ALWAYS, THE NULL"
PRINT "HYPOTHESIS IS THE STATUS QUO. THE REJECTION OF THE
NULL HYPOTHESIS LEADS"
PRINT "TO THE ACCEPTANCE OF AN ALTERNATIVE HYPOTHESIS
DENOTED BY H(A) OR H(1)."
PRINT "A HYPOTHESIS TEST CAN BE EITHER ONE OR
TWO-SIDED. FOR A ONE-SIDED TEST"
PRINT "THE REJECTION REGION FOR THE ALTERNATIVE HYPOTHESIS
";G$;" \rangle;G$;"(o) LIES ENTIRELY"
PRINT "IN THE RIGHT TAIL OF THE DISTRIBUTION, WHILE THE
REJECTION REGION FOR THE"
PRINT "ALTERNATIVE HYPOTHESIS ";G$;" \langle;G$;"(o) LIES
ENTIRELY IN THE LEFT TAIL."
PRINT "FOR A TWO-SIDED TEST ONE-HALF OF THE REJECTION
REGION LIES IN EACH TAIL."
PRINT "A TYPE I ERROR OCCURS IF WE REJECT THE NULL
HYPOTHESIS WHEN IT IS TRUE,"
PRINT "AND A TYPE II ERROR OCCURS IF WE ACCEPT THE NULL
HYPOTHESIS WHEN IT IS FALSE."
PRINT "THE PROBABILITY OF COMMITTING A TYPE I ERROR IS
CALLED THE LEVEL OF SIGNIFI-"
PRINT "CANCE OF THE TEST AND REPRESENTED BY ";A$;". THE
PROBABILITY OF A MAKING A"
PRINT "TYPE II ERROR IS REPRESENTED BY ";B$;". SINCE THE
DECISION MAKER USUALLY"
PRINT "CONTROLS THE PROBABILITY OF A TYPE I ERROR WITH THE
SELECTION OF ";A$;", REJECTION"
PRINT "OF THE NULL HYPOTHESIS, H(0), IS ALWAYS A STRONG
CONCLUSION. ACCEPTING"
PRINT "H(0) IS A WEAK CONCLUSION AND IS USUALLY TERMED 'FAILING TO REJECT'."

PRINT
CALL MOVER
END SUB

SUB HPAGE3
PRINT "USING ";G$;" TO REPRESENT A POPULATION PARAMETER, SUCH AS POPULATION MEAN OR VARIANCE, THE STEPS FOR DEVELOPING AND CARRYING OUT A PARAMETRIC HYPOTHESIS TEST CONCERNING ";G$;" AGAINST SOME ALTERNATIVE HYPOTHESIS IS SUMMARIZED AS FOLLOWS."
PRINT PRINT 1) H(0) : ";G$;" = ";G$;"(0)."
PRINT PRINT 2) H(A) : ALTERNATIVES ARE: ";G$;" < ";G$;"(0); ";G$;" > ";G$;"(0); ";G$;" \{ ";G$;"(0)."
PRINT PRINT 3) CHOOSE TWO OF THE FOLLOWING THREE VALUES: ";A$;";"B$;" AND n (SAMPLE SIZE). THE THIRD VALUE IS DEPENDENT ON THE FIRST TWO.
PRINT PRINT 4) SELECT THE APPROPRIATE TEST STATISTIC AND ESTABLISH THE REJECTION REGION.
PRINT PRINT 5) COMPUTE THE VALUE OF THE TEST STATISTIC FROM A RANDOM SAMPLE OF SIZE n.
PRINT PRINT 6) CONCLUSION: REJECT H(0) IF THE STATISTIC HAS A VALUE IN THE REJECTION REGION; OTHERWISE FAIL TO REJECT H(0)."
PRINT CALL MOVER
END SUB

SUB HPAGE4
PRINT "THE PARAMETRIC HYPOTHESIS TESTS CAN BE DIVIDED INTO TESTS ON MEANS AND TESTS ON VARIANCES. SOME SPECIFIC TESTS OF HYPOTHESES ON MEANS ARE:"
1) MEAN, VARIANCE KNOWN.

2) EQUALITY OF TWO MEANS, VARIANCE KNOWN.

3) MEAN OF A NORMAL DISTRIBUTION, VARIANCE UNKNOWN.

4) MEANS OF TWO NORMAL DISTRIBUTIONS, VARIANCES UNKNOWN AND EQUAL.

5) MEANS OF TWO NORMAL DISTRIBUTIONS, VARIANCES UNKNOWN AND NOT EQUAL.

IN THE CASES WHERE THE POPULATION VARIANCE(S) ARE KNOWN, Z IS THE TEST STATISTIC CALCULATED. WHEN TWO MEANS ARE INVOLVED THE CALCULATIONS ARE MORE COMPLICATED. t IS THE TEST STATISTIC USED IN THOSE CASES WHEN THE VARIANCE IS NOT KNOWN.

A SPECIAL CASE OF THE TWO SAMPLE t-TEST OCCURS WHEN THE OBSERVATIONS ON THE TWO POPULATIONS OF INTEREST ARE COLLECTED IN PAIRS. THE TEST PROCEDURE CONSISTS OF ANALYZING THE DIFFERENCES BETWEEN THE TWO OBSERVATIONS. IF THERE IS NO DIFFERENCE IN THE MEANS, THEN THE MEAN OF THE DIFFERENCES SHOULD BE ZERO. THIS PROCEDURE IS CALLED THE PAIRED t-TEST.

TWO TYPES OF PARAMETRIC TESTS INVOLVING VARIANCES WILL BE DISCUSSED. THE FIRST DEALS WITH THE TESTS OF HYPOTHESES ON THE VARIANCE OF A NORMAL DISTRIBUTION. IF THE HYPOTHESIS IS TRUE THEN THE TEST STATISTIC follows the CHI-SQUARE DISTRIBUTION WITH n - 1 DEGREES OF FREEDOM. THE SECOND TYPE OF TEST INVOLVES THE EQUALITY OF THE VARIANCES OF TWO NORMAL DISTRIBUTIONS. THE CALCULATED STATISTIC IS SIMPLY $s(1)^2 / s(2)^2$ AND IS DISTRIBUTED AS
PRINT "F, WITH n(1) - 1 AND n(2) - 1 DEGREES OF FREEDOM
IF THE NULL HYPOTHESIS "
PRINT "H(0): ;D$;"(1)^2 = ;D$;"(2)^2 IS TRUE. S(1)^2
AND S(2)^2 ARE THE FIRST AND"
PRINT "SECOND SAMPLE VARIANCES, RESPECTIVELY."
PRINT CALL MOVER
END SUB

SUB HPAGE6
PRINT "ANOTHER TYPE OF HYPOTHESIS TEST CONCERNS A
RANDOM VARIABLE THAT FOLLOWS"
PRINT "A BINOMIAL DISTRIBUTION. FOR EXAMPLE CONSIDER A
PRODUCTION PROCESS THAT"
PRINT "MANUFACTURES ITEMS THAT ARE CLASSIFIED AS EITHER
ACCEPTABLE OR DEFECTIVE."
PRINT "IT IS USUALLY REASONABLE TO MODEL THE OCCURRENCE
OF DEFECTIVES WITH THE"
PRINT "BINOMIAL DISTRIBUTION, WHERE THE BINOMIAL PARAMETER
p REPRESENTS THE PROPORTION OF DEFECTIVE ITEMS PRODUCED."
PRINT "WE TEST"
PRINT "H(0): p = p(o)"
PRINT "H(A): p <> p(o)"
PRINT "FOR A SINGLE SAMPLE PROPORTION, AND"
PRINT "H(0): p(1) = p(2)"
PRINT "H(A): p(1) <> p(2)"
PRINT "FOR A TEST OF HYPOTHESIS ON TWO PROPORTIONS."
PRINT "AN APPROXIMATE TEST BASED ON THE NORMAL
APPROXIMATION IS USED. THIS"
PRINT "PROCEDURE IS VALID AS LONG AS p IS NOT EXTREMELY
CLOSE TO ZERO OR ONE AND"
PRINT "IF THE SAMPLE SIZE IS RELATIVELY LARGE."
PRINT CALL MOVER
END SUB

SUB HPAGE7
A manufacturer of sports equipment has developed a new synthetic fishing line that he claims has a mean breaking strength of 15 pounds with a standard deviation of 0.5 pound. Test the hypothesis that \( \mu = 15 \) pounds against the alternative that \( \mu \neq 15 \) pounds if a random sample of 50 lines is tested and found to have a mean breaking strength of 14.8 pounds. Use a 0.01 level of significance. To solve let:

- \( H(0) : \mu = 15 \) pounds
- \( H(A) : \mu \neq 15 \) pounds

From the tables we find the rejection region for the Z statistic with \( \alpha = 0.01 \) is \( Z < -2.58 \) and \( Z > 2.58 \) where

\[
Z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}
\]

With \( \bar{x} = 14.8 \) and \( n = 50 \) we have

\[
Z = \frac{14.8 - 15}{0.5 / \sqrt{50}} = -2.828.
\]

Conclusion: reject \( H(0) \) and conclude that the average breaking strength is not equal to 15 but is in fact less than 15 pounds.

Example #2
Consider a machine that is used to fill cans with a soft drink beverage. If the variance of the fill volume exceeds 0.02 (fluid ounces)^2, then an unacceptably large percentage of the cans will be underfilled. The bottler is interested in testing the hypothesis that the variance of the fill volume is greater than or equal to 0.02. To solve let:

- \( H(0) : \sigma^2 = 0.02 \)
- \( H(A) : \sigma^2 > 0.02 \)

From the tables we find the rejection region for the chi-square statistic with \( \alpha = 0.05 \) is \( \chi^2 > 10.07 \). With \( n = 50 \) cans we have

\[
\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(49)(s^2)}{0.02}
\]

Conclusion: reject \( H(0) \) and conclude that the variance of the fill volume is greater than 0.02.
A random sample of n = 20 cans yields a sample variance of $s^2 = 0.0225$.

Thus, the chi-square test statistic is

$\chi^2 = \frac{(n - 1)s^2}{\sigma_0^2} = \frac{19 \times 0.0225}{0.02} = 21.38$

If we choose $\alpha = 0.05$, we find that the value from the table is 30.14, and we would conclude that there is no strong evidence that the variance of fill volume exceeds 0.02 (fluid ounces)$^2$.

---

Mr. X has just been indicted for a crime. Given the American judicial system, apply the principles of hypothesis construction to X's trial.

A) $H(0): X$ may be guilty.

B) $H(0): X$ is innocent.

C) $H(0): X$ may be innocent.

D) $H(0): X$ is guilty.

---

Let CR$ = "B"

Let CR$ = "A"
PRINT "QUESTION #2"
PRINT "THE ORGANIZING PRINCIPLES BEHIND HYPOTHESIS CONSTRUCTION ARE:
PRINT
PRINT "A) THE NULL HYPOTHESIS IS ALWAYS THE STATUS QUO HYPOTHESIS AND THE NULL"
PRINT " AND ALTERNATIVE HYPOTHESES MUST BE MUTUALLY EXCLUSIVE AND EXHAUSTIVE."
PRINT
PRINT "B) THE NULL HYPOTHESIS IS ALWAYS THE STATUS QUO HYPOTHESIS AND THE SAMPLE"
PRINT " STATISTIC X(BAR) MUST BE UNKNOWN."
PRINT
PRINT "C) THE POPULATION MEAN MUST BE UNKNOWN AND THE ALTERNATIVE HYPOTHESIS IS"
PRINT " THE STATUS QUO HYPOTHESIS."
PRINT
PRINT "D) THE NULL AND ALTERNATIVE HYPOTHESES ARE MUTUALLY EXCLUSIVE AND"
PRINT " EXHAUSTIVE AND THE SUM OF THE PROBABILITIES OF MAKING TYPE I AND"
PRINT " TYPE II ERRORS MUST EQUAL 1.0."
PRINT CALL ANSWER
END SUB

SUB HPAGE11
PRINT "NONPARAMETRIC TESTS, BESIDES HAVING NO DISTRIBUTIONAL ASSUMPTIONS, ARE"
PRINT "EASY TO UNDERSTAND AND USE AND CAN BE APPLIED TO QUALITATIVE AND RANKED DATA."
PRINT "THREE PARAMETRIC TESTS ARE DISCUSSED. THE WILCOXON TWO-SAMPLE TEST DETER-
PRINT "MINES WHETHER OR NOT THE NULL HYPOTHESIS H(0): ;
E$;(1) = ";E$;"(2) CAN BE REJECTED."
PRINT "FIRST WE SELECT A RANDOM SAMPLE FROM EACH OF THE POPULATIONS. LET n(1) BE THE"
PRINT "NUMBER OF OBSERVATIONS FROM THE SMALLER SAMPLE AND n(2) BE THE NUMBER OF"
PRINT "OBSERVATIONS FROM THE LARGER SAMPLE. WE ARRANGE AND RANK THE n(1) + n(2)"
PRINT "OBSERVATIONS OF THE COMBINED SAMPLES IN ASCENDING ORDER. IF THE SAMPLE MEANS"
PRINT "DO NOT DIFFER, WE WOULD EXPECT THE SUM OF THE RANKS TO NEARLY EQUAL FOR BOTH."
PRINT "CONSEQUENTLY, IF THE SUMS OF THE RANKS DIFFER
GREATLY, WE WOULD CONCLUDE THE
MEANS ARE NOT EQUAL.

THE SIGN TEST, THE SECOND NONPARAMETRIC TEST, IS APPLIED TO PAIRED
OBSERVATIONS DRAWN FROM CONTINUOUS POPULATIONS. THE HYPOTHESIS TO BE TESTED IS THAT THE DIFFERENCES D(j) HAVE A PROBABILITY DISTRIBUTION WITH A ZERO MEDIAN. IF THE UNDERLYING DISTRIBUTIONS ARE ASSUMED SYMMETRIC, THEN THE HYPOTHESIS TESTED IS THAT THE MEAN OF THE DISTRIBUTION OF DIFFERENCES \( \varepsilon \) D(d) IS ZERO. FOR EACH DIFFERENCE D(j) RECORD THE SIGN OF THE DIFFERENCE. LET \( R^+ \) BE THE NUMBER OF POSITIVE SIGNS AND \( R^- \) BE THE NUMBER OF NEGATIVE SIGNS. DENOTE \( R = \min (R^+, R^-) \). LET \( R^*; A\$; \) BE THE REJECTION VALUE CORRESPONDING TO A LEVEL OF SIGNIFICANCE \( \alpha \), FOR THE NUMBER OF TIMES THE LESS FREQUENT SIGN APPEARS. IF THE TEST STATISTIC \( R \) < \( R^*; A\$; \) THEN THE NULL HYPOTHESIS THAT THE TWO DISTRIBUTIONS HAVE THE SAME MEANS (OR MEDIANS) IS REJECTED. A DISADVANTAGE OF THIS TEST IS THAT THE MAGNITUDE OF THE DIFFERENCES IS NOT CONSIDERED.

A TEST THAT CONSIDERS BOTH THE SIGNS OF THE DIFFERENCES OF THE PAIRED OBSERVATIONS AS WELL AS THEIR MAGNITUDE IS THE WILCOXON TEST FOR PAIRED OBSERVATIONS, THE THIRD NONPARAMETRIC TEST. TO TEST THE HYPOTHESIS THAT \( \varepsilon; (1) = \varepsilon; (2) \) USING THIS METHOD, FIRST PERFORM THE SIGN TEST AND DISCARD ALL DIFFERENCES EQUAL TO ZERO AND THEN RANK THE
REMAINING D(j)'S WITHOUT
PRINT "REGARD TO SIGN. A RANK OF 1 IS ASSIGNED TO THE
SMALLEST D(j) IN ABSOLUTE"
PRINT "VALUE, A RANK OF 2 TO NEXT SMALLEST, AND SO ON.
IF THERE IS NO DIFFERENCES"
PRINT "BETWEEN THE TWO POPULATION MEANS, THE TOTAL OF THE
RANKS CORRESPONDING TO"
PRINT "THE POSITIVE DIFFERENCES SHOULD BE ALMOST EQUAL TO
THE RANKS OF THE NEGATIVE DIFFERENCES."
PRINT CALL MOVER
END SUB

SUB HPAGE14
PRINT "MOST FORMS OF HYPOTHESIS TESTING ARE CONCERNED
WITH INVESTIGATING"
PRINT "POPULATION PARAMETERS SUCH AS MEAN AND VARIANCE.
ANOTHER TYPE OF HYPOTHESIS"
PRINT "TESTING DETERMINES IF A POPULATION HAS A SPECIFIED
THEORETICAL DISTRIBUTION."
PRINT "THE TEST IS BASED ON HOW GOOD A FIT WE HAVE BETWEEN
THE FREQUENCY OF OCCURRENCE"
PRINT "OF OBSERVATIONS IN AN OBSERVED SAMPLE AND THE
EXPECTED FREQUENCY FROM THE"
PRINT "HYPOTHESIZED DISTRIBUTION. THE CHI-SQUARE TEST IS
THE MOST WIDELY Used AND"
PRINT "WILL BE DISCUSSED LATER. OTHER WAYS OF DETERMINING
GOODNESS OF FIT INCLUDE"
PRINT "GRAPHICAL METHODS AND LOOKING AT A HISTOGRAM OF THE
OBSERVED DATA. INSPECTING"
PRINT "A HISTOGRAM ENTAILS SUBJECTIVELY JUDGING WHETHER THE
DATA APPEARS TO FOLLOW"
PRINT "THE HYPOTHESIZED DISTRIBUTION."
PRINT "USING GRAPHICAL METHODS INVOLVE PLOTTING THE
OBSERVED DATA ON SPECIAL"
PRINT "GRAPH PAPER KNOWN AS PROBABILITY PAPER THAT HAS BEEN
DESIGNED FOR THE"
PRINT "HYPOTHESIZED DISTRIBUTION. THE OBSERVATIONS ARE
RANKED SMALLEST TO LARGEST"
PRINT "AND PLOTTED. IF THE POINTS FOLLOW A STRAIGHT LINE
THEN THE DATA FOLLOW"
PRINT "THE HYPOTHESIZED DISTRIBUTION. USUALLY, THE
DETERMINATION OF WHETHER OR"
PRINT "NOT THE DATA PLOT IS STRAIGHT IS SUBJECTIVE. IF
THE DATA FOLLOW THE"
PRINT "HYPOTHESIZED DISTRIBUTION THE MEAN IS ESTIMATED
AS THE 50TH PERCENTILE"
OF THE SAMPLE, AND THE STANDARD DEVIATION IS ESTIMATED AS THE DIFFERENCE

BETWEEN THE 84 TH AND 50 TH PERCENTILES.

PRINT "OF THE SAMPLE, AND THE STANDARD DEVIATION IS ESTIMATED AS THE DIFFERENCE"
PRINT "BETWEEN THE 84 TH AND 50 TH PERCENTILES."
PRINT CALL MOVER
END SUB

SUB HPAGE15
PRINT " THE CHI-SQUARE GOODNESS OF FIT TEST PROCEDURE CONSISTS OF OBTAINING"
PRINT "A RANDOM SAMPLE OF SIZE n OF THE RANDOM VARIABLE X, WHOSE PROBABILITY DI-
PRINT "TRIBUTION IS UNKNOWN. THESE n OBSERVATIONS ARE ARRANGED IN A FREQUENCY "
PRINT "HISTOGRAM HAVING k CLASS INTERVALS. LET O(i) BE THE OBSERVED FREQUENCY"
PRINT "IN THE i TH CLASS INTERVAL. THE EXPECTED FREQUENCY IS COMPUTED BY DETERMINING"
PRINT "THE THEORETICAL HYPOTHESIZED PROBABILITY ASSOCIATED WITH THE i TH CLASS"
PRINT "INTERVAL. THE EXPECTED FREQUENCIES ARE OBTAINED BY MULTIPLYING THE SAMPLE"
PRINT "SIZE TIMES THE RESPECTIVE PROBABILITIES. SOMETIMES POPULATION PARAMETERS"
PRINT "SUCH AS THE MEAN MUST BE ESTIMATED FROM THE SAMPLE TO COMPUTE THE EXPECTED"
PRINT "PROBABILITIES."
PRINT CALL MOVER
END SUB

SUB HPAGE16
PRINT " THE CHI-SQUARE TEST STATISTIC IS COMPUTED AS"
PRINT PRINT " THE CHI-SQUARE TEST STATISTIC IS COMPUTED AS"
PRINT PRINT " k [O(i) - E(i)]^2 "
PRINT PRINT " ;C$;" -------------------"
PRINT PRINT " i=1 E(i)"
PRINT PRINT "IT CAN BE SHOWN THAT THE CHI-SQUARE TEST STATISTIC APPROXIMATELY FOLLOWS"
PRINT PRINT "THE CHI-SQUARE DISTRIBUTION. THE NUMBER OF DEGREES OF FREEDOM IN THE "
PRINT PRINT "CHI-SQUARE GOODNESS OF FIT TEST IS EQUAL TO THE NUMBER OF INTERVALS MINUS"
PRINT PRINT "THE NUMBER OF QUANTITIES OBTAINED FROM THE OBSERVED"
DATA THAT ARE USED IN THE "CALCULATIONS OF EXPECTED FREQUENCIES. THIS TRANSLATES TO $k - p - 1$ WITH"
PRINT "$p$ THE NUMBER OF PARAMETERS ESTIMATED BY THE SAMPLE STATISTICS. AS $n$ INCREASES"
PRINT "THE TEST STATISTIC BETTER APPROXIMATES THE CHI-SQUARE DISTRIBUTION. IF THE"
PRINT "OBSERVED FREQUENCIES ARE CLOSE TO THE CORRESPONDING EXPECTED FREQUENCIES,"
PRINT "THE CHI-SQUARE VALUE WILL BE SMALL, INDICATING A GOOD FIT. IF THE OBSERVED"
PRINT "FREQUENCIES DIFFER CONSIDERABLY FROM THE EXPECTED FREQUENCIES, THE CHI-SQUARE"
PRINT "VALUE WILL BE LARGE AND THE FIT IS POOR. A GOOD FIT LEADS TO ITS ACCEPTANCE"
PRINT "OF THE $H(0)$, WHEREAS A POOR FIT LEADS TO ITS REJECTION. THE REJECTION REGION"
PRINT "WILL, THEREFORE, FALL IN THE RIGHT TAIL OF THE CHI-SQUARE DISTRIBUTION."
PRINT CALL MOVER
END SUB

SUB HPAGE17
PRINT " IF THE FREQUENCIES OF THE CLASS INTERVALS ARE TOO SMALL THEN THE"
PRINT "CHI-SQUARE TEST STATISTIC WILL NOT REFLECT THE DEPARTURE OF OBSERVED FROM"
PRINT "EXPECTED BUT ONLY THE SMALLNESS OF THE FREQUENCIES. IT IS SUGGESTED THAT"
PRINT "THE MINIMUM NUMBER OF EXPECTED FREQUENCY IN AN INTERVAL SHOULD RANGE FROM 3 TO"
PRINT "5. SINCE CLASS INTERVALS DO NOT HAVE TO BE THE SAME SIZE, AN INTERVAL CAN BE"
PRINT "COMBINED WITH AN ADJACENT CLASS INTERVAL TO INCREASE ITS EXPECTED FREQUENCY."
PRINT CALL MOVER
END SUB

SUB HPAGE18
PRINT "EXAMPLE #3"
PRINT "CONSIDER THE TOSSING OF A DIE. WE HYPOTHESIZE THAT THE DIE IS HONEST, WHICH"
PRINT "IS EQUIVALENT TO TESTING THE HYPOTHESIS THAT THE DISTRIBUTION OF OUTCOMES IS"
PRINT "UNIFORM. SUPPOSE THE DIE IS TOSSED 120 TIMES AND EACH OUTCOME ISRecorded."
PRINT "THEORETICALLY, IF THE DIE IS BALANCED, WE WOULD
EXPECT EACH FACE TO OCCUR 20 TIMES. THE RESULTS ARE GIVEN AS

      1  2  3  4  5  6
OBSERVE 20 22 17 18 19 24
EXPECT 20 20 20 20 20 20

USING THE CHI-SQUARE GOODNESS OF FIT TEST WE CAN DETERMINE IF THE OBSERVED FREQUENCIES DIFFER FROM THE EXPECTED ONES. WITH 6 - 1 OR 5 DEGREES OF FREEDOM,
AND A LEVEL OF SIGNIFICANCE OF 0.05 WE FIND THE CHI-SQUARE STATISTIC TO BE 11.070. IF THE CALCULATED CHI-SQUARE STATISTIC IS > 11.070 WE REJECT THE HYPOTHESIS THAT THE DISTRIBUTION IS UNIFORM AND CONCLUDE THE DIE IS NOT HONEST. USING THE PREVIOUS FORMULA, WE CALCULATE THE CHI-SQUARE STATISTIC TO BE 1.7, SINCE 1.7 < 11.070, WE FAIL TO REJECT H(0) AND CONCLUDE THE DIE IS BALANCED.

MANY TIMES, THE n ELEMENTS OF A SAMPLE MAY BE CLASSIFIED ACCORDING TO TWO DIFFERENT CRITERIA. THEN IT IS OF INTEREST TO KNOW WHETHER THE TWO METHODS OF CLASSIFICATION ARE STATISTICALLY INDEPENDENT. ASSUME THAT THE FIRST METHOD OF CLASSIFICATION HAS r LEVELS AND THE SECOND METHOD OF CLASSIFICATION HAS c LEVELS. WE SHALL LET O(i,j) BE THE OBSERVED FREQUENCY FOR LEVEL i OF THE FIRST CLASSIFICATION METHOD AND LEVEL j OF THE SECOND. CLASSIFICATION METHOD. GENERALLY, THE DATA APPEARS IN A r x c CONTINGENCY TABLE. WE ARE INTERESTED IN TESTING THE HYPOTHESIS THAT THE ROW AND COLUMN
METHODS OF CLASSIFICATION ARE INDEPENDENT. IF WE REJECT THIS HYPOTHESIS WE CONCLUDE THERE IS SOME INTERACTION BETWEEN THE TWO CRITERIA OF CLASSIFICATION.

THE EXACT TEST PROCEDURES ARE DIFFICULT TO OBTAIN BUT AN APPROXIMATE CHI-SQUARE STATISTIC IS VALID FOR LARGE n. THE CHI-SQUARE STATISTIC IS

\[ \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(O(i,j) - E(i,j))^2}{E(i,j)} \]

THE DEGREES OF FREEDOM IS \((r - 1) \times (c - 1)\)." CALL MOVER

EXAMPLE #4

THE CHI-SQUARE TEST CAN BE USED TO TEST THE INDEPENDENCE OF TWO VARIABLES.

SUPPOSE WE WISH TO STUDY THE RELATIONSHIP BETWEEN RELIGIOUS AFFILIATION AND GEOGRAPHICAL REGION. TWO GROUPS OF PEOPLE ARE CHOSEN AT RANDOM, ONE FROM THE EAST COAST AND ONE FROM THE WEST COAST OF THE UNITED STATES, EACH PERSON IS CLASSIFIED AS PROTESTANT, CATHOLIC OR JEWISH. TO DETERMINE THE EXPECTED FREQUENCIES OF EACH 'CELL' WE TAKE THE TOTAL FOR THAT ROW MULTIPLIED BY THAT COLUMN TOTAL AND DIVIDE BY THE GRAND TOTAL. THE OBSERVED AND EXPECTED FREQUENCIES ARE GIVEN AS (EXPECTED FREQUENCIES IN PARENTHESIS):

<table>
<thead>
<tr>
<th></th>
<th>PROTESTANT</th>
<th>CATHOLIC</th>
<th>JEWISH</th>
<th>TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAST COAST</td>
<td>182 (202)</td>
<td>215 (211)</td>
<td>203 (187)</td>
<td>600</td>
</tr>
<tr>
<td>WEST COAST</td>
<td>154 (134)</td>
<td>136 (140)</td>
<td>110 (126)</td>
<td>400</td>
</tr>
<tr>
<td>TOTALS</td>
<td>336</td>
<td>351</td>
<td>313</td>
<td>1000</td>
</tr>
</tbody>
</table>

THE DEGREES OF FREEDOM IS \((rows - 1) \times (columns - 1)\) OR \((2 - 1) \times (3 - 1)\) OR 2."

USING A LEVEL OF SIGNIFICANCE OF 0.05, AND 2 DEGREES OF FREEDOM WE FIND " FROM THE TABLE A CHI-SQUARE VALUE EQUAL TO 5.991. IF THE CALCULATED TEST"
PRINT "STATISTIC > 5.991 WE CONCLUDE THAT GEOGRAPHIC REGION AND RELIGIOUS AFFILIATION ARE NOT INDEPENDENT. WE COMPUTE THE STATISTIC TO BE"
PRINT "(182 - 202)^0.5 (110 - 126)^0.5" =----------------- +...+ ----------------- = 8.556"
PRINT "202 126" =----------------- +...+ ----------------- = 8.556"
PRINT "THE H(0) IS REJECTED AND WE CONCLUDE THE TWO VARIABLES ARE NOT INDEPENDENT."

CALL MOVER
END SUB

SUB REGRESS
DO
CLEAR
IF MARKER = 1 THEN
CALL RPAGE1
ELSEIF MARKER = 2 THEN
CALL RPAGE2
ELSEIF MARKER = 3 THEN
CALL RPAGE3
ELSEIF MARKER = 4 THEN
CALL RPAGE4
ELSEIF MARKER = 5 THEN
CALL RPAGE5
ELSEIF MARKER = 6 THEN
CALL RPAGE6
ELSEIF MARKER = 7 THEN
CALL RPAGE7
ELSEIF MARKER = 8 THEN
CALL RPAGE8
ELSEIF MARKER = 9 THEN
CALL RPAGE9
ELSEIF MARKER = 10 THEN
CALL RPAGE10
ELSEIF MARKER = 11 THEN
CALL RPAGE11
ELSEIF MARKER = 12 THEN
CALL RPAGE12
ELSEIF MARKER = 13 THEN
CALL RPAGE13
ELSEIF MARKER = 14 THEN
CALL RPAGE14
ELSEIF MARKER = 15 THEN
CALL RPAGE15
ELSEIF MARKER = 16 THEN
CALL RPAGE16
ELSEIF MARKER = 17 THEN
   CALL RPAGE17
ELSEIF MARKER = 18 THEN
   CALL RPAGE18
ELSEIF MARKER = 19 THEN
   STOP
ELSE
   PRINT "MARKER OUT OF BOUNDS."
END IF
LOOP UNTIL MARKER = 19
STOP
END SUB

SUB RPAGE1
PRINT "REGRESSION"
PRINT "IN MANY RESEARCH PROBLEMS THERE ARE TWO OR MORE
VARIABLES THAT ARE"
PRINT "INHERENTLY RELATED, AND IT IS NECESSARY TO EXPLORE
THE NATURE OF THIS"
PRINT "RELATIONSHIP. REGRESSION ANALYSIS IS A STATISTICAL
TECHNIQUE FOR INVEST-"
PRINT "IGATING THE RELATIONSHIP BETWEEN TWO OR MORE
VARIABLES. FOR EXAMPLE, IN A"
PRINT "CHEMICAL PROCESS, SUPPOSE THAT THE YIELD OF THE
PRODUCT IS RELATED TO THE"
PRINT "PROCESS OPERATING TEMPERATURE. REGRESSION ANALYSIS
CAN BE USED TO BUILD A"
PRINT "MODEL THAT EXPRESSES YIELD AS A FUNCTION OF
TEMPERATURE. THIS MODEL CAN"
PRINT "THEN BE USED TO PREDICT THE YIELD AT A GIVEN
TEMPERATURE LEVEL."
PRINT "QUITE OFTEN THERE IS A SINGLE DEPENDENT
variable or response, Y, which"
PRINT "IS UNCONTROLLED IN THE EXPERIMENT. THIS RESPONSE
DEPENDS ON ONE OR MORE"
PRINT "INDEPENDENT VARIABLES SAY X(1), X(2), ..., X(k),
WHICH ARE MEASURED WITH"
PRINT "NEGligible ERROR AND INDEED ARE OFTEN CONTROLLED
IN THE EXPERIMENT. THUS"
PRINT "THE INDEPENDENT VARIABLES X(1), X(2), ..., X(k), ARE
NOT RANDOM VARIABLES"
PRINT "BUT ARE FIXED QUANTITIES PRESELECTED BY THE
INVESTIGATOR AND HAVE NO DI-"
PRINT "TRIBUTIONAL PROPERTIES. IN THE EXAMPLE CITED
EARLIER, OPERATING TEMPERATURE"
PRINT "IS THE INDEPENDENT VARIABLE AND YIELD IS THE
RESPONSE, Y. THIS RELATIONSHIP,"
PRINT "FITTED TO A SET OF EXPERIMENTAL DATA, IS
CHARACTERIZED BY A PREDICTION"
PRINT "EQUATION CALLED A REGRESSION EQUATION."

CALL MOVER
END SUB

SUB RPAGE2
PRINT "THREE TYPES OF REGRESSION MODELS WILL BE
DISCUSSED. IN THE CASE OF A "
PRINT "SINGLE Y AND A SINGLE X, THE SITUATION BECOMES A
REGRESSION OF Y ON X. THE "
PRINT "MODEL THAT CONTAINS A SINGLE INDEPENDENT VARIABLE
IS CALLED SIMPLE LINEAR "
PRINT "REGRESSION. FOR K INDEPENDENT VARIABLES WE SPEAK
OF A REGRESSION OF Y ON"
PRINT "X(1), X(2), ..., X(K) OR MULTIPLE REGRESSION. IF
THE MODEL IS LINEAR THEN"
PRINT "IT IS CALLED A MULTIPLE LINEAR REGRESSION MODEL.
IF, ON THE OTHER HAND,"
PRINT "THE MODEL INVOLVES, SAY, POWERS OR PRODUCTS IN THE
X'S THEN IT IS CALLED"
PRINT "A POLYNOMIAL REGRESSION MODEL."

CALL MOVER
END SUB

SUB RPAGE3
PRINT "THE TERM LINEAR REGRESSION IMPLIES THAT THE
MEAN OF Y GIVEN A FIXED"
PRINT "VALUE OF X (DENOTED Y;R$;"X") IS LINEARLY RELATED
TO X IN THE USUAL SLOPE-
PRINT "INTERCEPT FORM; NAMELY"
PRINT "WHERE ";A$;" AND ";B$;" ARE PARAMETERS TO BE
ESTIMATED FROM THE SAMPLE DATA."
PRINT "DENOTING THEIR ESTIMATES BY 'A' AND 'B',
RESPECTIVELY, THE ESTIMATED "
PRINT "RESPONSE Y IS OBTAINED FROM THE SAMPLE REGRESSION
LINE"
PRINT "Y = A + BX."
PRINT "EACH OBSERVATION Y(i) CAN BE DESCRIBED BY THE MODEL"
PRINT "Y(i) = A + BX(i) + e(i),"
PRINT "WHERE e(i) IS CALLED THE RESIDUAL."
CALL MOVER

END SUB

SUB RPAGE4
PRINT "WE SHALL FIND A AND B, THE ESTIMATES OF "A" AND "B", SO THAT THE"
PRINT "SUM OF THE SQUARES OF THE RESIDUALS IS A MINIMUM."
PRINT "SQUARES IS OFTEN CALLED THE SUM OF SQUARES OF THE ERRORS ABOUT THE REGRESSION"
PRINT "LINE AND DENOTED BY SSE. THIS MINIMIZATION PROCEDURE FOR ESTIMATING "
PRINT "PARAMETERS IS CALLED THE METHOD OF LEAST SQUARES. HENCE, WE SHALL FIND"
PRINT "A AND B SO AS TO MINIMIZE"
PRINT "n
SSE = "i=1
PRINT "n
i=1"
PRINT "DIFFERENTIATING SSE WITH RESPECT TO A AND B WE HAVE"
PRINT "dSSE n
----- = -2 "i=1"
PRINT "dA"
PRINT "dSSE 2
----- = "X(i)"
PRINT "dB i=1"
CALL MOVER
END SUB

SUB RPAGE5
PRINT "SETTING THE PARTIAL DERIVATIVES EQUAL TO ZERO AND REARRANGING THE "
PRINT "TERMS, WE OBTAIN THE EQUATIONS (CALLED NORMAL EQUATIONS)"
PRINT "nA + B = X(i) = Y(i) (1)"

PRINT "A n n "
PRINT "A n n "
PRINT "A n n "
PRINT "A n n "
PRINT "A n n "
PRINT "A n n "
PRINT "FROM THE FIRST OF THE TWO NORMAT EQUATIONS WE CAN WRITE"
PRINT "A = Y - BX."

END SUB

SUB RPAGE6
PRINT "EXAMPLE #1"
PRINT "GIVEN THE FOLLOWING SAMPLE DATA, ESTIMATE THE REGRESSION LINE."
PRINT "i 1 2 3 4 5 6 7 8
PRINT "X(i) 1.5 1.8 2.4 3.0 3.5 3.9 4.4 4.8 5.0
PRINT "Y(i) 4.8 5.7 7.0 8.3 10.9 12.4 13.1 13.6 15.3
PRINT "USING A CALCULATOR WE FIND THAT"
PRINT "9 9 9"
PRINT "X(i) = 30.3, Y(i) = 91.1, Y(i) = 91.1, Y(i) = 91.1,"
X(i)Y(i) = 345.09,
PRINT " \( i = 1 \)
PRINT " \( 9 \)\nPRINT " \( i = 1 \)
PRINT " \( Y = 10.1222, \)
PRINT " \( i = 1 \)
PRINT " \( 9(345.09) - (30.3)(91.1) \) = 2.9303"  \\
PRINT " \( 9(115.11) - (30.3)^2 \) \\
PRINT " \( A = 10.1222 - (2.9303)(3.3667) = 0.2568. \) \\
PRINT " \( Y = 0.2568 + 2.9303X. \)
END SUB

SUB RPAGE7
LET CR$ = "C"
PRINT "QUESTION #1"
PRINT "Y = (\( \alpha \)) + (\( \beta \))(X) IS WHICH KIND OF EXPRESSION? "
PRINT "A) SAMPLE REGRESSION LINE."
PRINT "B) POPULATION DISTRIBUTION FOR THE SAMPLE SLOPE."
PRINT "C) POPULATION REGRESSION LINE."
PRINT "D) SAMPLE CORRELATION COEFFICIENT EQUATION."
CALL ANSWER
END SUB
SUB RPAGE8
PRINT "MULTIPLE LINEAR REGRESSION"
PRINT "IN MOST RESEARCH PROBLEMS WHERE REGRESSION ANALYSIS IS APPLIED, MORE"
PRINT "THAN ONE INDEPENDENT VARIABLE IS NEEDED IN THE REGRESSION MODEL. THE COM-
PRINT "PLEXITY OF MOST SCIENTIFIC MECHANISMS IS SUCH THAT IN ORDER TO BE ABLE TO "
PRINT "PREDICT AN IMPORTANT RESPONSE, A MULTIPLE REGRESSION MODEL IS NEEDED. WHEN"
PRINT "THIS MODEL IS LINEAR IN THE COEFFICIENTS IT IS CALLED A MULTIPLE LINEAR RE-
PRINT "SSION MODEL. FOR THE CASE OF \( k \) INDEPENDENT VARIABLES \( X(1), X(2), \ldots, X(k), \)"
PRINT "THE MEAN OF \( Y \);R$;"X(1), X(2), \ldots, X(k) IS GIVEN BE THE MULTIPL LINEAR REGRESSION"
PRINT "MODEL."
PRINT
PRINT ";E$;"[Y]=;B$(o)+;B$(1)X(1)+...+;B$(k)X(k)"
PRINT
PRINT "AND THE ESTIMATED RESPONSE IF OBTAINED FROM THE SAMPLE EQUATION"
PRINT " Y = B(o) + B(1)X(1) + B(2)X(2) + ... + B(k)X(k),"
PRINT
PRINT "WHERE EACH REGRESSION COEFFICIENT ;B$;(i) IS ESTIMATED BY B(i)'S FROM THE"
PRINT "SAMPLE DATA. NOTE THAT THE VARIABLES X(1), X(2), ..., X(k) MAY BE QUALITATIVE OR THEY MAY BE DUMMY VARIABLES ASSOCIATED WITH SOME QUALITATIVE"
PRINT "VARIABLES."
CALL MOVER

END SUB

SUB RPAGE9
PRINT "POLYNOMIAL REGRESSION MODELS"
PRINT " THE PREVIOUS REGRESSION MODELS HAVE DEALT WITH PROBLEMS OF ESTIMATION"
PRINT "WHERE IT IS POSTULATED THAT A RESPONSE IS RELATED TO A SINGLE INDEPENDENT"
PRINT "CONTROLLED VARIABLE X, OR PERHAPES A SET OF VARIABLES THROUGH AN EQUATION IN "
PRINT "WHICH THE X’S OCCUR LINEARLY. SIMILAR LEAST SQUARES TECHNIQUES CAN BE APPLIED"
PRINT "WHERE THE MODEL INVOLVES POWERS AND PRODUCTS IN THE X’S. THIS TYPE OF MODEL"
PRINT "IS CALLED A POLYNOMIAL REGRESSION MODEL."
PRINT " FOR THE CASE OF THE SINGLE INDEPENDENT VARIABLE THE POLYNOMIAL REGRES-
PRINT "SION MODEL FOR DATA OBTAINED FROM AN EXPERIMENT THAT YIELDS n PAIRS OF "
PRINT "OBSERVATIONS OF THE FORM [(X(i),Y(i); i = 1, 2, ..., n] CAN BE REPRESENTED"
PRINT "BY THE MODEL"
PRINT "Y(i) = ;B$;(o) + ;B$;(1)X(i) + ;B$;(2)(X(i))^2 + ... + ;B$;(r)(X(i))^r + ;I$"
PRINT "AND ESTIMATED BY "
PRINT "^" 
PRINT "Y=B(o)+B(1)X(i)+B(2)X(i)^2+ ... +B(r)X(i)^r + e"
PRINT "WHERE \( r \) IS THE DEGREE OF THE POLYNOMIAL."
CALL MOVER
END SUB

SUB RPAGE10
PRINT "THE PROCEDURE FOR FITTING A POLYNOMIAL REGRESSION MODEL CAN BE GENERALIZED TO THE CASE OF MORE THAN ONE INDEPENDENT VARIABLE. FOR EXAMPLE, WE"
PRINT "HAVE A RESPONSE \( Y \) WITH \( k = 2 \) INDEPENDENT VARIABLES AND A QUADRATIC MODEL IS"
PRINT "POSTULATED OF THE TYPE "
PRINT " \( Y(i) = B_0 + B_1 X_1(i) + B_2 X_2(i) + B_{11} X_1(i)^2 + B_{22} X_2(i)^2 + B_{12} X_1(i) X_2(i) \)"
PRINT "WHERE \( Y(i), i = 1, 2, \ldots, n, \) IS THE RESPONSE TO THE COMBINATION \( [X_1(i), X_2(i)] \)"
PRINT "OF THE INDEPENDENT VARIABLES IN THE EXPERIMENT."
PRINT " IN THIS SITUATION \( n \) MUST BE AS LEAST 6 SINCE THERE ARE SIX PARAMETERS"
PRINT "TO ESTIMATE BY THE LEAST SQUARES PROCEDURE. IN ADDITION, SINCE THE MODEL"
PRINT "CONTAINS QUADRATIC TERMS IN BOTH VARIABLES, AT LEAST THREE LEVELS OF EACH"
PRINT "VARIABLE MUST BE USED."
CALL MOVER
END SUB

SUB RPAGE11
PRINT "ANALYSIS OF VARIANCE"
PRINT "OFTEN THE PROBLEM OF ANALYZING THE QUALITY OF THE ESTIMATED REGRESSION"
PRINT "EQUATION IS HANDLED THROUGH THE ANALYSIS OF VARIANCE (ANOVA) APPROACH."
PRINT "THIS IS MERELY A PROCEDURE WHERE BY THE TOTAL VARIATION IN THE DEPENDENT"
PRINT "VARIABLE IS SUBDIVIDED INTO MEANINGFUL COMPONENTS THAT ARE OBSERVED AND"
PRINT "TREATED IN A SYSTEMATIC FASHION."
PRINT " ANOVA TECHNIQUES FOR A SIMPLE LINEAR REGRESSION MODEL WILL BE DISCUSSED."
PRINT " THESE TECHNIQUES CAN BE SIMILARLY APPLIED TO MORE COMPLEX MODELS. FROM A"
COMPUTATIONAL POINT OF VIEW IT IS ADVANTAGEOUS TO INTRODUCE THE NOTATION

WHERE X IS THE INDEPENDENT VARIABLE AND Y IS THE DEPENDENT VARIABLE.

\[ \sum_{i=1}^{n} \left( x(i) \right)^2 \]

\[ \sum_{i=1}^{n} (x(i) - \bar{x})^2 = \sum_{i=1}^{n} \left( x(i) \right)^2 - \frac{\left( \sum_{i=1}^{n} x(i) \right)^2}{n} \]

\[ \sum_{i=1}^{n} \left( y(i) \right)^2 \]

\[ \sum_{i=1}^{n} (y(i) - \bar{y})^2 = \sum_{i=1}^{n} \left( y(i) \right)^2 - \frac{\left( \sum_{i=1}^{n} y(i) \right)^2}{n} \]

CALL MOVER

END SUB

SUB RPAGE12

COMPUTATIONAL NOTATION CONTINUED

\[ \sum_{i=1}^{n} \left( x(i)^2 \right) \]

\[ \sum_{i=1}^{n} \left( y(i)^2 \right) \]

\[ \sum_{i=1}^{n} (y(i) - y) = \sum_{i=1}^{n} (x(i)y(i) - \bar{x}\bar{y}) \]

\[ \sum_{i=1}^{n} (x(i)y(i) - \bar{x}\bar{y}) = \sum_{i=1}^{n} x(i)y(i) - \sum_{i=1}^{n} x(i) \sum_{i=1}^{n} y(i) \]

PREVIOUSLY THE SSE WAS CALCULATED BY

\[ \text{SSE} = \sum_{i=1}^{n} (y(i) - A - BX(i)) \]

BY SUBSTITUTION, THE SSE CAN NOW BE WRITTEN

\[ \text{SSE} = \sum_{i=1}^{n} (y(i)^2 - B[S(xy)]) \]

WITH B BEING EQUAL TO \( S(xy) / S(xx) \); ALSO

\[ S(yy) = B[S(xy)] + \text{SSE} \]

CALL MOVER
WITH THE FINAL EQUATION \[ s(\bar{Y}) = B(s(\bar{X})) + s(e) \] we have achieved a partitioning of the total sum of corrected squares of \( Y \) into two components that should reflect particular meaning to the experimenter. We shall indicate this partitioning symbolically as

\[ \text{SST} = \text{SSR} + \text{SSE}. \]

SST is called the regression sum of squares and it reflects the amount of variation in the \( Y \) values explained by the model, in this case the postulated straight line. SSE again reflects the variation about the regression line. SST is the total variation. SSR, SSE, and SST are all independent chi-square variables with 1, \( n - 2 \), and \( n - 1 \) degrees of freedom respectively.

ANOVA techniques can be used in conjunction with hypothesis testing to assess the adequacy of the model by setting up a hypothesis test about the model parameters and constructing confidence intervals.

For a simple linear regression model a hypothesis test may be

\[ H(0): \quad B = 0 \]

\[ H(A): \quad B \neq 0 \]

Where the null hypothesis essentially says that variation in \( Y \) is not explained by the straight line but rather by chance or random fluctuations.

We compute the F statistic (sometimes called the variance ratio) as

\[ F = \frac{\text{SSR}/1}{\text{SSR}} \]
PRINT "SSE/(n - 2)  S^2"
PRINT "WHERE S^2 IS AN UNBIASED ESTIMATOR OF ";'D$;'"^2 WITH n - 2 DEGREES OF FREEDOM."
PRINT "REFLECTING THE VARIATION ABOUT THE REGRESSION LINE. WE REJECT THE H(0)"
PRINT "AT THE ";'A$;' LEVEL OF SIGNIFICANCE WHEN F > F[';'A$;'(1,n - 2)]."
PRINT "FIRST THE VALUES"
PRINT "SST = S(YY)"
PRINT "SSR = B[S(XY)]"
PRINT "ARE COMPUTED, THEN MAKING USE OF THE PREVIOUS SUM OF SQUARES IDENTITY"
PRINT "SSE = SST - SSR."
CALL MOVER

END SUB

SUB RPAGE15
PRINT "THE RESULTS ARE USUALLY SUMMARIZED IN AN ANOVA TABLE AS INDICATED BELOW"
PRINT " ANOVA TABLE FOR TESTING ";'B$;' = 0"
PRINT " SOURCE OF SUM OF DEGREES OF MEAN COMPUTED" VARIATION SQUARES FREEDOM SQUARE
PRINT " REGRESSION SSR 1 SSR/1 (SSR/1)/S^2"
PRINT " ERROR SSE n - 2 S^2 = SSE/(n-2)"
PRINT " TOTAL SST n - 1"
PRINT " WHEN THE NULL HYPOTHESIS IS REJECTED, THAT IS, WHEN THE COMPUTED f"
PRINT " STATISTIC EXCEEDS THE REFLECTION VALUE, WE CONCLUDE THAT THERE IS A SIG-
PRINT " NIFICANT AMOUNT OF VARIATION IN THE RESPONSE ACCOUNTED FOR BY THE POSTULATED"
PRINT " MODEL, THE STRAIGHT-LINE FUNCTION. IF THE f STATISTIC IS IN THE ACCEPTANCE"
REGION, WE CONCLUDE THAT THE DATA DID NOT REFLECT SUFFICIENT EVIDENCE TO "

"SUPPORT THE POSTULATED MODEL. KEEP IN MIND THE ORIGINAL NULL HYPOTHESIS"

"SAID THAT THE VARIATION IN Y WAS NOT EXPLAINED BY THE STRAIGHT LINE BUT"

"RATHER BY CHANGE OR RANDOM FLUCTUATION."

CALL MOVER

END SUB

SUB RPAGE16

PRINT "CORRELATION"
PRINT "UP TO THIS POINT WE HAVE ASSUMED THAT THE INDEPENDENT VARIABLE X IS "
PRINT "CONTROLLED AND THEREFORE NOT A RANDOM VARIABLE. IN FACT, IN THIS CONTEXT, X "
PRINT "IS OFTEN CALLED A MATHEMATICAL VARIABLE, WHICH, IN THE SAMPLING PROCESS,"
PRINT "IS MEASURED WITH NEGLIGIBLE ERROR. IN MANY APPLICATIONS OF REGRESSION"
PRINT "TECHNIQUES, IT IS MORE REALISTIC TO ASSUME THAT BOTH X AND Y ARE RANDOM"
PRINT "VARIABLES AND THE MEASUREMENTS \{(X(i),Y(i)); i = 1, 2, \ldots, n\} ARE OBSER-"
PRINT "VATIONS FROM A JOINT DENSITY FUNCTION f(X,Y). FOR A SIMPLE LINEAR MODEL"
PRINT "p IS A MEASURE OF THE LINEAR RELATIONSHIP BETWEEN TWO VARIABLES X AND Y"
PRINT "AND IS ESTIMATED BY THE SAMPLE CORRELATION COEFFICIENT \( r \) WHERE"
PRINT "\( \frac{S(XY)}{[S(xx)][S(yy)]} \) "
PRINT "\( r = \frac{S(XY)}{[S(xx)][S(yy)]} \) "
PRINT "THE \( r \) RANGES FROM -1 TO +1; \( r \) WILL BE -1 OR +1 WHEN THE SSE = 0 AND THE "
PRINT "POINTS LIE IN A STRAIGHT LINE. A \( r \) CLOSE TO 0 INDICATES THAT THERE IS NO"
PRINT "RELATIONSHIP BETWEEN X AND Y. VARIABLES THAT EXHIBIT CORRELATION OVER TIME"
PRINT "ARE REFERRED TO AS AUTOCORRELATED VARIABLES."
CALL MOVER

END SUB

SUB RPAGE17
PRINT "IN THE CASE OF A MORE COMPLICATED MODEL THE ADEQUACY OF A FITTED"
PRINT "REGRESSION MODEL IS ILLUSTRATED BY THE COEFFICIENT OF MULTIPLE"
PRINT "DETERMINATION (R^2):"
PRINT " R^2 = SSR/SST"
PRINT "THIS QUANTITY MERELY INDICATES WHAT PROPORTION OF THE TOTAL VARIATION IN THE RESPONSE Y IS EXPLAINED BY THE FITTED MODEL. OFTEN AN EXPERIMENTER WILL REPORT R * 100 PERCENT AND INTERPRET THE RESULTS AS A PERCENTAGE VARIATION" PRINT "EXPLAINED BY THE POSTULATED MODEL. THE SQUARE ROOT OF R^2 IS CALLED THE MULTIPLE CORRELATION COEFFICIENT BETWEEN Y AND THE SET X(1), X(2), ..., X(k)."

CALL MOVER
END SUB

SUB RPAGE18
LET CR$ = "A"
PRINT "QUESTION #2"
PRINT "CORRELATION ANALYSIS IS WHEN ?"
PRINT " A) X AND Y ARE RANDOM VARIABLES."
PRINT " B) X AND Y ARE PRESET."
PRINT " C) X IS PRESET AND Y IS A RANDOM VARIABLE."
PRINT " D) X IS A RANDOM VARIABLE AND Y IS PRESET."

CALL ANSWER
END SUB

SUB EXDES
DO
    CLEAR
    IF MARKER = 1 THEN
        CALL DPAGE1
    ELSEIF MARKER = 2 THEN
        CALL DPAGE2
    ELSEIF MARKER = 3 THEN
        CALL DPAGE3
    ELSEIF MARKER = 4 THEN
        CALL DPAGE4
    END IF
END DO
CALL DPAGE4
ELSEIF MARKER = 5 THEN
CALL DPAGE5
ELSEIF MARKER = 6 THEN
CALL DPAGE6
ELSEIF MARKER = 7 THEN
CALL DPAGE7
ELSEIF MARKER = 8 THEN
CALL DPAGE8
ELSEIF MARKER = 9 THEN
CALL DPAGE9
ELSEIF MARKER = 10 THEN
CALL DPAGE10
ELSEIF MARKER = 11 THEN
CALL DPAGE11
ELSEIF MARKER = 12 THEN
CALL DPAGE12
ELSEIF MARKER = 13 THEN
CALL DPAGE13
ELSEIF MARKER = 14 THEN
CALL DPAGE14
ELSEIF MARKER = 15 THEN
CALL DPAGE15
ELSEIF MARKER = 16 THEN
CALL DPAGE16
ELSEIF MARKER = 17 THEN
STOP
ELSE
PRINT "MARKER OUT OF BOUNDS."
END IF
LOOP UNTIL MARKER = 17
STOP
END SUB
SUB DPAGE1

PRINT " EXPERIMENTAL DESIGN"
PRINT PRINT " A TRUE EXPERIMENT MAY BE DEFINED AS A STUDY IN
WHICH CERTAIN INDEPENDENT VARIABLES ARE MANIPULATED, THEIR EFFECT ON ONE
OR MORE DEPENDENT"
PRINT "VARIABLES IS DETERMINED, AND THE LEVEL OF INDEPENDENT
VARIABLES ARE ASSIGNED"
PRINT "AT RANDOM TO UNITS IN THE STUDY. THUS MANIPULATION
AND RANDOMIZATION ARE"
PRINT "ESSENTIAL FOR A TRUE EXPERIMENT FROM WHICH ONE MAY
BE ABLE TO INFER CAUSE"
PRINT "AND EFFECT."
PRINT "MOST SUCCESSFUL EXPERIMENTS CONTAIN THREE PHASES: THE EXPERIMENTAL OR"
PRINT "PLANNING PHASE, THE DESIGN PHASE, AND THE ANALYSIS PHASE. THE EXPERIMENTAL"
PRINT "PHASE INVOLVES STATING THE PROBLEM, CHOOSING THE RESPONSE OR DEPENDENT"
PRINT "VARIABLE, SELECTING THE FACTORS TO BE VARIED, CHOOSING THE LEVELS OF THESE"
PRINT "FACTORS, AND DETERMINING HOW THE FACTOR LEVELS ARE TO BE COMBINED. THE"
PRINT "DESIGN PHASE CONSISTS OF DECIDING THE NUMBER OF OBSERVATIONS TO TAKEN, THE"
PRINT "ORDER OF EXPERIMENTATION, THE METHOD OF RANDOMIZATION TO BE USED, THE"
PRINT "MATHEMATICAL MODEL TO DESCRIBE THE EXPERIMENT, AND THE HYPOTHESIS TO BE"
PRINT "TESTED. THE ANALYSIS PHASE INCLUDES DATA COLLECTION AND PROCESSING, COM-
PRINT "PUTATION OF THE TEST STATISTICS, AND INTERPRETATION OF THE RESULTS. THE"
PRINT "LATTER TWO PHASES, EXPERIMENTAL DESIGN AND ANALYSIS, ARE OUR TOPICS OF "
PRINT "INTEREST."
CALL MOVER
END SUB

SUB DPAGE2
PRINT "IN AN EXPERIMENT WHENEVER ONLY ONE FACTOR OR INDEPENDENT VARIABLE IS"
PRINT "VARIED, WHETHER THE LEVELS OF THE FACTOR ARE QUANTITATIVE OR QUALITATIVE,"
PRINT "FIXED OR RANDOM, THE EXPERIMENT IS CALLED A SINGLE FACTOR EXPERIMENT."
PRINT "MULTIFACTOR EXPERIMENTS INVOLVE VARYING TWO OR MORE FACTORS."
PRINT "THREE TYPES OF SINGLE FACTOR DESIGNS ARE DISCUSSED: COMPLETELY RAN-
PRINT "DOMIZED, RANDOMIZED BLOCK, AND LATIN SQUARE. ANALYSIS OF VARIANCE (ANOVA)"
PRINT "TECHNIQUES WILL BE DISCUSSED WITH EACH DESIGN WITH AN EXAMPLE GIVEN FOR THE"
PRINT "COMPLETELY RANDOMIZED DESIGN AND ADJUSTMENTS NEEDED TO ADAPT THE TECHNIQUES"
PRINT "TO THE OTHER DESIGNS."
PRINT "FINALLY, THE MULTIFACTOR DESIGN, THE VARYING OF TWO OR MORE FACTORS,"
"SINGLE FACTOR DESIGN - COMPLETELY RANDOMIZED"

COMPLETELY RANDOMIZED DESIGN, THE FIRST TYPE OF SINGLE FACTOR DESIGN,
OCURS WHEN NO RESTRICTIONS ARE PLACED ON RANDOMIZATION. THIS DESIGN IS
USED WHEN THE ORDER OF EXPERIMENTATION APPLIED TO THE LEVELS OF THE FACTOR "IS COMPLETELY RANDOM, SO THAT ANY REGION TO WHICH THE TREATMENTS MIGHT BE" APPLIED IS CONSIDERED APPROXIMATELY HOMOGENEOUS. USUALLY AN EQUAL NUMBER
"OF SUBJECTS SHOULD APPEAR IN EACH TREATMENT."
THE MATHEMATICAL MODEL FOR THE COMPLETELY RANDOMIZED DESIGN IS "

Y(i,j) = \( \beta \) + \( \gamma \) + e(i,j)

WHERE Y(i,j) REPRESENTS THE i TH OBSERVATION (i = 1, 2, ..., n) ON THE j TH TREATMENT (j = 1, 2, ..., k LEVELS). FOR EXAMPLE Y(2,3) REPRESENTS THE SECOND OBSERVATION USING THE LEVEL THREE OF THE FACTOR. \( \beta \) IS A COMMON EFFECT
"OF THE WHOLE EXPERIMENT, \( \gamma \) REPRESENTS THE EFFECT OF THE j TH TREATMENT" AND e(i,j) REPRESENTS THE RANDOM ERROR PRESENT IN THE i TH OBSERVATION
"ON THE j TH TREATMENT."

COMPLETELY RANDOM - CONTINUED

THE ANALYSIS OF A SINGLE FACTOR COMPLETELY RANDOMIZED EXPERIMENT"
USUALLY CONSISTS OF A ONE-WAY ANALYSIS OF VARIANCE (ANOVA) TEST WHERE THE HYPOTHESIS $H(0): \beta_j = 0$ FOR ALL $j$ (TREATMENTS) IS TESTED. IF THE HYPOTHESIS IS TRUE, THEN NO TREATMENT EFFECTS EXIST AND EACH OBSERVATION $Y(i,j)$ IS MADE UP OF POPULATION MEAN, $\mu$, AND RANDOM ERROR, $e(i,j)$.

FOR THE HYPOTHESIS TEST THE REJECTION REGION IS USUALLY TAKEN AS THE UPPER TAIL OF THE $F$ DISTRIBUTION. THE $H(0)$ IS REJECTED IF THE CALCULATED $F$ VALUE IS GREATER THAN OR EQUAL TO $F(k-1,N-k)$ WHERE $k$ EQUALS THE NUMBER OF TREATMENT LEVELS AND $N$ IS THE TOTAL NUMBER OF OBSERVATIONS. IN CALCULATING $F$ THE SUM OF SQUARES BETWEEN TREATMENTS IS ALWAYS PUT INTO THE NUMERATOR,

THUS A SIGNIFICANT $F$ WOULD INDICATE THAT THE DIFFERENCES BETWEEN MEANS HAS SOMETHING IN IT BEYOND THE ESTIMATE OF VARIANCE. THESE UNBIASED ESTIMATES OF POPULATION VARIANCE, SUM OF SQUARES, DIVIDED BY DEGREES OF FREEDOM, ARE ALSO REFERRED TO AS MEAN SQUARES. THE $F$ VALUE IS CALCULATED BY DIVIDING THE MEAN SQUARE BETWEEN TREATMENTS BY THE MEAN SQUARE ERROR.

(OR WITHIN). THE NUMBER OF DEGREES OF FREEDOM FOR BETWEEN TREATMENTS IS THE NUMBER OF TREATMENTS MINUS 1. FOR THE ERROR TERM OR WITHIN TREATMENTS

THE DEGREES OF FREEDOM IS THE TOTAL NUMBER OF OBSERVATIONS ($N$) MINUS THE NUMBER OF TREATMENTS.

BEFORE COMPUTING THESE SUM OF SQUARES AND THE ANOVA TABLE SOME SHORTHAND NOTATION IS USEFUL. LET $T.j$ REPRESENT THE TOTAL SUM OF THE OBSERVATIONS TAKEN UNDER TREATMENT $j$, $n(j)$ REPRESENT THE NUMBER OF OBSERVATIONS.
PRINT "VATIONS TAKEN FOR TREATMENT j, AND \(Y_{ij}\) REPRESENT THE OBSERVED MEAN\nFOR TREATMENT j. \(T..\) REPRESENTS THE TOTAL SUM OF ALL OBSERVATIONS AND N\nTHE TOTAL NUMBER OF OBSERVATIONS TAKEN."
PRINT "THE TOTAL SUM OF SQUARES, SST, IS CALCULATED BY" PRINT
PRINT \(k \sum_{j} n(j) T..^2\) PRINT \(SS(\text{TOTAL}) = \sum_{i=1}^{\infty} \sum_{j=1}^{\infty} \sum_{n(j)} Y_{ij}^2 - -------\) PRINT \(j=1 i=1 N\)
PRINT "THE SUM OF SQUARES BETWEEN TREATMENTS IS CALCULATED BY" PRINT \(k \sum_{j=1}^{\infty} \sum_{n(j)} T.j^2 T..^2\) PRINT \(SS(\text{TREATMENT}) = \sum_{j=1}^{\infty} \sum_{n(j)} ------- \) PRINT \(j=1 n(j) N\)
PRINT "THE SUM OF SQUARES FOR ERROR OR WITHIN TREATMENTS IS DETERMINED BY" PRINT \(SS(\text{ERROR}) = SS(\text{TOTAL}) - SS(\text{TREATMENT})."\nCALL MOVER END SUB

SUB DPAGE6 PRINT "EXAMPLE #\#1"
PRINT "CONSTRUCT AN ANOVA TABLE FOR THE FOLLOWING FABRIC WEAR RESISTANCE DATA."
PRINT "FABRIC"
PRINT "A B C D"
PRINT 1.93 2.25 2.40 2.33" PRINT 2.38 2.72 2.68 2.40" PRINT 2.20 2.75 2.31 2.28" PRINT 2.25 2.70 2.28 2.25" PRINT "T.j: 8.76 10.72 9.67 9.26 T.. = 38.41" PRINT \(n(j): 4 4 4 4\) PRINT \(N = 16\"
PRINT \(n(j)\) PRINT \(\sum_{i=1}^{\infty} \sum_{n(j)} Y_{ij}^2: 19.2918 28.7534 23.4769 21.4498\) PRINT \(i=1\)"
PRINT " k  n(j)"
PRINT " ;C$; " ;C$; " Y(i,j)^2 = 92.9719"
PRINT " j=1  i=1"

CALL MOVER

END SUB

SUB DPAGE7

PRINT "EXAMPLE #1 CONTINUED"
PRINT "TO CALCULATE THE SUM OF SQUARES:
PRINT " k  n(j) T..^2 (38.41)^2"
PRINT "SS(TOT)=" ;C$; " ;C$; "Y(i,j)^2 - -------=92.9717 - 
PLAY " j=1  i=1 N 16"
PRINT " k  T.j^2  T..^2" PRINT " SS(TREATMENT) = " ;C$; " ------- = " PRINT " j=1  n(j)  N"
PRINT " 8.76  10.72  9.67  9.26 (38.4 
1)'^2"
PRINT " ------- + ------- + ------- + ------- - ------- 
----- = 0.5201"
PRINT " 4  4  4  4  16"
PRINT " SS(ERROR) = SS(TOTAL) - SS(TREATMENT) = 0.7639 - 
0.5201 = .2438"
PRINT " ANOVA TABLE"
PRINT " SOURCE OF VARIATION  D.F.  SS
MS   F"
PRINT " TREATMENT (BETWEEN)  3  0.5201
0.1734  8.54" PRINT " ERROR (WITHIN)  12  0.2438
0.0203" PRINT " TOTAL  15  0.7639"

CALL MOVER

END SUB

SUB DPAGE8
"TO TEST THE HYPOTHESIS THAT ALL OF THE TREATMENT MEANS ARE EQUAL:"

"H(0): \$F_j = 0 \text{ for all } j = 1, 2, 3, \text{ and } 4."

"THE TEST STATISTIC IS:"

"F(3,12) = 0.1734/0.0203 = 8.54"

"WHICH IS SIGNIFICANT AT THE 1 PERCENT LEVEL. THE TABLES SHOW 5.95 AS"

"THE 1 PERCENT F [F(0.99)] FOR 3 AND 12 DEGREES OF FREEDOM. WE CAN REJECT"

"THE HYPOTHESIS AND CLAIM THAT THERE IS A CONSIDERABLE DIFFERENCES IN AVERAGE"

"WEAR RESISTANCE AMONG THE FOUR FABRICS. THE NEWMAN - KEUL'S RANGE TEST AND"

"SCHEFFE'S TEST ARE TWO TESTS THAT CAN BE USED TO MAKE MORE SPECIFIC COM-

"PARISONS BETWEEN MEANS AFTER THE HYPOTHESIS TEST."

"THE SECOND TYPE OF SINGLE FACTOR DESIGN DISCUSSED IS THE RANDOMIZED"

"BLOCK DESIGN. THIS DESIGN INTRODUCES A BLOCKING FACTOR WHICH THE COMPLETELY"

"RANDOMIZED DESIGN DOES NOT INCORPORATE. FOR EXAMPLE, SUPPOSE FOUR BRANDS"

"OF TIRES (A, B, C, AND D) ARE BEING TESTED FOR TREAD WEAR. FOUR TIRES OF"

"EACH BRAND WILL BE USED AS WILL FOUR DIFFERENT CARS (I, II, III, AND IV)."

"IN THE COMPLETELY RANDOMIZED DESIGN SUPPOSE BRAND A IS NEVER USED ON CAR "

"III OR BRAND B ON CAR I. ANY VARIATION WITHIN BRANDS A AND B MAY REFLECT"

"VARIATION BETWEEN THE CARS. THUS THE RANDOM ERROR MAY NOT BE MERELY AN"

"EXPERIMENTAL ERROR. SINCE THE CHIEF OBJECTIVE OF EXPERIMENTAL DESIGN IS"

"TO REDUCE EXPERIMENTAL ERROR, A BETTER DESIGN MIGHT
BE ONE IN WHICH CAR VARIATION IS REMOVED FROM ERROR VARIATION. A DESIGN THAT REQUIRES THAT EACH BRAND BE USED ONCE ON EACH CAR IS A RANDOMIZED COMPLETE BLOCK DESIGN.

PRINT "RANDOMIZED BLOCK DESIGN - CONTINUED"
PRINT "IN THE RANDOMIZED COMPLETE BLOCK DESIGN THE ORDER IN WHICH THE FOUR BRANDS OF TIRES FROM THE PREVIOUS EXAMPLE ARE PLACED ON A CAR IS RANDOM"
PRINT "AND EACH CAR GETS ONE TIRE OF EACH BRAND. THIS PROVIDES A MORE HOMOGENEOUS ENVIRONMENT IN WHICH TO TEST THE FOUR BRANDS. IN GENERAL, THESE GROUPINGS ARE CALLED BLOCKS, AND RANDOMIZATION IS NOW RESTRICTED WITHIN BLOCKS. THIS ALLOWS THE CAR (BLOCK) VARIATION TO BE INDEPENDENTLY ASSESSED AND REMOVED FROM THE ERROR TERM. THE MODEL FOR THIS DESIGN IS"
PRINT "Y(i,j) = \$ + \$B(i) + \$F(j) + e(i,j)"
PRINT "WHERE \$B(i) NOW REPRESENTS THE BLOCK (CAR) EFFECT."

PRINT "RANDOMIZED BLOCK DESIGN (ANOVA)"
PRINT "THE ANALYSIS OF THIS MODEL IS A TWO-WAY ANALYSIS OF VARIANCE, SINCE THE BLOCK EFFECT MAY NOW ALSO BE ISOLATED. THE SS(TOTAL) AND THE SS(TREATMENT) ARE CALCULATED AS BEFORE. THE CAR (BLOCK) EFFECT IS SIMILAR TO THE BRAND EFFECT BUT TOTALED FOR THE FOUR TIRES ON EACH CAR (I, II, III, AND IV)."
PRINT "THE CAR SUM OF SSQUARES IS COMPUTED EXACTLY LIKE THE
BRAND SUM OF SQUARES
PRINT "EXCEPT CAR TOTALS (Ti.) ARE USED INSTEAD OF BRAND TOTALS. CALLING THE"
PRINT "NUMBER OF TREATMENTS IN GENERAL k, THEN"

PRINT
PRINT "n \sum_{i=1}^{n} (Ti.)^2 (T..)^2" - --------- - ---------.
PRINT "SS(BLOCK) = \sum_{i=1}^{n} (Ti.)^2 (T..)^2"
PRINT "N" "N"
PRINT "THE SS(ERROR) IS CALCULATED AS"
PRINT "SS(ERROR) = SS(TOTAL) - SS(TREATMENT) - SS(BLOCK)"
PRINT "THE PARTIAL ANOVA TABLE FOR THIS DESIGN IS:"
PRINT "SOURCE OF VARIATION DEGREES OF FREEDOM"
PRINT "BETWEEN BLOCKS \( n - 1 \)"
PRINT "BETWEEN TREATMENTS \( k - 1 \)"
PRINT "ERROR \( (n - 1)(k - 1) \)"
PRINT "TOTAL \( nk - 1 \)"
CALL MOVER

END SUB

SUB DPAGE12
PRINT "LATIN SQUARE DESIGN"
PRINT "IN THE PREVIOUS TIRE BRAND EXAMPLE WHERE THE RANDOMIZED BLOCK DESIGN"
PRINT "IS USED THE FOUR BRANDS WERE RANDOMIZED ONTO THE FOUR WHEELS OF EACH CAR"
PRINT "WITH NO REGARD FOR POSITION. TO COUNTERBALANCE THIS THE POSITIONS CAN IMPOSE"
PRINT "ANOTHER RESTRICTION ON THE RANDOMIZATION IN SUCH A WAY THAT EACH BRAND IS NOT"
PRINT "ONLY USED ONCE ON EACH CAR BUT ALSO ONLY ONCE IN EACH OF THE FOUR POSSIBLE"
PRINT "POSITIONS: LEFT FRONT, LEFT REAR, RIGHT FRONT, AND RIGHT REAR. A DESIGN IN"
PRINT "WHICH EACH TREATMENT APPEARS ONCE AND ONLY ONCE IN EACH ROW (POSITION) AND "
PRINT "ONCE IN EACH COLUMN (CAR) IS CALLED A LATIN SQUARE DESIGN. INTEREST IS STILL"
PRINT "CENTERED ON ONE FACTOR, TREATMENT, BUT TWO RESTRICTIONS ARE PLACED ON"
PRINT "RANDOMIZATION. SUCH A DESIGN IS ONLY POSSIBLE WHEN THE NUMBER OF LEVELS"
PRINT "OF BOTH RESTRICTIONS EQUALS THE NUMBER OF TREATMENT LEVELS."
PRINT "THE MODEL FOR THIS DESIGN IS"
PRINT "Y(i,j,k) = \( E_i + B_j + F_k + e(i,j,k) \)"
PRINT "WHERE \( K_k \) REPRESENTS THE POSITION EFFECT."
CALL MOVER
END SUB

SUB DPAGE13
PRINT "LATIN SQUARE - CONTINUED"
PRINT "THE ANALYSIS OF THE DATA IN A LATIN SQUARE DESIGN IS A SIMPLE EXTENSION"
PRINT "OF THE RANDOMIZED BLOCK DESIGN EXCEPT THAT THE DATA IS NOW ADDED IN A THIRD"
PRINT "DIRECTION, POSITION. THE POSITION SUM OF SQUARES IS CALCULATED USING THE"
PRINT "SAME METHOD AS THE SUM OF SQUARES (BLOCK) EXCEPT THAT POSITION TOTALS ARE"
PRINT "USED INSTEAD OF BLOCKING TOTALS. THE SS(ERROR) FOR THE LATIN SQUARE"
PRINT "DESIGN IS"
PRINT "SS(ERROR) = SS(TOTAL) - SS(TREATMENT) - SS(BLOCK) - SS(POSITION)"
CALL MOVER
END SUB

SUB DPAGE14
PRINT "MULTIFACTOR DESIGN"
PRINT "THE PREVIOUS METHODS OF EXPERIMENTAL DESIGN HAVE DEALT WITH THE EFFECTS"
PRINT "OF A SINGLE FACTOR. SUPPOSE THERE ARE NOW TWO FACTORS OF INTEREST TO THE"
PRINT "EXPERIMENTER, FOR EXAMPLE, THE EFFECT OF BOTH TEMPERATURE AND ALTITUDE"
PRINT "ON THE CURRENT FLOW IN A SMALL COMPUTER. ONE TRADITIONAL METHOD IS TO HOLD"
PRINT "ALTITUDE CONSTANT AND VARY THE TEMPERATURE AND THEN"
HOLD THE TEMPERATURE

PRINT "CONSTANT AND VARY THE ALTITUDE, OR IN GENERAL HOLD ALL FACTORS CONSTANT"

PRINT "EXCEPT ONE AND TAKE CURRENT FLOW READINGS FOR SEVERAL LEVELS OF THIS ONE"

PRINT "FACTOR, THEN CHOOSE ANOTHER FACTOR TO VARY, HOLDING ALL OTHERS CONSTANT,"

PRINT "AND SO FORTH."

PRINT "A FACTORIAL EXPERIMENT IS ONE IN WHICH ALL LEVELS OF A GIVEN FACTOR"

PRINT "ARE COMBINED WITH ALL LEVELS OF EVERY OTHER FACTOR IN THE EXPERIMENT. THUS"

PRINT "IF FOUR TEMPERATURES ARE CONSIDERED AT THREE ALTITUDES, A 4 X 3 FACTORIAL"

PRINT "EXPERIMENT WOULD BE RUN REQUIRING TWELVE DIFFERENT EXPERIMENTAL CONDITIONS."

PRINT "WHEN A CHANGE IN ONE FACTOR PRODUCES A DIFFERENT CHANGE IN THE RESPONSE"

PRINT "VARIABLE AT ONE LEVEL OF ANOTHER FACTOR THAN AT OTHER LEVELS OF THIS FACTOR,"

PRINT "THERE IS AN INTERACTION BETWEEN THE TWO FACTORS."

PRINT "THE ADVANTAGES OF A FACTORIAL EXPERIMENT COMPARED TO THE TRADITIONAL"

PRINT "METHOD ARE THAT THE FACTORIAL DESIGN IS MORE EFFICIENT (FEWER OBSERVATIONS"

PRINT "ARE REQUIRED), IT USES ALL DATA POINTS TO COMPUTE EFFECTS, AND IT INDICATES"

PRINT "POSSIBLE INTERACTION BETWEEN FACTORS."

CALL MOVER

END SUB

SUB DPAGE15

PRINT "MULTIFACTOR DESIGN - CONTINUED"

PRINT "THE MATHEMATICAL MODEL FOR A 3 X 2 FACTORIAL EXPERIMENT WITH 2 OBSER-

PRINT "VATIONS PER CELL CAN BE WRITTEN AS"

PRINT "Y(i,j,k) = \"E\" + \"F\"(i,j) + e[k(i,j)]"

PRINT "WHERE"

PRINT "i = 1, 2, 3 FOR FACTOR 1"

PRINT "j = 1, 2 FOR FACTOR 2"

PRINT "k = 1, 2 FOR THE TWO OBSERVATIONS IN EACH i,j TREATMENT COMBINATION"
";F$;"(i,j) = THE SIX TREATMENT EFFECTS"
PRINT " e[k(i,j)] = THE ERROR WITHIN EACH OF THE SIX TREATMENTS."
PRINT "THE NOTATION k(i,j) INDICATES THAT THE ERRORS ARE UNIQUE TO EACH i,j COMBINATION OR ARE NESTED WITHIN EACH i,j."
PRINT "A PARTIAL ANOVA TABLE FOR A TWO-FACTOR FACTORIAL WITH n REPLICATIONS"
PRINT "PER CELL IS GIVEN ON THE FOLLOWING SCREEN."

CALL MOVER

SUB DPAGE16
PRINT "MULTIFACTOR DESIGN - CONTINUED"
PRINT "PARTIAL GENERAL ANOVA TABLE FOR TWO-FACTOR FACTORIAL WITH n REPLICATIONS PER CELL:
PRINT "SOURCE OF VARIATION                      DEGREES OF FREEDOM"
PRINT "FACTOR A(i)                          (A - 1)"
PRINT "FACTOR B(j)                          (B - 1)"
PRINT "A X B INTERACTION                     (A - 1)(B - 1)"
PRINT "ERROR                                AB(n - 1)"
PRINT "TOTAL                                ABn - 1"
CALL MOVER
END SUB

LET MARKER = 1
IF HELP$ = "EST" THEN
   CALL ESTIMATE
ELSEIF HELP$ = "HYP" THEN
   CALL HYPOTEST
ELSEIF HELP$ = "REG" THEN
   CALL REGRESS
ELSEIF HELP$ = "EXP" THEN
   CALL EXDES
ELSE
PRINT "HELP$ OUT OF BOUNDS ";HELP$}
END IF

END