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The LibreTexts approach is highly collaborative where an Open Access textbook environment is under constant revision by students, faculty, and outside experts to supplant conventional paper-based books. Campus BookshelvesBookshelvesLearning Objects Home is shared under a not declared license and was authored, remixed, and/or curated by LibreTexts. The statistical practice of hypothesis testing is widespread not only in statistics but also throughout the natural and social sciences. When we conduct a hypothesis test there a couple of things that could go wrong. There are two kinds of errors, which by design cannot be avoided, and we must be aware that these errors exist. The errors are given the quite pedestrian names of type I and type II errors. What are type I and type II errors, and how we distinguish between them? Briefly: Type I errors happen when we reject a true null hypothesis Type II errors happen when we fail to reject a false null hypothesis We will explore more background behind these types of errors with the goal of understanding these statements. The process of hypothesis testing can seem to be quite varied with a multitude of test statistics. But the general process is the same. Hypothesis testing involves the statement of a null hypothesis and the selection of a level of significance. The null hypothesis is either true or false and represents the default claim for a treatment or procedure. For example, when examining the effectiveness of a drug, the null hypothesis would be that the drug has no effect on a disease. After formulating the null hypothesis and choosing a level of significance, we acquire data through observation. Statistical calculations tell us whether or not we should reject the null hypothesis. In an ideal world, we would always reject the null hypothesis when it is false, and we would not reject the null hypothesis when it is indeed true. But there are two other scenarios that are possible, each of which will result in an error. The first kind of error that is possible involves the rejection of a null hypothesis that is actually true. This kind of error is called a type I error and is sometimes called an error of the first kind. Type I errors are equivalent to false positives. Let’s go back to the example of a drug being used to treat a disease. If we reject the null hypothesis in this situation, then our claim is that the drug does, in fact, have some effect on a disease. But if the null hypothesis is true, then, in reality, the drug does not combat the disease at all. The drug is falsely claimed to have a positive effect on a disease. Type I errors can be controlled. The value of alpha, which is related to the level of significance that we selected has a direct bearing on type I errors. Alpha is the maximum probability that we have a type I error. For a 95% confidence level, the value of alpha is 0.05. This means that there is a 5% probability that we will reject a true null hypothesis. In the long run, one out of every twenty hypothesis tests that we perform at this level will result in a type I error. The other kind of error that is possible occurs when we do not reject a null hypothesis that is false. This sort of error is called a type II error and is also referred to as an error of the second kind. Type II errors are equivalent to false negatives. If we think back again to the scenario in which we are testing a drug, what would a type II error look like? A type II error would occur if we accepted that the drug had no effect on a disease, but in reality, it did. The probability of a type II error is given by the Greek letter beta. This number is related to the power or sensitivity of the hypothesis test, denoted by 1 – beta. Type I and type II errors are part of the process of hypothesis testing. Although the errors cannot be completely eliminated, we can minimize one type of error. Typically when we try to decrease the probability one type of error, the probability for the other type increases. We could decrease the value of alpha from 0.05 to 0.01, corresponding to a 99% level of confidence. However, if everything else remains the same, then the probability of a type II error will nearly always increase. Many times the real world application of our hypothesis test will determine if we are more accepting of type I or type II errors. This will then be used when we design our statistical experiment. Deadline pressure? Get your assignment done in just 3 hours. Quick, easy, and available 24/7. Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Here is a list hypothesis testing exercises and solutions. Try to solve a question by yourself first before you look at the solution.Question 1 In the population, the average IQ is 100 with a standard deviation of 15. A team of scientists want to test a new medication to see if it has either a positive or negative effect on intelligence, or not effect at all. A sample of 30 participants who have taken the medication has a mean of 140. Did the medication affect intelligence? View Solution to Question 1A professor wants to know if her introductory statistics class has a good grasp of basic math. Six students are chosen at random from the class and given a math proficiency test. The professor wants the class to be able to score above 70 on the test. The six students get the following scores:62, 92, 75, 68, 83, 95. Can the professor have 90% confidence that the mean score for the class on the test would be above 70. Solution to Question 2 Question 3 In a packaging plant, a machine packs cartons with jars. It is supposed that a new machine would pack faster on the average than the machine currently used. To test the hypothesis, the time it takes each machine to pack ten cartons are recorded. The result in seconds is as follows. New MachineOld Machine 42.1 42.7 41 43.6 41.3 43.8 41.8 43.3 42.4 42.5 42.8 43.5 43.2 43.1 42.3 41.7 41.8 44 42.744.1Do the data provide sufficient evidence to conclude that, on the average, the new machine packs faster? Perform the required hypothesis test at the 5% level of significance. Solution to Question 3 Question 4 We want to compare the heights in inches of two groups of individuals. Here are the measurements: X: 175, 168, 168, 190, 156, 181, 182, 175, 174, 179 Y: 120, 180, 125, 188, 130, 190, 110, 185, 112, 188 Solution to Question 4 Question 5 A clinic provides a program to help their clients lose weight and asks a consumer agency to investigate the effectiveness of the program. The agency takes a sample of 15 people, weighing each person in the sample before the program begins and 3 months later. The results a tabulated belowDetermine is the program is effective. Solution to Question 5Question 6 A sample of 20 students were selected and given a diagnostic module prior to studying for a test. And then they were given the test again after completing the module. . The result of the students scores in the test before and after the test is tabulated below.We want to see if there is significant improvement in the student’s performance due to this teaching method Solution to Question 6 Question 7 A study was performed to test wether cars get better mileage on premium gas than on regular gas. Each of 10 cars was first filled with regular or premium gas, decided by a coin toss, and the mileage for the tank was recorded. The mileage was recorded again for the same cars using other kind of gasoline. Determine wether cars get significantly better mileage with premium gas.Mileage with regular gas: 16,20,21,22,23,22,27,25,27,28 Mileage with premium gas: 19, 22,24,24,25,25,26,26,28,32 Solution to Question 7 Question 8 An automatic cutter machine must cut steel strips of 1200 mm length. From a preliminary data, we checked that the lengths of the pieces produced by the machine can be considered as normal random variables with a 3mm standard deviation. We want to make sure that the machine is set correctly. Therefore 16 pieces of the products are randomly selected and weight. The figures were in mm: 1193,1196,1198,1195,1198,1199,1204,1193,1203,1201,1196,1200,1191,1196,1198,1191 Examine wether there is any significant deviation from the required size Solution to Question 8How to Conduct Wilcoxon Signed Rank Test Question 9 Blood pressure reading of ten patients before and after medication for reducing the blood pressure are as followsPatient: 1,2,3,4,5,6,7,8,9,10 Before treatment: 86,84,78,90,92,77,89,90,90,86 After treatment: 80,80,92,79,92,82,88,89,92,83Test the null hypothesis of no effect agains the alternate hypothesis that medication is effective. Execute it with Wilcoxon test Solution to Question 9Question on ANOVA Sussan Sound predicts that students will learn most effectively with a constant background sound, as opposed to an unpredictable sound or no sound at all. She randomly divides 24 students into three groups of 8 each. All students study a passage of text for 30 minutes. Those in group 1 study with background sound at a constant volume in the background. Those in group 2 study with nose that changes volume periodically. Those in group 3 study with no sound at all. After studying, all students take a 10 point multiple choice test over the material. Their scores are tabulated below.Group1: Constant sound: 7,4,6,8,6,6,2,9 Group 2: Random sound: 5,5,3,4,4,7,2,2 Group 3: No sound at all: 2,4,7,1,2,1,5,5 Solution to Question 10Question 11 Using the following three groups of data, perform a one-way analysis of variance using $\alpha = 0.05$.Group 1Group 2Group 3512356454376332744543876745 56Solution to Question 11Question 12 In a packaging plant, a machine packs cartons with jars. It is supposed that a new machine would pack faster on the average than the machine currently used. To test the hypothesis, the time it takes each machine to pack ten cartons are recorded. The result in seconds is as follows.New Machine: 42,41,41.3,41.8,42.4,42.8,43.2,42.3,41.8,42.7 Old Machine: 42.7,43.6,43.8,43.3,42.5,43.5,43.1,41.7,44,44.1Perform an F-test to determine if the null hypothesis should be accepted. Solution to Question 12Question 13 A random sample 500 U.S adults are questioned about their political affiliation and opinion on a tax reform bill. We need to test if the political affiliation and their opinon on a tax reform bill are dependent, at 5% level of significance. The observed contingency table is given below.favorindifferentopposedtotaldemocrat1388364285republican646784215total2021501485 00Solution to Question 13Question 14 Can a dice be considered regular which is showing the following frequency distribution during 1000 throws?Thrown Value123456Frequency182154162175151176Solution to Question 14Solution to Question 15Question 16 A newly developed muesli contains five types of seeds (A, B, C, D and E). The percentage of which is 35%, 25%, 20%, 10% and 10% according to the product information. In a randomly selected muesli, the following volume distribution was found.ComponentABCDENumber of Pieces1841451006363Lets us decide about the null hypothesis whether the composition of the sample corresponds to the distribution indicated on the packaging at alpha = 0.1 significance level. Solution to Question 16Question 17 A research team investigated whether there was any significant correlation between the severity of a certain disease runoff and the age of the patients. During the study, data for n = 200 patients were collected and grouped according to the severity of the disease and the age of the patient. The table below shows the resultAgebelow 4040 – 60above 60runoffslight41349average252512serious63315Let us decided about the correlation between the age of the patients and the severity of disease progression. Solution to Question 17Question 18 A publisher is interested in determine which of three book cover is most attractive. He interviews 400 people in each of the three states (California, Illinois and New York), and asks each person which of the cover he or she prefers. The number of preference for each cover is as follows:CaliforniaIllinoisNew YorkTotalFirst Cover8160182323Second Cover789395266Third Cover2412471236 11Total4004004001200Table 1Do these data indicate that there are regional differences in people’s preferences concerning these covers? Use the 0.05 level of significance.Solution to Question 18Question 19 Trees planted along the road were checked for which ones are healthy(H) or diseased (D) and the following arrangement of the trees were obtained:H H H H D D D H H H H H H H D D H H D D DTest at the = 0.05 significance wether this arrangement may be regarded as randomSolution to Question 19 Question 20 Suppose we flip a coin n = 15 times and come up with the following arrangementsH T T T H H T T T T H H T H H(H = head, T = tail)Test at the alpha = 0.05 significance level whether this arrangement may be regarded as random.Solution to Question 20 16 marksA hypothesis test uses a sample of data in an experiment to test a statement made about the value of a population parameter ().Explain, in the context of hypothesis testing, what is meant by:(i) ‘sample of data’, (ii) ‘population parameter’(iii) ‘null hypothesis’,(iv) ‘alternative hypothesis’,(v) ‘a Type I error’,(vi) ‘a Type II error’.Did this page help you?2a3 marksFrom previous research, Marta has found that in general there is a 15% chance that any given customer ordering food at her restaurant will choose a salad. She wants to test whether people are more inclined to eat salads when it is sunny out.(i) Clearly defining the value of the population parameter (), state a suitable null hypothesis that Marta could use for this test.(ii) State a suitable alternative hypothesis that Marta could use for this test.(iii) Give an example of a test statistic that Marta could use to carry out this test.2b1 markAfter carrying out the test, Marta had evidence to conclude that people are more likely to eat salads when the sun is out. State whether she accepted or rejected the null hypothesis you have written in part (a)(i).Did this page help you?36 marksFor the following null and alternative hypotheses, state whether the test is a one-tailed or a two-tailed test and give a suitable example context for each problem.(i) (ii) (iii) Did this page help you?46 marksIn a quiz, students have to choose the correct answer to each question from three possible options. There is only one correct answer for each question. Ethan got answers correct, and he claims that he merely guessed the answer to every question but his teacher believes he used some knowledge in the quiz. he uses the null hypothesis to test her belief at the 10% significance level.(i) If the teacher wishes to test to see if Ethan was trying to get the answers correct, rather than guessing them at random, write down the alternative hypothesis she should use and explain the conditions under which the null hypothesis would be rejected.(ii) If the teacher wishes to test to see if Ethan was trying to get the answers incorrect, rather than guessing them at random, write down the alternative hypothesis she should use and explain the conditions under which the null hypothesis would be rejected.(iii) If the teacher wishes to test to see whether Ethan was not guessing the answers at random, but she is uncertain whether he was using his knowledge to get them right or to get them wrong, write down the alternative hypothesis she should use and explain the conditions under which the null hypothesis would be rejected.Did this page help you?5a4 marksA hypothesis test at the 4% significance level is carried out on a spinner with four sectors using the following hypotheses:(i) Describe what the parameter, , could be defined as.(ii) In the context of this question, explain how the significance level of 4% should be used.(iii) If the significance level were instead given as 10%, would the probability of incorrectly rejecting the null hypothesis be likely to increase or decrease? Give a reason for your answer.5b2 marksThe spinner is spun 50 times and it is decided to reject the null hypothesis if there are less than 7 or more than 18 successes.(i) The critical regions for this test are given as and . Write down the values of and .(ii) State the set of values for which a Type II error could occur.Did this page help you?6a2 marksTwo volunteers at a national park, Owen and Cathy, have begun a campaign to stop people leaving their litter behind after visiting the park. To see whether their campaign has had an effect, Owen conducts a hypothesis test at the 10% significance level, using the following hypotheses:(i) State the percentage of people who left litter behind in the national park before the start of the campaign.(ii) State whether this is a one-tailed or two-tailed test. 6b2 marksOwen observes a random sample of 100 people at the national park and finds that 14 of them left litter behind. He calculates that if were true, then the probability of 14 or less people leaving litter would be 0.08044.With reference to the hypotheses above, state with a reason whether Owen should accept or reject his null hypothesis.6c2 marksCathy conducted her own hypothesis test at the 10% significance level, using the same sample data as Owen, but instead she used the following hypotheses: (i) Explain how Cathy’s hypothesis test is different to Owen’s.(ii) Using these hypotheses, state whether the sample results given in part (b) should lead Cathy to accept or reject her null hypothesis. Give a reason for your answer.Did this page help you?7a2 marksA drinks manufacturer, BestBubbles, claims that in taste tests more than 50% of people can distinguish between its drinks and those of a rival brand. The company decides to test its claim by having 20 people each taste two drinks and then attempt to determine which was made by BestBubbles and which was made by the rival company. The random variable represents the number of people who correctly identify the drink that was made by BestBubbles.(i) State, giving a reason, whether this is a one-tailed or a two-tailed test.(ii) Write down the null and alternative hypotheses for this test.7b5 marksUnder the null hypothesis, it is given that:(i) Calculate and (ii) Given that a 10% level of significance was used, write down the critical value and the critical region for this test.(iii) State the actual level of significance for this test. 7c2 marksIn fact, 15 of the 20 people correctly identify the drink made by BestBubbles.(i) State whether there is sufficient evidence to reject the null hypothesis at the 10% significance level.(ii) Write a conclusion for this hypothesis test in the context of the question.Did this page help you?8a4 marksFor each of the following statements, write down whether an error has been made, and if so state whether it is a Type I or a Type II error.(i) is true and is accepted.(ii) is true and is rejected.(iii) is not true and is accepted.(iv) is not true and is rejected.8b1 markExplain why the probability of a Type I error is usually just below the significance level.8c2 marksDescribe how to calculate the probability of a Type II error.Did this page help you?1a2 marksExplain what you understand by a critical region of a test statistic.1b2 marksNationally 44% of A Level mathematics students identify as female. The headteacher of a particular school claims that the proportion of A Level mathematics students in the school who identify as female is higher than the national average.(i) State a suitable null hypothesis to test the headteacher’s claim.(ii) State a suitable alternative hypothesis to test the headteacher’s claim.1c2 marksThe headteacher takes a random sample of 60 A Level mathematics students and records the number of them who identify as female, . For a test at the 10% significance level the critical region is .Given that , comment on the headteacher’s claim.Did this page help you?2a2 marksThe probability of a chicken laying an egg on any given day is 65%. Two farmers, Amina and Bert, have 30 chickens each. They believe that the probability of their chickens laying an egg on any given day is different to 65%.(i) State a suitable null hypothesis to test the farmers’ belief.(ii) State a suitable alternative hypothesis for a two-tailed test.2b1 markDuring a specific day, Amina and Bert each record the number of their 30 chickens that lay an egg. At the 5% significance level the critical regions for this test are and .Write down the critical values for the hypothesis test.2c4 marks(i) Given that for Amina , comment on her belief.(ii) Given that for Bert , comment on his belief.Did this page help you?3a2 marksA memory experiment involves having participants read a list of 20 words for two minutes and then recording how many of the words they can recall. Peter, a psychologist, claims that more than 60% of teenagers can recall all the words. Peter takes a random sample of 40 teenagers and records how many of them recall all the words.(i) State a suitable null hypothesis to test the psychologist’s claim.(ii) State a suitable alternative hypothesis to test the psychologist’s claim.3b3 marksGiven that the critical value for the test is , state the outcome of the test if(i) 18 out of the 40 teenagers recall all the words(ii) 19 out of the 40 teenagers recall all the words(iii) 20 out of the 40 teenagers recall all the words.Did this page help you?4a2 marksA machine produces toys for a company. It was found that 8% of the toys it was producing were faulty. After an engineer works on the machine, she claims that the proportion of faulty toys should now have decreased.State suitable null and alternative hypotheses to test this claim.4b2 marksAfter the engineer is finished, the manager of the company takes a random sample of 100 toys and finds that 2 of them are faulty. Given that when , determine the outcome of the hypothesis test using a 1% level of significance. Give your conclusion in context.Did this page help you?5a2 marksAfter it was estimated that only 72% of patients were turning up for their appointments at Pearly Teeth dental surgery, the owner began sending text message reminders to the patients on the day before their appointments. In order to test whether the reminders have increased the proportion of patients turning up to their appointments, the owner decides to conduct a hypothesis test at the 5% level of significance using the next 160 patients scheduled for appointments as a sample.State suitable null and alternative hypotheses to test this claim.5b1 markGiven that for this hypothesis test the random variable to be used is , describe in context what represents.5c2 marksOut of the 160 patients used for the sample, 127 turned up for their appointments. Under the assumption that the null hypothesis is true, it is given that .Determine the outcome of the hypothesis test, giving your conclusion in context.Did this page help you?6a2 marksChase buys a board game which contains a six-sided dice. He rolls the dice 150 times and obtains the number six on 15 occasions. Chase wishes to test his belief that the dice is not fair.(i) State a suitable null hypothesis to test Chase’s belief.(ii) State a suitable alternative hypothesis for a two-tailed test.6b3 marksGiven that when , test Chase’s belief that the dice is not fair, using a 2% level of significance.Did this page help you?7a2 marksA test of the null hypothesis is carried out for the random variable . The observed value of the test statistic is . You are given the following probabilities:Determine the outcome of the test, with reasons, when the alternative hypothesis is: with a 1% level of significance.7b2 marks with a 5% level of significance.Did this page help you?8a1 markA two-tailed test of the null hypothesis is carried out for the random variable . Write down the alternative hypothesis.8b2 marksOne of the critical regions is . You are given the following probabilities:Given that a 10% level of significance is used, determine the other critical region. Give a reason for your answer by using a relevant probability.8c2 marksYou are also given that .Find the actual level of significance of this test.Did this page help you?9a2 marksBirds belonging to a certain species have been known to be stealing milk from milk deliveries across Canada. It is known that the foil caps on 3% of the bottles of all milk deliveries are being pecked open by the birds. Residents in a certain urban area believe that more than 3% of their milk bottles are being pecked open by the birds. They decide to test their claim at the 10% significance level by taking a random sample of 100 milk bottles from a delivery and seeing how many have been pecked open by the birds. The residents determine that the null hypothesis will be rejected in favour of the alternative hypothesis if more than 5 of the milk bottles in their sample have been pecked open by the birds.State suitable null and alternative hypotheses for the residents’ test.9b2 marksGiven that 4 of the bottles are found to have been pecked open by the birds, state which of the two error types, Type I or Type II, could have been made. Justify your answer.9c1 markWrite down the greatest possible probability of making a Type I error.Did this page help you?1a4 marksJoel is a manager at a swimming pool and claims that less than half of customers wear goggles in the water. Joel forms a sample using the next 100 swimmers and he notes that 42 of them wear goggles.If then:Stating your hypotheses clearly, test Joel’s claim using a 5% level of significance.1b2 marksJoel discovers that there was a family of 12 people included in the sample, all of whom wore goggles.Explain how this information affects the conclusion to the hypothesis test.Did this page help you?2a4 marksAt Hilbert’s Hotel three quarters of customers leave feedback upon departure by writing a comment in a book on the reception desk. Karla, the manager, decides to get rid of the feedback book and instead leaves a feedback form in each room. To test whether this new system has made a difference to the proportion of guests who leave feedback, Karla forms a sample using the next 80 room bookings. Once the 80 sets of guests leave Hilbert’s Hotel, Karla counts that 65 feedback forms have been completed.When the following probabilities are given:Test, using a 10% level of significance, whether there is evidence to suggest that the feedback forms have changed the proportion of guests who leave feedback. State your hypotheses clearly.2b2 marksKarla repeats the same test, with the same hypotheses, the following week and finds that 53 out of the 80 sets of guests fill in their feedback forms. This leads to the null hypothesis being rejected. Karla claims that this shows that there is evidence that the proportion of guests leaving feedback has decreased.Explain whether Karla’s claim is valid.Did this page help you?3a1 markExplain one advantage of using critical regions instead of finding probabilities for a hypothesis test.3b1 markA test of the null hypothesis against the alternative hypothesis is carried out for the random variable . The table below shows the probabilities for different values that can take: 00.00040610.00354920.01508530.04148440.082968Calculate .3c3 marks(i) Using a 5% level of significance, find the critical region for the test.(ii) State the actual level of significance for the test.Did this page help you?4a3 marksA group of high school statistics students are investigating the probability of winning a game called Chi Squares. Their teacher claims that they have more than a 60% chance of winning the game. To test the claim, they play 30 games of Chi Squares and win 80% of them. They perform a hypothesis test using a 5% level of significance. Below are shown the solutions of two students, Gertrude and Nate:Gertrude’s solutionNate’s solutionLet be the number of games won, do not reject Let be the number of games won, so reject You are given that the students have correctly calculated their probabilities.Identify and explain the three mistakes made by Gertrude.4b2 marksIdentify and explain the two mistakes made by Nate.4c1 markUse the information above to find the correct probability they should have used to test the observed value , showing your calculation clearly.Did this page help you?5a1 markExplain what you understand by the significance level of a hypothesis test.5b2 marks(i) Give an advantage of using a lower significance level for a hypothesis test.(ii) Give a disadvantage of using a lower significance level for a hypothesis test.5c6 marksFor each of the following scenarios, explain whether a 1%, 5% or 10% level of significance would be most appropriate.(i) A shopkeeper takes a sample of 10 cartons of milk to test whether the amount of milk in a carton has decreased.(ii) A doctor takes a sample of 100 patients to test whether there is an improvement to the recovery rate of an illness when a new drug is used, compared with the current best treatment regime.(iii) A manager takes a sample of 100 employees to test whether their level of job satisfaction has changed after new working hours have been introduced.Did this page help you?6a3 marksThe table below shows the cumulative probabilities for different values that can take: 00.00097710.01074220.05468830.17187540.37695350.623047Kieran collects coins and suspects that one of them is biased. To test his suspicion Kieran flips the coin 10 times and records the number of times, , that it lands on tails.Stating your hypotheses clearly, find the critical regions for the test using a 10% level of significance.6b2 marksCalculate the probability of making a Type I error.6c1 markThe coin lands on heads on each of the 10 flips. Kieran claims that the coin is definitely biased.Comment on the validity of Kieran’s claim.6d1 markDescribe one adjustment Kieran could make to his test to give a more reliable conclusion.Did this page help you?7a1 markIt is known that historically 40% of all bees in a certain part of the UK belonged to pollinating species. Farmers in the area, however, believe that that percentage has decreased in the past ten years. They design an experiment in which they will safely catch 200 bees in the area, check which species they belong to, and then release them. The farmers carry out a hypothesis test at the 10% significance level. They calculate that for .Clearly defining any parameters, state the null and alternative hypotheses for the farmers’ test.7b2 marksFind the probability of a Type I error. Justify your answer.7c2 marksIt is discovered subsequently that in fact only 30% of bees in the area now belong to pollinating species. Given that for .Find the probability that the farmers’ hypothesis test could have resulted in a Type II error. Justify your answer.Did this page help you?1a3 marksIn the context of hypothesis testing, explain the term:(i) critical region(ii) critical value1b3 marksThe table below shows the probabilities for different values that can take:400.000133390.001329380.006480370.020520360.047452A test of the null hypothesis against the alternative hypothesis is carried out for the random variable Using a 5% level of significance, find the values of which would lead to the rejection of the null hypothesis.1c3 marksA second test is carried out with the same null hypothesis against the alternative hypothesis Given that is a critical value, find the minimum level of significance for the test.Did this page help you?2a5 marksMeditest is a company manufacturing medical tests which are used to determine whether a patient has a certain illness. Meditest claims that the tests are 95% accurate, however a particular hospital will only purchase the tests if they are more than 95% accurate. Meditest test the accuracy of their product using a sample of 250 patients with the illness and agree on a 1% level of significance. They discover that the tests are accurate for 245 out of the 250 patients.If then and .Stating your hypotheses clearly, test whether Meditest’s product is more than 95% accurate using a 1% level of significance.2b1 markMeditest notice that they would have had sufficient evidence to reject the null hypothesis using a 5% level of significance. They change the level of significance from 1% to 5% and report to the hospital that their product is more than 95% accurate.Comment on the validity of Meditest’s report to the hospital.Did this page help you?3a4 marksFrank is the owner of a factory which has recently opened near a school where Hilda is the headteacher. Before the factory opened, the attendance rate at the school was good 90% of the time. Hilda claims that the proportion of days when the attendance rate is good has decreased and she suspects this is due to the fumes from the factory making the children sick. Frank disagrees and claims that the factory has made no difference to the attendance rate. To test their claims a sample of 40 days is taken and on 32 days the attendance rate is good.If then:Stating your hypotheses clearly, test Hilda’s claim using a 5% level of significance. Give your answer in context.3b1 markExplain whether the outcome of the test supports Hilda’s suspicion.3c3 marksStating your hypotheses clearly, test Frank’s claim using a 5% level of significance.3d1 markSuggest a reason why Frank might want to use a two-tailed test.3e2 marksState, with a reason, whether a one-tailed test or a two-tailed test would have been more appropriate for this scenario.Did this page help you?4a4 marksAt a certain international school in Thailand 10% of students who drive motorbikes were found to be doing so without proper safety equipment. Mr Roy, the head of school began a ‘protect your head’ campaign. To see if the campaign had worked Mr Roy takes a random sample of 20 students who drive motorbikes and observes them to see if they are wearing proper safety equipment. If all of the students are wearing proper safety equipment Mr Roy will conclude that his campaign has worked.(i) Find the probability of a Type I error.(ii) Unfortunately, one student in Mr Roy’s sample rides to school without proper safety equipment that day. Which of the errors, Type I or Type II is possible? Explain your answer.4b3 marksMr Roy enlists the help of some students from the school who have a go at improving the campaign. He then repeats the same hypothesis test a few weeks later using another random sample of 20 students who drive motorbikes.Given that the proportion of students who drive motorbikes but without proper safety equipment is now 4%, find the probability of a Type II error.Did this page help you?5a4 marksGiven that then:When a sample of size 40 is used to test against , it is known that is the critical value using a 5% level of significance. Use the probabilities above to find upper and lower bounds for the value of .5b2 marksWhen a sample of size 40 is used to test against , it is known that is one of the two critical values using a 5% level of significance. Use the probabilities above to find an improvement for one of the bounds for the value of .Did this page help you?6a2 marksIf then and .A sample of size 30 is used to test the null hypothesis against the alternative hypothesis using a % level of significance.Given that there is at least one value that leads to the rejection of the null hypothesis, find the range of values for .6b3 marksA sample of size 100 is used to test the null hypothesis against the alternative hypothesis using a 5% level of significance.Given that there are no critical values for this test, find the range of values for .6c4 marksA sample of size is used to test the null hypothesis against the alternative hypothesis using a 1% level of significance.Given that there is exactly one critical region for this test, find the range of values for .Did this page help you?