P3.9 Table P3.9 gives the number of telephone calls received per hour in an office and the distribution.

Table P3.9

Number of telephone calls received, x	10	11	12	13	14	15
f (x)	0.08	0.15	0.30	0.20	0.20	0.07

Determine the mean and standard deviation of the number of telephone calls received per hour in that office.

P3.10 Table P3.10 gives the results of the experiment of rolling a die with the discrete random variable number of dots.

Table P3.10

Number of dots, x	1	2	3	4	5	6
Probability, f (x)	1/6	1/6	1/6	1/6	1/6	1/6

Determine the mean and variance of that random variable x.

P3.11 The time to failure of an electronic component is a continuous random variable known to have the density function $0.5e^{-0.5t}$ where t is in years. What is the probability that this component will fail within the first year of operation?

P3.12 Find the mean μ for the probability density function, ρ(x), of the life of a projector bulb, random variable x, is given as:

and
$$\rho(x) = \begin{cases} 0 & ; \quad \text{for } x < 0 \\ 1/900\, e^{-x/900} & ; \quad \text{for } x \geq 0 \end{cases}$$

P3.13 The density function for a continuous random variable x is given as:

$f(x) = 0.25(x - 2)$ for $2 \leq x \leq 5$

Sketch the density and distribution functions.

P3.14 The daily consumption of an electric power of a certain machine (in units of power) is a random variable whose probability density is given by:

$$f(x) = \begin{cases} 1/9\, x\, e^{-x/3} ; & \text{for } x > 0 \\ 0 ; & \text{for } x \leq 0 \end{cases}$$

Determine the probabilities that on a given day

(a) the consumption of this machine is no more than 6 units

(b) the power supply is inadequate in the daily capacity if the supply is 9 units.

P3.15 The total lifetime (in years) of a certain machine is a random variable whose distribution function is given by:

$$f(x) = \begin{cases} 0 ; & \text{for } x \leq 5 \\ 1 - 25/2^2 ; & \text{for } x > 5 \end{cases}$$

Find the probabilities that such a machine system will have life

(a) beyond 10 years

(b) less than 8 years

(c) anywhere from 12 to 15 years.

P3.43 A die is rolled three times. Find the probability of getting one 4 in the three rolls. Also find the probability of getting two 4'*s*, three 4'*s*, and no 4'*s* in three rolls.

P3.44 In a production process the defective rate is 15 per cent. Assuming a random sample of 10 items is drawn from this process, find the probability that two of them are defective.

P3.45 Batches of 50 shock absorbers from a production process are tested for conformance to quality requirements. The mean number of non-conforming absorbers in a batch is 5. Assume that the number of non-conforming shock absorbers in a batch, denoted as x, is a binomial random variable.

(a) find n and p

(b) find $p(x \leq 2)$

(c) find $p(x \geq 49)$.

P3.46 A production process manufactures certain mechanical components for a machine system. On average, 1.5% of the components will not perform up to specifications. When a shipment of 100 components is received at the plant, they are tested, and if more than 2 are defective, the shipment is returned to the manufacturer. What is the probability of returning a shipment?

P3.47 A quality test engineer claims that 1 in 10 of certain manufactured parts is due to material defects. Using binomial distribution and rounding to four decimals, find the probability that at least of 3 out of 5 of the tested parts are due to material defects.

P3.48 At the ABC House Delivery Service, providing high-quality service to its customers is the top priority of the company. The company guarantees a refund of all charges if a package it is delivering does not arrive at it's destination by the specified time. It is known from past data that despite all efforts, 3% of the packages mailed through this company do not arrive at their destinations within the specified time. A corporation mailed 10 packages through ABC House Delivery Service on Monday.

(a) find the probability that exactly one of these 10 packages will not arrive at it's destination within the specified time.

(b) find the probability that at most one of these 10 packages will not arrive at it's destination within the specified time.

P3.49 Five per cent of a large batch of high-strength steel components purchased for a mechanical system are defective.

(a) if seven components are randomly selected, find the probability that exactly three will be defective

(b) find the probability that two or more components will be defective.

P3.50 The number of customers arriving a bank in the next period is a Poisson distribution having a mean of eight. Find the probability that exactly six customers will arrive in the next period.

P3.51 If the probability of a concrete beam failing in compression is 0.05, use the Poisson approximation to obtain the probability that from a sample of 50 beams

(a) at least three will fail in compression

(b) no beam will fail in compression.

P3.52 The number of defects on an electronic component which is used in a computerized system has been found to follow the Poisson distribution with $\lambda = 3$. Find the probability that a randomly selected electronic component will have two or less defects.

P3.53 The number of telephone calls made to a certain company's operator is a Poisson random variable with a mean of 5 calls per hour.

(a) what is the probability that 5 calls are received in one hour?

(b) what is the probability that 10 calls are received in 1.5 hour?

(c) what is the probability that less than 2 calls are received in 1 – 1/2 hours?

P3.54 A photocopying machine in an office breaks down an average of three times per month. Using the Poisson probability distribution formula, find the probability that during the next month this machine will have

(a) exactly two breakdowns

(b) at most one breakdown.

P3.55 The proportion of mechanical manufactured parts that are non-conforming is 0.04. Obtain the Poisson approximation to the binomial distribution for the probability of three or fewer non-conforming parts in a sample of 100.

P3.56 An examination consists of five questions, and to pass the examination a student has to answer at least four questions correctly. Each question has three possible answers, of which only one is correct. If a student guesses on each question, what is the probability that the student will pass the test?

P3.71 The diameter of a component in a machine system is normally distributed with mean 0.2508 cm and standard deviation 0.0005 cm. The specifications on the component are 0.25 $\pm$0.0015 cm. Determine the proportion of components confirms to specifications.

P3.72 The mass, μ, of a particular electronic component is normally distributed with a mean of 66 g and a standard deviation of 5 g. Determine

(a) the per cent of components that will have a mass less than 72 g

(b) the per cent of components that will have a mass in excess of 72 kg

(c) the per cent of components that will have a mass between 61 and 72 g.

P3.73 Customers buying copper rods supplied by a certain manufacturer require that the rods be between 9.9 cm and 10.5 cm, inclusive. The manufacturing process is such that the actual rod lengths are well approximated by a normal distribution with mean 10.1 cm and standard deviation 0.20 cm. Determine the percentage of the manufacturer's production is acceptable to the customer.

P3.74 Refer to Problem P3.73 and determine what rod length is exceeded by 95% of the manufacturer's product.

P5.1 A manufacturing company tested 25 printed circuit boards and the findings are as follows: Mean length of life for 25 boards = 3,566 hours. Standard deviation of life length in sample = 150 hours. Construct a 90% confidence interval for the mean length of life for the new printed circuit boards.

P5.2 The mean tensile strength of a sample of 25 high quality steel specimens equals to 50,000 MPa. Find a 95% confidence interval on the mean tensile strength if the standard deviation is known to be 500 MPa.

P5.3 *(a)* The standard deviation of a normally distribution manufacturing process is 3g. Determine the sample size for a 90% confidence interval so that the estimation of the mean process is within 1g of the true but unknown mean yield.

(b) An electrical light bulb manufacturing company likes to estimate the light bulb's mean life. Assume a normal distribution of the life of a light bulb. Assuming the standard deviation is 30 hours, find the how many bulbs should be tested so as to be: *(i)* 95% confident that the estimate $\overline{x}$ will not differ from the true mean life by more than 10 hours. *(ii)* 98% confident to accomplish *(i)*.

P5.4 A college administrator wishes to estimate the mean age of all students currently enrolled. In a random sample of 20 students, the mean age is found to be 21 years. From past studies, the standard deviation is known to be 1.5 years. Construct a 90% confidence interval of the population mean age.

P5.5 In order to estimate the amount of time (in minutes) that a teller spends on a customer, a bank manager decided to observe 64 customers picked at random. The amount of time the teller spent on each customer was recorded. It was found that a sample mean was 4 minutes will standard deviation 1.2 minutes. Find a 98% confidence interval for the mean amount of time μ.

P5.6 When 25 cigarettes of a particular brand were tested in a laboratory for the amount of tar content, it was found that their mean content was 20 milligrams with $S = 2$ milligrams. Set a 90% confidence

interval for the mean tar content μ in the population of cigarettes of the brand. Assume that the amount of tar in a cigarette is normally distributed.

P5.7 The breaking strength of a machine part is required to be at least 75 MPa. Based on previous test data, the standard deviation of breaking strength is 6 MPa. A random sample of 16 specimens is tested and the average value is found to be 73 MPa. Construct a 95% confidence interval on the mean breaking strength.

P5.8 The diameters of copper shafts produced by a certain manufacturing process should have a mean diameter of 0.51 mm. The diameter is known to have a standard deviation of 0.0002 mm. A random sample 40 shafts has an average diameter of 0.509 mm. Construct a 95% confidence interval on the mean shaft diameter.

P5.20 With a random sample of 1000 people, 400 are women who turn up to see a baseball game. Find a 95% confidence interval for the percentage of women at the game.

P5.21 A sample of 600 observations selected from a population produced a sample proportion equal to 0.7.

(*a*) make a 90% confidence interval for *p*.

(*b*) construct a 95% confidence interval for *p*.

(*c*) make a 99% confidence interval for *p*.

(*d*) does the width of the confidence intervals constructed in part *(a)* through *(c)* increase as the confidence level increases?

P5.22 In a survey, 90% of drivers rated their driving as excellent or good. Suppose that this percentage was based on a random sample of 400 drivers,

(*a*) what is the point estimate of this corresponding population proportion?

(*b*) find a 95% confidence interval for the corresponding population proportion.

P5.23 A mail order company guarantees its customers that the products ordered will be mailed within 72 hours after an order is receives. The quality control department took a sample of 50 orders and found that 40 of them were mailed within 72 hours of the placement of the orders.

(*a*) construct a 98% confidence interval for the percentage of all orders that are mailed within 72 hours of their placement

(*b*) if the confidence interval found in part *(a)* is too wide, suggest a way to reduce the width of the interval.

P5.24 In a poll of 2000 adults, 60% of adults said that public education needs to be improved. Construct a 95% confidence interval for the proportion of all adults who hold this opinion.

P5.37 Table P5.37 gives the systolic blood pressure of 7 adults before and after the completion of a special dietary plan based on a special dietary plan for 3 months. Construct a 95% confidence interval for μ_d. Assume that the population of paired differences, μ_d, is (approximately) normally distributed.

Table P5.37

Before	209	179	195	221	232	199	223
After	192	185	186	223	221	182	232

P5.38 A college claims that the Math tutoring service offers significantly increases the test scores of students in mathematics. The following table gives the scores per 120 of 8 students before and after they took the tutoring help.

Before	82	75	89	91	66	70	91	69
After	97	72	94	111	80	72	117	76

Make a 95% confidence interval for the mean μ_d of the population paired differences where a paired difference is equal to the score before attending the tutoring service minus the score after attending the tutoring service. Assume that the population of paired differences is approximately normally distributed.

P5.39 A medical agency measured the corneal thickness of 8 patients who had glaucoma in one eye but not in the other. The following are the data on corneal thickness in microns.

Patient	Normal	Glaucoma
1	484	488
2	479	479
3	493	481
4	445	427
5	437	441
6	399	409
7	464	459
8	477	460

Assume that the population of paired differences is approximately normally distributed. Make a 95% confidence interval for the mean μ_d of the population difference, where a paired difference is equal to the difference in corneal thickness for normal and Glaucoma in microns.

P5.46 Two different grinding processes are used to finish certain machine part. Both processes can produce parts at identical mean surface roughness. The company would like to select the process having the least variability in surface roughness. A random sample of $n_1 = 11$ parts from the first process results in a sample standard deviation $S_1 = 5$ micro millimeters, and a random sample of $n_2 = 16$ parts from the second process results in a sample standard deviation of $S_2 = 4$ micro millimeters. Find a 90% confidence interval on the ratio of the two standard deviations, σ_1/σ_2.

P5.47 A study has been conducted to study the capability of a gauge by measuring the weights of 2 sheets of paper. The data are shown below:

Paper 1 $S_1 = 0.091159$ $n_1 = 15$

Paper 2 $S_2 = 0.084499$ $n_2 = 15$

Use $\alpha = 0.05$ and find a confidence interval.

P5.48 The diameter of brass rods manufactured on two different machines is being studied. Two random samples of sizes $n_1 = 15$ and $n_2 = 17$ are selected, and the sample means and sample variances are $\overline{X}_1 = 9.75$, $S_1^2 = 0.3$, $\overline{X}_2 = 7.65$ and $S_2^2 = 0.4$ respectively. Assume that the data are drawn from a normal distribution. Construct the following:

(a) a 90% two-sided confidence interval on σ_1/σ_2

(b) a 95% two-sided confidence interval on σ_1/σ_2. Compare the width of this interval with the width of the interval in part (*a*).

(c) a 90% lower confidence bound on σ_1/σ_2

P5.51 In a random sample of 90 turbine blades, 10 have a surface finish that is rougher than the specifications allow. Suppose that a modification is made in the surface roughness finishing process and that, subsequently, a second random sample of 90 turbine blades is obtained. The number of defective blades in this second sample is 8. Find an approximate 95% confidence interval on the difference in the proportion of defective turbine blades produced under the two processes.

P5.52 In a random sample of 50 people from state *A*, 40 said they favoured death penalty and 24 out of 48 from state *B* were in favour of death penalty. Find a 95% confidence interval for $p_1 - p_2$, where p_1 is the proportion of those in state *A* favouring death penalty and p_2 is the proportion of those in state *B* favouring death penalty.

P5.53 An independent health agency investigated the health of independent random samples of white and African-American elderly (aged 70 or older). Of the 5989 elderly surveyed, 629 had at least one stroke, whereas 203 of 1006 African-American elderly surveyed reported at least one stroke. Find a 95% confidence interval for the difference between the stroke incidences of white and African-American elderly.

P5.54 In a survey of 1000 drivers 25–34 years old, 27% said they buckle up, whereas 350 of 1000 drivers 45–64 years old said that they did. Find a 95% confidence interval for the difference between the proportion of seat-belt users for drivers in the age group 25–34 years and 45–64 years.

P5.59 The government would like to estimate the mean family size for all families in a particular state at a 99% confidence level. It is known that the standard deviation σ for all sizes of all families in that state is 0.7. How large a sample should the government select if it wants its estimate to be within 1% of the population mean?

P5.60 *(a)* How large a sample should be selected so that the maximum error of estimate for a 99% confidence interval for *p* is 0.04 when the value of the sample proportion obtained from a preliminary sample is 0.6?

(b) Find the most conservation sample size that will produce the maximum error for a 98% confidence interval for *p* equal to 0.04?

P5.61 A hardware store company guarantees all hardware deliveries within 30 minutes of the placement of orders on the plane. An agency wants to estimate the proportion of all hardware delivered within 30 minutes by the company. What is the most conservative estimate of the sample size that would limit the maximum error to within 0.03 of the population proportion for a 99% confidence interval?

P5.62 A transportation safety agency wants to estimate the proportion of all drivers who wear seat belts while driving. Assume that a preliminary study has shown that 85% of drivers wear seat belts while driving. How large should the sample size be so that the 90% confidence interval for the population proportion has a maximum error of 0.02?

3.9 $\mu = 12.5$; $\sigma = 1.36$

3.10 $\mu = 3.5$; $\sigma^2 = 2.92$

3.11 0.39347

3.12 900 hours

3.13

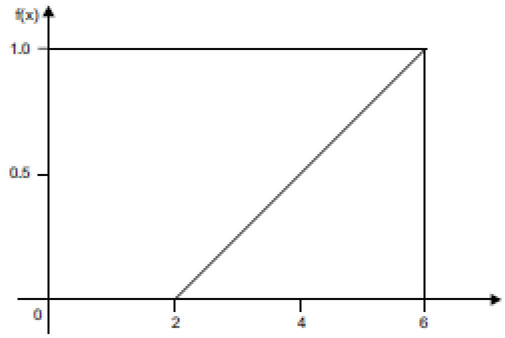

Fig. 3.13(a): Density function

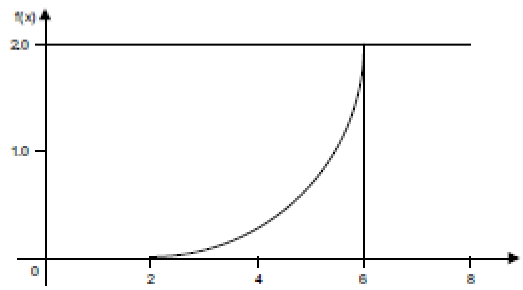

Fig. 3.13(b): Distribution function

3.14 *(a)* 0.5941

(b) 0.1992

3.15 *(a)* ¼

(b) 39/64

(c) 1/16

3.43 $P(1) = 0.347$; $P(2) = 0.069$; $P(3) = 0.005$; $P(0) = 0.579$

3.44 0.2759

3.45 *(a)* $n = 50$ and $p = 0.1$

(b) 0.112

(c) 4.51×10^{-48}

3.46 $P(\text{return}) = 0.19$

3.47 0.0086

3.48 *(a)* 0.228

(b) 0.9655

3.49 *(a)* 0.00356

(b) 0.0444

3.50 0.122

3.51 *(a)* 0.4575

(b) 0.082

3.52 0.423

3.53 *(a)* 0.1755

(b) 0.0858

(c) 0.2873

3.54 *(a)* 0.2240

(b) 0.1992

3.55 $P(X \leq 3) = 0.433$ (using Poisson distribution with $\lambda = 4$)

3.56 0.453

3.71		99.73%
3.72	*(a)*	0.8849
	(b)	0.1151
	(c)	0.7262
3.73		0.8415
3.74		$x = 9.771$
5.1		3514.67 to 3617.33
5.2		49,000 to 50,196
5.3	*(a)*	$n \approx 25$
	(b)	*(i)* $n \approx 35$ *(ii)* $n \approx 49$
5.4		$20.45 \le \mu \le 21.55$
5.5		$3.65 \le \mu \le 4.35$
5.6		$19.3156 \le \mu \le 20.6844$
5.7		$70.06 \le \mu \le 75.94$
5.8		$0.5089 \le \mu \le 0.5091$
5.20		0.3697 to 0.4303
5.21	*(a)*	0.669145 to 0.73085
	(b)	0.66334 to 0.73665
	(c)	0.651754 to 0.74824
	(d)	Yes
5.22	*(a)*	$\hat{p} = 0.90; \pm 0.0294$
	(b)	0.8706 to 0.9294
5.23	*(a)*	66.82% to 93.18%
	(b)	lowering the confidence level and increasing the sample size
5.24		0.57853 to 0.621471
5.37		–4.7428 to 15.314
5.38		–18.866 to –2.634
5.39		0.9396 to 18.4732
5.46		$0.609375 \le \frac{\sigma_1^2}{\sigma_2^2} \le 4.453125$
5.47		$0.45 \le \frac{\sigma_1^2}{\sigma_2^2} \le 4.05$
5.48	*(a)*	$0.309 \le \frac{\sigma_1^2}{\sigma_2^2} \le 1.7475$
	(b)	$0.2565 \le \frac{\sigma_1^2}{\sigma_2^2} \le 2.115$
	(c)	$0.6124 \le \frac{\sigma_1^2}{\sigma_2^2}$
5.51		$-0.065387 \le p_1 - p_2 \le 0.109787$
5.52		$0.1213 \le p_1 - p_2 \le 0.4797$
5.53		–0.122774 to –0.070752
5.54		–0.113897 to –0.046103
5.59		$n \approx 32{,}617$
5.60	*(a)*	$n \approx 999$
	(b)	$n \approx 1040$
5.61		$n \approx 1849$
5.62		$n \approx 2122$