

නව නිර්දේශය/புதிய பாடத்திட்டம்/New Syllabus

ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව
 திணைக்களம் இலங்கைப் பரீட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம்
 Department of Examinations, Sri Lanka
 இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம்

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2020
 கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2020
 General Certificate of Education (Adv. Level) Examination, 2020

ව්‍යාපාර සංඛ්‍යාතය II
 வணிகப் புள்ளிவிவரவியல் II
Business Statistics II

31 E II

පැය තුනයි
 மூன்று மணித்தியாலம்
Three hours

අමතර කියවීමේ කාලය - මිනිත්තු 10 යි
 மேலதிக வாசிப்பு நேரம் - 10 நிமிடங்கள்
Additional Reading Time - 10 minutes

Use additional reading time to go through the question paper, select the questions you will answer and decide which of them you will prioritise.

Instructions:

- * Answer *five* questions selecting at least *two* questions from each part.
- * Statistical tables and graph papers will be provided. Use of calculators is *not allowed*.

Part I

1. (a) Explain the difference between pre-test and editing of a completed questionnaire.
 Describe **three** weaknesses that could be identified through pre-test and through editing of a completed questionnaire. (04 marks)
- (b) State whether the following statements are true or false and explain your answers.
 (i) Interval scale has units of measurements which vary from scale to scale between arbitrary starting point and terminating point but no mathematical operations can be done except taking the sum and difference.
 (ii) Classification of students by their reading ability as Below Average, Average and Above Average is an example for interval scale.
 (iii) Variables are classified as qualitative and quantitative considering the scales of measurements. (03 marks)
- (c) State the most appropriate method of data collection for each of the following studies. Describe how the each method is applied giving one advantage and one disadvantage.
 (i) Explore various aspects of the issue of domestic violence by conducting discussions with experts in the field and victims.
 (ii) Study the efficiency of nurses in carrying out of their functions. (03 marks)
- (d) The following stem-and-leaf diagrams represent the marks of Mathematics of students in two classes A and B of grade 10 in a school.

	Class A		Class B
3	2 3 4 5	4	2 3
4	1 3 4 4 5 6 7	5	3 4 5 6 8 8
5	0 2 3 4 5 7 8	6	1 4 6 7 8 9
6	2 3 4 5 6	7	0 3 3 7 7 8
7	4 5 5	8	0 2 6 7 9
8	6	9	6 7

Draw Box-and-Whiskers plots on a same graph and compare the performance of students of two classes in the subject of Mathematics. (06 marks)

- (e) The hourly payments of 70 workers are given in the following table.

Wage	No. of workers
60-69	8
70-79	10
80-89	15
90-99	16
100-109	10
110-129	8
130-189	3

Construct the histogram for the above frequency distribution and highlight the area corresponding to the payment 90–119. (04 marks)

2. (a) What are the properties of a good average? Describe these properties with reference to mean, median and mode. (04 marks)
- (b) Define the geometric mean of a data set.
If the sales of a certain firm doubles in a period of 10 years, what is the average percentage growth rate per year? (05 marks)
- (c) In a national examination the mean of the marks scored for a certain subject was 50 and the standard deviation was 10. In the following year for the same subject the mean was 60 while standard deviation increased to 15. Calculate an appropriate measure and compare the performance of the students of two years. (03 marks)
- (d) The marks obtained by 100 students in an examination are given in the following frequency distribution.

Marks	No. of students
0-9	6
10-19	8
20-29	10
30-39	12
40-49	20
50-59	25
60-69	10
70-79	9

Compute Pearson's first coefficient of skewness and second coefficient of skewness. Comment on the shape of the distribution using your results. (08 marks)

3. (a)(i) "It is sometimes stated that Laspeyers's price index tends to overestimate price changes while Paasche's index tends to underestimate price changes." Explain this statement giving reasons. (02 marks)
- (ii) Explain what is meant by time reversal test and factor reversal test. Show that the Marshall-Edgeworth Price Index satisfies the time reversal test. (03 marks)

- (iii) The prices and quantities of commodities A, B, C and D for years 2016 and 2018 are given in the following table.

Commodity	2016		2018	
	Price	Quantity	Price	Quantity
A	10	8	20	6
B	25	10	30	5
C	20	15	25	15
D	10	20	10	25

Verify that Marshall-Edgeworth Price Index is a good approximation for the Fisher's Ideal Price Index by calculating these indices for the year 2018 taking 2016 as the base year. Explain the reasons for this in your own words. (05 marks)

- (b)(i) Explain what is meant by trend of a time series. Describe the method of semi-average and the method of moving average for estimating trend. (03 marks)

- (ii) The quarterly sales (in thousand Rupees) values of a certain item for the years 2015, 2016 and 2017 are given in the following table. The values given in brackets are trend values.

Year	Quarter			
	Q ₁	Q ₂	Q ₃	Q ₄
2015	6 (12)	15 (15)	15 (15)	20 (18)
2016	15 (18)	20 (20)	25 (20)	30 (25)
2017	25 (25)	30 (25)	27 (30)	25 (35)

Estimate the seasonal indices by the method of Ratio to Trend. If the actual sale for the first quarter of 2018 is Rs.100 000 what is the expected sales for the fourth quarter? (07 marks)

4. (a) An office clerk recorded the time in minutes **Y** taken to travel to the office when he leaves home **X** minutes after 6 a.m. on 8 randomly selected days. The results are as follows,

X	0	5	10	15	20	25	30	35
Y	20	25	39	35	40	45	46	50

$$\sum X = 140 \quad \sum Y = 300 \quad \sum X^2 = 3500 \quad \sum Y^2 = 12012 \quad \sum XY = 6095$$

- (i) Fit the regression line of **Y** on **X** by using the method of least squares and explain the meaning of the regression coefficient. (05 marks)
- (ii) Calculate the coefficient of determination and comment on the goodness of fit. (05 marks)
- (b) Ten competitors in a musical contest were ranked by two judges in the following order.

Judge A	4	8	7	6	5	9	10	3	2	1
Judge B	6	7	8	1	5	10	9	2	3	4

Calculate the Spearman's rank correlation coefficient and Karl Pearson's product moment correlation coefficient between ranks and verify that both answers are equal. Explain whether the two judges agree in their judgement. (05 marks)

- (c) A producer receives parts in large lots and it has been decided to use an acceptance sampling plan. The following acceptance sampling plans are considered.

Plan I – Examine a random sample of size 50 and accept the lot if the acceptance number $c \leq 1$.

Plan II– Examine a random sample of size 100 and accept the lot if acceptance number $c \leq 2$.

- (i) Calculate the acceptance probabilities of lots for each plan at defective percentage 1%, 2%, 5% and 7%.

- (ii) Plot the values obtained in (i) for each plan on the same graph. .

- (iii) If it is required to have a sampling plan with 95% acceptance at 2% defective percentage and 5% acceptance at 7% defective percentage which plan is close to this requirement? (07 marks)

- (d) The number of defectives in 10 samples of 100 item each are given below.

Sample No.	1	2	3	4	5	6	7	8	9	10
No. of defectives	8	4	12	3	12	8	8	15	12	8

Find the control limits for constructing np -chart and explain whether the process is under control. (03 marks)

Part II

5. (a) Explain the difference between the terms of the following pairs.

(i) Sample space and Events.

(ii) Mutually exclusive events and Collectively exhaustive events. (03 marks)

- (b) 3 students are selected at random from a class which has 10 boys and 5 girls. Find the following probabilities,

(i) exactly **one** girl is selected.

(ii) at least **one** girl is selected. (04 marks)

- (c) The following table classifies 1000 persons by their sex and by whether or not they favour a certain development proposal.

	Male	Female	Total
Favour	250	450	700
Oppose	170	130	300
Total	420	580	1000

If a person is selected at random from 1000 persons, find the probabilities that,

(i) the selected person favours the development proposal.

(ii) the selected person favours the development proposal given that the person is male.

(iii) the selected person opposes the development proposal given that the person is female. (03 marks)

- (d) Bean seeds from supplier A have 80% germination percentage and those from supplier B have 70% germination percentage. A seed packing company purchases 70% of bean seeds from supplier A and 30% from supplier B and mixes these seeds together.

(i) Find the probability that a seed selected at random from the mixed seeds will germinate.

(ii) Given that the selected seed germinates find the probability that the seed was purchased from supplier B. (06 marks)

- (e) An electronic system has three components K_1 , K_2 and K_3 . If K_1 fails K_2 is used and if K_2 fails K_3 is used. If K_3 fails the system will fail. The probability of failure of any one of these component is 0.2 and failure of these components are mutually independent. What is the probability that this system **does not** fail? To increase the reliability of the system fourth component with the same probability of failure is added. What is the probability that the new system **does not** fail? (04 marks)
6. (a) (i) In a certain town 20% of the households is known to purchase a particular brand of soap. In a survey 100 investigators take random samples of 10 households to see whether the households purchase this soap. How many investigators are expected to report that at most three households purchase this soap in the samples?
- (ii) A manufacturer claims that at most 10% of his product is defective. To test this claim 15 units are selected at random and his claim is accepted if among 15 units at most 2 are defective. Find the probability that the manufacturer's claim is accepted if the actual probability that a unit is defective is 0.2. (06 marks)
- (b) (i) The average number of telephone calls arrived at a certain switchboard is 420 calls per hour. The board can make a maximum of 15 connections per minute. Assuming a poisson distribution find the probability of that some calls **cannot** be connected in a given minute.
- (ii) The daily demand for a certain commodity in a shop follows a poisson distribution with mean 2. If shop keeper stocks at the beginning of each three day period how many item should be held at the beginning of the period so that he can be 95% certain of meeting the demand for the period. (06 marks)
- (c) (i) The life of an electric component is normally distributed with mean of 800 hours and standard deviation of 60 hours. What is the probability that the component will fail before 680 hours. If the standard deviation remains 60 hours what would have been the mean to ensure that **not** more than 10% of components fail before 800 hours.
- (ii) State the conditions under which the poisson distribution may be approximated by the normal distribution. In a large factory there are 16 breakdowns of machine per month on the average. Assuming breakdowns occur at constant rate, at random and independent of one another, find the probability that there will **not** be more than 22 breakdown in a given month. (08 marks)
7. (a) Describe the following methods of sampling giving **two** advantages and **two** disadvantages of each method.
- (i) Stratified random sampling
- (ii) Cluster sampling
- (iii) Quota sampling (06 marks)
- (b) The electric light bulbs of manufacturer **A** have mean life time of 1600 hours with standard deviation 200 hours, while those of manufacturer **B** has mean life time of 1400 hours with standard deviation 100 hours. If a random samples of 125 bulbs of each type are tested, what is the probability that the sample mean life time of type **A** will exceed the sample mean life time of type **B** by 240 hours? (06 marks)

- (c) (i) For a population of size $N=6$ the values of the variable Y are 8, 4, 2, 10, 5 and 7. Calculate the sample mean \bar{y} for all possible simple random samples of size 2 from the population.

Verify that the sample mean \bar{y} is an unbiased estimator for the population mean \bar{Y} using the sampling distribution of \bar{y} .
Calculate the variance of \bar{y} using only the formula.

- (ii) Calculate sample mean \bar{y} for all possible systematic samples taken from the population given in (i).

Verify that the sample mean \bar{y} is an unbiased estimator for the population mean \bar{Y} using the sampling distribution of \bar{y} .

Calculate the variance of the sample mean using the sampling distribution of \bar{y} and find the efficiency of the systematic sampling compared with respect to simple random sampling. (08 marks)

8. (a) Explain the difference between each of the following pair of terms.

(i) Simple hypothesis and Composite hypothesis.

(ii) Power of the hypothesis test and Most powerful critical region.

(iii) Significance level and p-value. (03 marks)

- (b) The number of accidents in a certain city in 300 days are given below.

No. of accidents	0	1	2	3	4	5	6	7	8	9	10
No. of days	28	32	70	60	50	30	20	5	3	1	1

(i) Fit a poisson distribution for these data.

(ii) Test the goodness of fit at 5% significance level and state your conclusion. (05 marks)

- (c) In an epidemic 500 persons contacted the disease and 300 persons received no treatment. From those who received no treatment, 80 persons did not recover and of those who received treatment 70 persons recovered. Test the hypothesis that the treatment was not effective in curing the disease at 5% significance level. What is the p-value of the test? (05 marks)

- (d) The following table gives the outputs of three machines observed for a random samples of 5 different hours for each machine.

Machine I	Machine II	Machine III
6	5	10
8	3	7
5	8	11
12	7	10
9	7	12
40	30	50

$$\sum \sum x_{ij}^2 = 1060$$

- (i) Write down the analysis of variance model for analysing this data.
- (ii) Construct the analysis of variance table and test the hypothesis that mean output of three machines are equal at 5% significance level.
- (iii) Construct a 95% confidence interval for the difference of mean output of machine II and the mean output of machine III. (Use the mean square error (MSE) in the analysis of variance table as the estimate for common variance σ^2). (07 marks)