# INDIAN STATISTICAL INSTITUTE

97

## QUESTION PAPERS
*for*
## The Computer's Certificate Examinations
## March & September 1957

# INDIAN STATISTICAL INSTITUTE

## COMPUTER'S CERTIFICATE EXAMINATION, MARCH 1957

### PART IA : SECTION I

*Time : 3 Hours*                                          *Full Marks : 100*

(a) Answers to the different groups are to be given in separate books.

(b) All questions carry equal marks.

(c) Use of calculating machines is not permitted.

### GROUP A

1. *Either,* The following is an abstract of crop records for 10 grids each of which is 4 acres in area. Copy it out neatly after carefully scrutinising and correcting obvious mistakes.

| Grid nb. | Area in acres under | | | | | | |
|---|---|---|---|---|---|---|---|
| | jute | aus | aman | sugarcane | fallow | home-stead | total |
| 1 | 2.13 | 0.17 | 0.23 | 0.08 | — | 1.39 | 4.00 |
| 2 | 0.93 | 1.11 | 0.00 | — | 1.66 | — | 4.00 |
| 3 | 0.55 | 0.32 | 0.15 | 2.27 | 0.80 | — | 4.00 |
| 4 | 1.33 | 0.18 | 0.27 | 0.88 | 1.34 | — | 4.00 |
| 5 | 0.46 | 0.82 | 0.45 | 0.91 | 1.18 | 0.18 | 4.00 |
| 6 | 2.11 | 1.17 | 0.00 | 0.72 | — | — | 4.00 |
| 7 | 0.00 | — | 4.00 | — | — | — | 4.00 |
| 8 | 0.00 | — | 3.93 | — | 0.07 | — | 4.00 |
| 9 | 0.08 | 1.32 | 0.68 | — | — | 1.92 | 4.00 |
| 10 | 4.00 | — | — | — | — | — | 4.00 |
| Total | 111.59 | 5.00 | 97.1 | 4.86 | 5.35 | 3.49 | 40.00 |

*Or,* Scrutinize the calculations in the following working sheet, correct mistakes, if any, work out the last column and present the whole working sheet in a neat tabular form.

Calculations of multipliers (working sheet)

| Village serial no. | $n$ | $P_i$ | $P_{ijk}$ | $\dfrac{P_i}{P_{ijk}}$ | $\dfrac{P'_{ij}}{P_{ij}}$ | Col. (5) × Col. (6) | $\dfrac{\text{Col. (7)}}{\text{Col. (2)}}$ | $X_{ijk}$ | $r_{ijk}$ | Col. (8) × Col. (9) ÷ Col. (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| 91 | 4 | 9262085 | 2451 | 3819.70 | 1.0071 | 3846.82 | 961.71 | 150 | 0.34 | |
| 105 | 4 | 9362085 | 127 | 71717.24 | 1.0393 | 74535.73 | 18633.93 | 23 | 1.00 | |
| 94 | 4 | 9362085 | 952 | 9834.13 | 1.0068 | 9991.00 | 2497.75 | 176 | 1.00 | |
| 196 | 4 | 9805024 | 3597 | 2741.30 | 1.0799 | 2960.33 | 740.08 | 175 | 0.35 | |
| 225 | 2 | 5638736 | 440 | 128153.11 | 1.0000 | 128153.11 | 32038.28 | 54 | 1.00 | |

2. Present the data given below in a neat tabular form with proper heading, spacing etc.

"The official wholesale price index number (base : year ended August 1939 = 100) remained almost stationary at 418.9 during the week ended 20th October 1956 compared with 418.8 for the previous week. The index was down by 0.2 per cent when compared with the corresponding week of last month but was higher by 16.3 per cent than that of a year ago. The index of food articles advanced further by 0.5 per cent compared with 393.7 for the previous week, by 3 points compared to that for the corresponding week last month and 23 per cent more compared to last year. The index for industrial raw material was raised by 0.5 per cent to 505.6 compared to last week due to rise in prices of raw jute, groundnut and rapeseed. The corresponding index last year was 407.9 whereas the index for the corresponding week of last month was same as in the current week. The index of semi-manufactures declined by 0.5 per cent as compared with 404.2 of the previous week. The index during the corresponding week of last month was 407.7 and that for last year was 332.2. Lower prices of rayon and silk brought down the index for manufactures by 0.3 per cent compared with 390.0 for the last week and was less by 0.8 per cent compared to last month but was 5 per cent more than last year. The index number of miscellaneous items was 581.9 compared to 418.8, 419.8 and 360.3 during last week and corresponding week of last month and last year respectively."

## GROUP B

3. *Either,* (a) Complete the following calculations :—

| $x$ | $f$ | $fx$ | $x-5$ | $f(x-5)$ | $f(x-5)^2$ |
|-----|-----|------|-------|----------|------------|
| 7.0 | 2 |  |  |  |  |
| 6.5 | 4 |  |  |  |  |
| 6.0 | 6 |  |  |  |  |
| 5.5 | 8 |  |  |  |  |
| 5.0 | 10 |  |  |  |  |
| 4.5 | 8 |  |  |  |  |
| 4.0 | 6 |  |  |  |  |
| 3.5 | 4 |  |  |  |  |
| 3.0 | 2 |  |  |  |  |

Total

(b) Evaluate

$$\frac{64 \times (7.092 - 3.457) + 45}{12.5}$$

*Or,*

(a). Tabulate the values of $y$ from the following relation

$(y - 4.5) = 0.8(x - 2)$ for the values of $x = 1, 2, 3$ and $4$.

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¶b) Complete the missing entries in the following table and evaluate

$\Sigma a$, $\Sigma b$, $\Sigma(a^2+b^2)$ and $\Sigma ab$

| $(a+b)$ | $(a-b)$ | $2a$ | $2b$ | $(a+b)^2$ | $(a-b)^2$ | $2(a^2+b^2)$ | $4ab$ |
|---------|---------|------|------|-----------|-----------|--------------|-------|
| 13.2 | 5.6 | | | | | | |
| 6.5 | 5.7 | | | | | | |
| 9.3 | 3.9 | | | | | | |
| 10.0 | 8.0 | | | | | | |
| 4.1 | −1.3 | | | | | | |
| −5.3 | 3.1 | | | | | | |
| **Total** | | | | | | | |

4. The following data relate to the amount (in lakhs of rupees) of cheques passed through clearing houses at Calcutta on a weekly basis for the year 1940.

| Weeks 1940 | | Amount | Weeks 1940 | | Amount |
|------------|-----|--------|------------|-----|--------|
| January | 5 | 3117 | July | 5 | 2081 |
| | 12 | 3043 | | 12 | 1729 |
| | 19 | 3048 | | 19 | 1628 |
| | 26 | 2502 | | 26 | 1237 |
| February | 2 | 3428 | August | 2 | 1938 |
| | 9 | 2779 | | 9 | 1734 |
| | 16 | 2015 | | 16 | 1414 |
| | 23 | 2156 | | 23 | 1510 |
| | | | | 30 | 1401 |
| March | 1 | 2729 | | | |
| | 8 | 2502 | September | 6 | 2028 |
| | 15 | 2308 | | 13 | 1738 |
| | 22 | 1766 | | 20 | 1737 |
| | 29 | 1747 | | 27 | 1988 |
| April | 5 | 3065 | October | 4 | 2415 |
| | 12 | 2536 | | 11 | 947 |
| | 19 | 2022 | | 18 | 1642 |
| | 26 | 2118 | | 25 | 2074 |
| May | 3 | 2507 | November | 1 | 1034 |
| | 10 | 2087 | | 8 | 1716 |
| | 17 | 1919 | | 15 | 2158 |
| | 24 | 2250 | | 22 | 1898 |
| | 31 | 1797 | | 29 | 1624 |
| June | 7 | 2369 | December | 6 | 2465 |
| | 14 | 1577 | | 13 | 1964 |
| | 21 | 1763 | | 20 | 2177 |
| | 28 | 1431 | | 27 | 1321 |

Arrange these amounts in ascending order of magnitude and find out the week in which the highest and lowest amounts are recorded. Find the difference between the highest and the lowest amounts, and also the ratio of the lowest to the highest amounts. Find also the ranks of the last week in each of the 12 months.

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Time : 3 *Hours*                                                      *Full Marks* : 100

(a) Answers to the different groups are to be given in separate books.

(b) Figures in the margin indicate full marks.

(c) Use of calculating machines is not permitted.

## GROUP A

1. (a) Draw the lines

$$3y - x - 15 = 0$$
$$y = 2x - 8$$
$$\text{and} \quad 4y = -3x + 24$$

and estimate the area contained within the triangle formed by these three lines.

(b) Calculate the values of y corresponding to the values of $x = -3, -2, -1.5, -1, -0.5, 0, 0.5, 1, 1.5, 2$ and 3, in the equation

$$y = 5x^2 + 2x - 22$$

and draw a smooth curve through the points corresponding to the above values of $x$ and $y$.                                                                       (30)
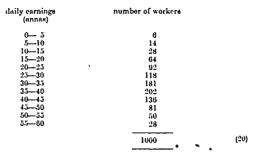
2. *Either*, Calculate the values of $f$, where

$$f = 99u^4 - 50u^2(uv - 3v^2) + 3uv^3 - v^4$$

for $u = 2, \quad v = 20, 21, 22, 23$
$u = 3, \quad v = 20, 21, 22, 23$                                          (20)

*Or*, The following table shows the distribution of 1000 workers according to their daily earnings. Let $x$ indicate the daily earnings and $y$ the cumulative frequencies, indicating the number of workers whose earnings are below specified levels.

Draw a curve showing the number of workers earning daily below 5as., 10as., 15as. ..... 60 as.

Determine the values of $x$ corresponding to the value of $y = 250, 500$ and 750.

| daily earnings (annas) | number of workers |
|---|---|
| 0— 5 | 6 |
| 5—10 | 14 |
| 10—15 | 28 |
| 15—20 | 64 |
| 20—25 | 92 |
| 25—30 | 118 |
| 30—35 | 181 |
| 35—40 | 202 |
| 40—45 | 136 |
| 45—50 | 81 |
| 50—55 | 50 |
| 55—60 | 28 |
| | 1000 |

(20)

4

3. (a) Evaluate (i) log $(2356)^{12}$, (ii) log $\sqrt[1]{2356}$, (iii) log $\sqrt{(2356)^{12}}$

(b) Solve the equation,

$$48.37x^2 - 144.5x + 95.21 = 0$$

(c) By contracted method, find the value of :—

(i) $4.7892 \times 3.1765$

(ii) $4.39876 \div 2.48719$ correct to four places of decimals.

Find (i) and (ii) also by using logarithmic tables. (30)

4. (a) Logarithms of population of a town during four successive decennial censuses are as follows:—

| Census year | Log of population |
|---|---|
| 1901 | 5.1216 |
| 1911 | 5.2256 |
| 1921 | 5.2015 |
| 1931 | 5.3911 |

Calculate by simple interpolation logarithms of population figures for the years 1902 and 1925. From these find the population figures for 1902 and 1925.

(b) Breaking strength in lbs. of 20 specimens of copper wire

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 578 | 572 | 570 | 568 | 572 | 570 | 570 | 572 | 596 | 584 |
| 569 | 567 | 576 | 576 | 570 | 568 | 572 | 569 | 590 | 585 |

The above data relate to breaking strengths of 20 specimens of copper wire. Find the mean and the standard error of the mean. (20)

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## PART IB : SECTION I

(a) Answers to the different groups are to be given in separate books.

(b) Figures in the margin indicate full marks.

(c) Use of calculating machines is permitted.

### GROUP A

1. The following table gives the frequency distribution of marks in English (as shown in the tabulation sheets) of 2357 candidates, who appeared at the School-leaving Certificate Examination of U.P. in 1910 :—

| Class interval | Frequency |
|---|---|
| 1—10 | 10 |
| 11—20 | 84 |
| 21—25 | 131 |
| 26—30 | 246 |
| 31—35 | 364 |
| 36—40 | 441 |
| 41—45 | 397 |
| 46—50 | 333 |
| 51—55 | 186 |
| 56—60 | 107 |
| 61—70 | 52 |
| 71—80 | 6 |

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(a) Compute the mean, standard deviation, $\beta_1$ and $\beta_2$ of this distribution.

(b) A check on the tabulation of the examination results later on revealed the following recording mistakes

| Student | Correct score of the student as given by the examiner | Score as entered (wrongly) by the tabulator |
|---|---|---|
| 1 | 39 | 36 |
| 2 | 23 | 28 |
| 3 | 56 | 65 |
| 4 | 61 | 67 |
| 5 | 33 | 38 |
| 6 | 27 | 21 |

Compute revised estimates of the mean, standard deviation of the distribution after taking into account these corrections in the frequency distribution. (30)

2. *Either*, Given below are the total facial lengths (TFL) and the upper facial lengths (UFL) of 40 Dacca Muslims, obtained in connection with the Bengal Anthropometric studies, 1945.

| Sl. | TFL (in mms) | UFL (in mms) | Sl. | TFL (in mms) | UFL (in mms) | Sl. | TFL (in mms) | UFL (in mms) | Sl. | TFL (in mms) | UFL (in mms) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 104 | 59 | 11 | 114 | 58 | 21 | 120 | 66 | 31 | 113 | 63 |
| 2 | 115 | 64 | 12 | 110 | 62 | 22 | 117 | 64 | 32 | 107 | 59 |
| 3 | 122 | 68 | 13 | 112 | 67 | 23 | 114 | 64 | 33 | 106 | 60 |
| 4 | 114 | 65 | 14 | 110 | 61 | 24 | 125 | 68 | 34 | 114 | 65 |
| 5 | 116 | 67 | 15 | 112 | 61 | 25 | 112 | 61 | 35 | 105 | 64 |
| 6 | 114 | 62 | 16 | 110 | 61 | 26 | 118 | 63 | 36 | 119 | 66 |
| 7 | 125 | 66 | 17 | 115 | 65 | 27 | 106 | 63 | 37 | 110 | 64 |
| 8 | 106 | 57 | 18 | 114 | 60 | 28 | 117 | 65 | 38 | 114 | 67 |
| 9 | 107 | 63 | 19 | 120 | 66 | 29 | 107 | 57 | 39 | 117 | 62 |
| 10 | 117 | 60 | 20 | 120 | 65 | 30 | 125 | 68 | 40 | 110 | 62 |

Compute the product-moment correlation coefficient between TFL and UFL. (20)

*Or*, The following table gives per capita retail sales (*Y*) and per capita income (*X*) in 25 States during the year 1953. Fit a straight line $Y = a + bX$ by the method of least squares.

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Exhibit the regression line and the observed data on a graph paper.

| States | Per capita sales Y | Per capita income X |
|--------|--------------------|---------------------|
| 1  | 93  | 148 |
| 2  | 84  | 132 |
| 3  | 83  | 123 |
| 4  | 99  | 140 |
| 5  | 82  | 112 |
| 6  | 87  | 119 |
| 7  | 87  | 125 |
| 8  | 103 | 134 |
| 9  | 79  | 104 |
| 10 | 100 | 123 |
| 11 | 90  | 171 |
| 12 | 45  | 76  |
| 13 | 103 | 135 |
| 14 | 81  | 102 |
| 15 | 65  | 97  |
| 16 | 106 | 143 |
| 17 | 71  | 103 |
| 18 | 81  | 94  |
| 19 | 69  | 104 |
| 20 | 57  | 83  |
| 21 | 72  | 89  |
| 22 | 67  | 80  |
| 23 | 66  | 92  |
| 24 | 75  | 96  |
| 25 | 53  | 92  |

(20

## GROUP B

3. *Either,* Six machines used for wool combing were tested for the Percentage of noils (short pieces of wool separated from the longer fibres by combing). During each of eleven successive weeks, one test was performed with each machine, the following data being obtained. Set up the analysis of variance table and test whether there are significant differences between (1) machines, (2) weeks.

| Week | machine | | | | | |
|------|------|------|------|------|------|------|
|      | A | B | C | D | E | F |
| 1  | 10.6 | 11.4 | 10.4 | 12.2 | 14.8 | 12.4 |
| 2  | 9.2  | 9.6  | 7.8  | 10.0 | 11.8 | 9.6  |
| 3  | 7.6  | 8.4  | 8.0  | 9.4  | 9.4  | 9.2  |
| 4  | 7.6  | 8.6  | 8.4  | 9.6  | 12.0 | 10.0 |
| 5  | 7.6  | 8.8  | 9.4  | 9.2  | 11.4 | 10.4 |
| 6  | 9.8  | 11.8 | 11.0 | 12.2 | 14.6 | 14.8 |
| 7  | 6.0  | 7.6  | 6.6  | 7.4  | 9.0  | 9.0  |
| 8  | 10.6 | 15.0 | 11.0 | 15.0 | 14.6 | 18.0 |
| 9  | 9.0  | 11.0 | 9.0  | 12.0 | 12.0 | 14.0 |
| 10 | 6.6  | 9.6  | 8.6  | 13.0 | 12.6 | 13.0 |
| 11 | 8.4  | 10.4 | 8.0  | 11.6 | 10.6 | 16.0 |

(30)

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*Or,* The original weight (*X*) and gain (*Y*) during a feeding experiment of 15 hogs on three rations—5 hogs on each ration—are given below. Set up a table of covariance analysis and test whether there are any significant differences between the rations after correction for the effect of initial weight.

| Hog | Ration 1 | | Hog | Ration 2 | | Hog | Ration 3 | | |
|-----|------|------|-----|------|------|-----|------|------|---|
| | *X* | *Y* | | *X* | *Y* | | *X* | *Y* | |
| 1 | 51 | 1.1 | 6 | 53 | 1.7 | 11 | 48 | 1.3 | |
| 2 | 62 | 1.3 | 7 | 65 | 1.0 | 12 | 58 | 1.4 | |
| 3 | 48 | 1.2 | 8 | 47 | 1.5 | 13 | 39 | 1.2 | |
| 4 | 40 | 1.1 | 9 | 52 | 1.6 | 14 | 55 | 1.3 | |
| 5 | 39 | 0.9 | 10 | 59 | 1.6 | 15 | 61 | 1.4 | (30) |

4. Using the data tabulated below compute an index number of prices of agricultural commodities in 1948 with 1939 prices as base.

| Commodity | Unit | Quantity produced in 1939 (in million units) | Price per unit (in dollars) | |
|-----------|------|------|------|------|
| | | | 1939 | 1948 |
| Corn | Bu | 2679 | 2.62 | 5.72 |
| Cotton | ℔. | 5705 | 0.71 | 2.20 |
| Hay | ton(sh) | 76.59 | 40.30 | 86.65 |
| Wheat | Bu | 952.1 | 4.26 | 9.57 |
| Oats | Bu | 1107 | 1.40 | 3.25 |
| Potatoes | Bu | 297.3 | 3.16 | 6.92 |
| Sugar | ℔. | 4371 | 0.20 | 0.53 |
| Barley | Bu | 131.1 | 2.43 | 4.12 |
| Tobacco | ℔. | 1444 | 0.78 | 2.51 |
| Flax seed | Bu | 6.77 | 8.76 | 17.52 |
| Ryo | Bu | 78.7 | 2.66 | 4.18 |
| Rice | Bu | 42.69 | 5.33 | 9.83 | (20) |

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## PART IB : SECTION II

Time : 3 *Hours*             *Full Marks* : 100

    (a) Answers to the different groups are to be given in separate books.

    (b) Figures in the margin indicate full marks.

    (c) Use of calculating machines is permitted.

### GROUP A

1. The following table gives the frequency distribution of interpupillary distances of 465 adult males.

Fit a normal distribution to the data. Draw the histogram and the fitted curve on the same graph. Compute the expected frequencies in all the classes. Examine the goodness of fit.

| Interpupillary distance in millimetres | Frequency |
|---|---|
| 56—57 | 2 |
| 58—59 | 14 |
| 60—61 | 35 |
| 62—63 | 87 |
| 64—65 | 115 |
| 66—67 | 97 |
| 68—69 | 59 |
| 70—71 | 49 |
| 72—73 | 6 |
| 74—75 | 1 |
| | 465 |

(35)

2. *Either.* (a) In December 1947, there was an outbreak of plague in a jail in Bombay. Of 127 persons who were uninoculated 15 contracted plague. Of 140 persons who were inoculated, 6 contracted plague. Set up the data in a $2 \times 2$ contingency table and using the chi-square test, examine whether there is association between inoculation and contracting plague.

(b) The following gives the actual percentage of different groups in a certain American city and also the observed frequencies in a sample of 1000 drawn from the population. Is there any evidence of bias in the sampling ?

| groups | actual percentage in the population | observed frequency in the sample |
|---|---|---|
| American | 62 | 640 |
| German | 5 | 44 |
| Italian | 15 | 138 |
| Spanish | 7 | 67 |
| Negro | 10 | 96 |
| Miscellaneous | 1 | 15 |
| Total | 100 | 1000 |

(15)

*Or,* (a) Compute $e^{-m} \dfrac{m^x}{x!}$

for $m = 1, 2$ and $x = 0, 1, 2, 3$

(Note : $0! = 1$)

(b) From the following table of values of $u(x,y)$ find by linear interpolation the values of $u$ corresponding to the following values of $x$ and $y$

(i) $x = 23, \quad y = 21$

(ii) $x = 15, \quad y = 12$

| $x$ \ $y$ | 25 | 20 | 15 |
|---|---|---|---|
| 10 | 7.407 | 8.043 | 8.457 |
| 20 | 9.322 | 10.072 | 10.575 |
| 30 | 12.071 | 12.984 | 13.643 |

(15)

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2

3. The following table gives the number of wagons loaded and railway freight in ton miles carried by them between January 1954 and December 1955. Represent graphically the monthly values of number of wagons loaded, total freight carried and freight carried per loaded wagon and comment on the graphs. (25)

Inland Transport : Wagons loaded and freight carried

| Year | Month | Wagons loaded (thousands) | Railway freight ton miles (millions) |
|------|-------|---------------------------|--------------------------------------|
| (1) | (2) | (3) | (4) |
| 1954 | January | 618 | 2531 |
| | February | 578 | 2274 |
| | March | 623 | 3308 |
| | April | 579 | 2275 |
| | May | 507 | 2341 |
| | June | 553 | 2238 |
| | July | 568 | 2325 |
| | August | 566 | 2449 |
| | September | 556 | 2394 |
| | October | 573 | 2458 |
| | November | 605 | 2523 |
| | December | 656 | 2724 |
| 1955 | January | 671 | 2762 |
| | February | 632 | 2696 |
| | March | 676 | 3330 |
| | April | 633 | 2468 |
| | May | 606 | 2649 |
| | June | 576 | 2528 |
| | July | 609 | 2809 |
| | August | 614 | 2655 |
| | September | 611 | 2603 |
| | October | 631 | 2703 |
| | November | 648 | 2752 |
| | December | 718 | 3091 |

4. For each of the following items, write the name of at least one publication from which you can get the required information.  For each of the publications indicate also the name of the publishing authority and its periodicity of publication namely, weekly, monthly etc.

(i) 'All-India' second estimate of cotton crop for 1956-57.

(ii) The index of wholesale prices for 'semi-manufactures' for the week ending November 17, 1956.

(iii) Number of boy students on rolls in recognised engineering institutions in Bihar during 1951-52.

(iv) Area not available for cultivation in the State of Assam during each of the four years from 1946-50.

(v) Total number of cows over 3 years in the United Provinces in 1945.

(vi) Units of electrical energy generated and sold in India during September 1956.

(vii) Number of mandays lost during May 1956 due to industrial disputes in the State of West Bengal.

(viii) Average hours worked per week by underground miners in Mica mines in Bihar during the year 1954.

(ix) Total mileage of extra municipal roads in Madras as on 31st March 1950

(x) General index of industrial production in September 1956 (base 1951 = 100).

(25)

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## PART IC : SECTION I

Time : 4 *Hours*                                                                          Full *Marks* : 100

(a) Answers to the different groups are to be given in separate books.

(b) Figures in the margin indiciate full marks.

• (c) Use of calculating machines is permitted.

### GROUP A

1. *Either,* The following table gives the performance tests on 5 types of gasoline in terms of miles per gallon ($y$) and miles per hour ($x$). Tests were carried out in a single automobile. 5 drivers were employed. Test for the significance of the differences in miles per gallon ($y$) given by the 5 types of gasoline and the 5 drivers, after eliminating the effect of miles per hour ($x$) of the automobiles.

Type of gasoline

|        |   |   | A  | B  | C  | D  | E  |
|--------|---|---|----|----|----|----|----|
|        | 1 | $x$ | 44 | 45 | 34 | 42 | 35 |
|        |   | $y$ | 28 | 29 | 32 | 29 | 34 |
|        | 2 | $x$ | 33 | 28 | 31 | 25 | 26 |
|        |   | $y$ | 36 | 39 | 37 | 38 | 38 |
| Driver | 3 | $x$ | 39 | 36 | 38 | 36 | 40 |
|        |   | $y$ | 32 | 31 | 31 | 30 | 32 |
|        | 4 | $x$ | 40 | 34 | 33 | 36 | 35 |
|        |   | $y$ | 31 | 34 | 34 | 32 | 33 |
|        | 5 | $x$ | 36 | 36 | 35 | 36 | 37 |
|        |   | $y$ | 33 | 35 | 34 | 32 | 31 |

(30)

*Or,* The following data give the results of duplicate determination of the percent solid content of wet brewer's yeast for 6 different samples using 3 drying periods, (3 hours, 6 hours and 9 hours). Analyse the data and prepare the appropriate analysis of variance table.

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| sample | drying period | | |
|---|---|---|---|
| | 3 hours | 6 hours | 9 hours |
| 1 | 3.24 | 3.16 | 2.96 |
| | 3.56 | 3.26 | 3.01 |
| 2 | 3.92 | 3.81 | 3.76 |
| | 3.86 | 3.80 | 3.75 |
| 3 | 9.13 | 8.86 | 8.70 |
| | 9.23 | 8.79 | 8.75 |
| 4 | 8.35 | 8.11 | 7.94 |
| | 8.29 | 8.24 | 7.99 |
| 5 | 5.51 | 5.06 | 4.84 |
| | 5.53 | 5.11 | 4.80 |
| 6 | 6.63 | 6.61 | 6.60 |
| | 6.65 | 6.57 | 6.50 |

(30)

2. (a) The correlation coefficients between pairs of the three varieties $X_1$, $X_2$, $X_3$ computed from a sample of 30 are as follows :—

$$r_{12} = 0.30$$
$$r_{13} = 0.74$$
$$r_{23} = 0.39$$

(i) Examine if $r_{12}$ is significantly different from zero.

(ii) Compute the partial correlation coefficient $r_{13.2}$ and test for its significance.

(iii) Compute the multiple correlation coefficient $R_{1.23}$ and test for its significance.

(b) Given $n = 100$, $p = 0.03$, and $r = 56$; evaluate

$$^nC_r \quad p^r(1-p)^{n-r} \tag{20}$$

### GROUP B

3. (a) Calculate $\lfloor n$ approximately for integral values of $n$ from 9 to 16 with the help of the following formula :—

$$\lfloor n = \sqrt{2\pi n} \ n^n e^{-n}$$

(b) Find the value of $\dfrac{\lfloor 10}{\lfloor x \lfloor 10-x} (0.4)^x (0.6)^{10-x}$

for integral values of $x$ from 1 to 10. Find also the value of

$$\dfrac{\lfloor 10}{\lfloor x \lfloor 10-x} (0.1)^x (0.9)^{10-x}$$

for the same values of $x$.

Plot these values on a graph and draw smooth curves passing through these points. Find out graphically the mode of both the curves. (20)

4. The following table gives the population of a certain district for the census years from 1821 to 1951 (figures for earlier years estimated):

| Year | Population (in '000) |
|------|----------------------|
| 1821 | 160 |
| 1831 | 172 |
| 1841 | 211 |
| 1851 | 274 |
| 1861 | 302 |
| 1871 | 362 |
| 1881 | 432 |
| 1891 | 472 |
| 1901 | 512 |
| 1911 | 574 |
| 1921 | 652 |
| 1931 | 761 |
| 1941 | 870 |
| 1951 | 994 |

(a) Fit a cubic of the form $y = a + bx + cx^2 + dx^3$ to this data where $y$ is the population and $x$ the year.

(b) Represent the data graphically and draw the fitted curve.

(c) Find with the help of the fitted curve the population for the years 1905, 1936 and 1961.                                                                                    (30)

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## PART IC : SECTION II

*Time* : *4 Hours*                                                                          *Full marks* : 100

(a) Answers to the different groups are to be given in separate books.

(b) Figures in the margin indicate full marks.

(c) Use of calculating machines is permitted.

### GROUP A

1. *Either*,  (a) Evaluate the following determinant and also the co-factors of each of the diagonal elements:—

$$\begin{vmatrix} 2385 & 1205 & 477 \\ 1245 & 2171 & 240 \\ 3210 & 1005 & 642 \end{vmatrix}$$

(b)

| $x$ | 50 | 51 | 52 | 53 | 54 | 55 | 56 |
|-----|----|----|----|----|----|----|----|
| $f(x)$ | 3.684 | 3.705 | 3.730 | 3.756 | 3.780 | 3.803 | 3.826 |

Using the above data, calculate $f(50.23)$, $f(52.5)$, $f(52.75)$ and $f(53.8)$.

(20)

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*Or,* In an agricultural experiment with six types of a particular crop and five blocks, the following figures were obtained for the yield of grain per plot of equal size

| Blocks | TYPE | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 12.0 | 11.5 | 11.5 | 11.0 | 9.5 | 9.3 |
| 2 | 10.8 | 11.4 | 12.0 | 11.1 | 9.6 | 9.7 |
| 3 | 13.2 | 13.1 | 12.5 | 11.4 | 12.4 | 10.4 |
| 4 | 14.0 | 14.0 | 14.0 | 12.3 | 11.5 | 9.5 |
| 5 | 14.6 | 13.2 | 14.2 | 14.3 | 13.7 | 12.0 |

Find out whether there exist significant differences among the types. Furthermore, compare type 1 with types 2 and 5. (20)

2. 1,000 shots are fitted from a battery gun at a target 52 feet long and 11 feet high. All the shots hit the target and their distribution in 11 horizontal strips of one foot each is as follows :—

| strip number | number of shots |
|---|---|
| 1 | 1 |
| 2 | 4 |
| 3 | 10 |
| 4 | 89 |
| 5 | 190 |
| 6 | 212 |
| 7 | 204 |
| 8 | 193 |
| 9 | 79 |
| 10 | 16 |
| 11 | 2 |

The point of aim is the central line of the target. Find $\beta_1$ and $\beta_2$ and hence determine the appropriate type of Pearsonian curve which will fit the above data and evaluate the constants involved. (30)

### GROUP B

3. The following table gives the electric power production (per calendar day) of the United States of America during the years 1921-1928.

Electric Power Production : 1921–1928
(Average per calendar day, Millions of Killowatt)

| Year | 1st quarter | 2nd quarter | 3rd quarter | 4th quarter |
|---|---|---|---|---|
| 1921 | 112 | 107 | 109 | 120 |
| 1922 | 123 | 124 | 130 | 145 |
| 1923 | 153 | 149 | 148 | 159 |
| 1924 | 165 | 155 | 153 | 171 |
| 1925 | 177 | 172 | 178 | 195 |
| 1926 | 200 | 194 | 199 | 216 |
| 1927 | 220 | 215 | 214 | 228 |
| 1928 | 235 | 230 | 238 | 256 |

(a) Find out the seasonal components for the four quarters by the method of link relatives.

(b) Fit also a straight line trend to the annual production figures.

(c) Estimate the electric power production of the United States in the four quarters of 1929.

In this case, the 1st quarter relates to the period January to March, the second to April-June, the 3rd to July-September and the 4th to October-December.    (30)

4. How will you proceed to collect the following information ?

(a) Production of steel in India, U.K., U.S.A. for the years 1950—55.

(b) Number of accidents in railways for the years 1950-55 in the Indian Union.

(c) Average monthly wage per worker for the registered factories in the different States of the Indian Union (classified by men, women and children) in the year 1955.

(d) Index numbers of the cost of living in the different cities like Calcutta, Bombay, Madras, Delhi, Nagpur, Lucknow of the Indian Union for the years 1950—56.

(e) Crude birth and death rates in India, U.K., U.S.A., U.S.S.R., China, and France for the years 1950—55.

(f) Area irrigated under food crops, jute, cotton, oil seeds expressed as percentages of the corresponding areas cultivated under the above crops for the different states of the Indian Union in the years 1950—56.

Illustrate your answer with appropriate blank tables and mention the source in each case with special reference to the following points :—

   (i) Name of the publication

   (ii) Issuing authority.    (20)

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# INDIAN STATISTICAL INSTITUTE

Time : 3 *Hours*                                                     *Full Marks* : 100

(a) Answers to the different groups are to be given in separate books.

(b) All questions carry equal marks.

(c) Use of calculating machines is not permitted.

### GROUP A

1. Scrutinise the following computation sheet and copy it out neatly after correcting *obvious* mistakes.

| $X$ | $x$ | $w$ | $Y$ | $\eta = \dfrac{X}{Y}$ | $\eta w$ | $\eta x w$ |
|------|--------|-------|------|---------|---------|--------|
| 6.24 | 2.7952 | 7.52 | 0.09 | 69.333 | 521.384 | 3253.4 |
| 9.36 | 2.9713 | 12.09 | 0.26 | 66.000 | 435.240 | 4073.8 |
| 11.92 | 3.0763 | 8.56 | 0.36 | 33.111 | 283.430 | 3378.5 |
| 14.01 | 3.1404 | 9.29 | 0.44 | 34.841 | 295.803 | 4144.2 |
| 16.27 | 3.2114 | 11.36 | 0.49 | 33.204 | 777.197 | 6137.0 |
| 18.96 | 3.2783 | 10.44 | 0.51 | 37.176 | 388.117 | 7358.7 |

2. In a housing census, housing units were classified into three major types—1. Permanent housing units (including dwellings and collective houses), 2. Mobile housing units and 3. Improvised housing units. At the time of the census, the following were found to be used for habitation :—hotels, houses, hospitals, flats, boarding houses, barns, garages, booths, army barracks, squatter's houses, convents, jails, transportable houses, tents, floating houses, mills, warehouses, caves, inns, boarding schools, caravans, stables, huts, creches.

Arrange these habitation units appropriately under the three major heads, giving suitable serial and sub-serial numbers.

3. Given below is an extract from a journal relating to agricultural targets in the Second Five-Year Plan. Present the data, together with percentage increase in output for each type of crop calculated, in a neat tabular form.

"The targets set to be reached in 1960-61, with figures in brackets representing the existing levels of output, are :—Foodgrains 75 million tons (65 millon tons), Oil-seeds, 7 million tons (5.5 million tons), Sugarcane 7.1 million tons (5.8 million tons), Cotton 5.5 million bales (4.2 million bales), Jute 5.0 million bales (4.0 million bales), Coconut 210,000 tons (130,000 tons), Arecanut 2.7 million maunds (2.2 million maunds), Pepper 32,000 tons (26,000 tons), Cashewnut 80,000 tons (60,000 tons) and Tea 706 million lbs (644 million lbs)".

4. *Either,*
   Fill up the blanks in the following table :—

| $a$ | $(a+b)$ | $(a-b)$ | $(a+b)^2$ | $(a-b)^2$ | $ab$ |
|-----|---------|---------|-----------|-----------|------|
| 4.3 | 5.7 | | | | |
| 5.6 | 6.0 | | | | |
| 7.5 | 9.4 | | | | |
| 3.2 | 4.9 | | | | |
| 1.9 | 6.5 | | | | |
| 5.0 | 7.2 | | | | |
| 6.4 | 6.7 | | | | |
| 2.6 | 3.5 | | | | |

*Or,*
   Evaluate

$$\frac{5 \times (5.723 - 4.008) + 6.4(3.901 - 5.102)}{(4.5 \times 2.4 - 2.9 \times 2.0)} + \frac{(1.005 + 5.995)}{14.0} + \frac{(7.981 - 5.431)}{5.1}$$

5. *Either*

From the relation

$$y = 10 \left( 2.5 - x + \frac{x^2}{10} \right)$$

find the values of $y$ for the values of

$$x = 2, 2.5, 3, 3.5, 4, 4.5 \text{ and } 5.$$

*Or,*
   Tabulate the values of $y$ from the relation
   $$(y-7) = 42 + (x-0) + (x-11)^2$$
   for the values of $x = 5, 7, 9, 11, 13 \text{ and } 15.$

6. Following are the heights in inches of 53 students of a class.

     55, 56, 57, 57, 52, 53, 56, 51, 49, 48, 47, 48, 49, 60, 62, 46, 51, 60, 50,

     53, 54, 55, 56, 57, 56, 54, 59, 60, 47, 48, 64, 65, 63, 46, 62, 61, 52, 52,

     53, 52, 55, 54, 52, 52, 53, 55, 48, 50, 51, 52, 66, 61, 52.

(a) Tabulate them by grouping in class-intervals of five inches.

(b) Arrange the heights in ascending order of magnitudes.

(c) Find out the height of the 27th student in this order.

(d) Find the difference between the tallest and shortest of these students.

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(a) Answers to the different groups are to be given in separate books.

(b) All questions carry equal marks.

(c) Use of calculating machines is not permitted.

## GROUP A

1. (a) Evaluate :—

(i) $\text{Log } \sqrt[10]{1287}$

(ii) $\left[ \text{Log } \dfrac{1+0.75}{1-0.75} \right] \times 1.1513$

(iii) $1 - \text{Antilog } \left[ \log \dfrac{396693}{412165} \right]$

(b) Find the roots of the equation

$$x(21x - 49) = 952$$

(c) If $\pi = 3.14159$, find $\pi^2$ and $\dfrac{1}{\sqrt{\pi}}$ correct to five significant figures.

2. The table below gives data on production and prices of wheat in a State, during 10 successive years :—

| Years | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Production (lakh maunds) | 4.5 | 5.4 | 6.0 | 7.1 | 6.2 | 10.1 | 8.4 | 6.7 | 8.9 | 6.3 |
| Average price per maund (Rs.) | 8.4 | 5.1 | 6.2 | 7.5 | 9.1 | 9.6 | 18.3 | 14.4 | 6.7 | 8.3 |

Find the value of wheat produced in each of the years. Calculate mean and standard error of mean for any two of the following :—

(i) production, (ii) value of production, (iii) price.

*Or,* (a) From the following data, calculate the price relatives of each of the following items of food with 1939 as base

| Items of food group | weights | Price per seer | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1939 | | | 1949 | | |
| | | Rs. | As. | Ps. | Rs. | As. | Ps. |
| Wheat | 40 | 0 | 1 | 3 | 0 | 7 | 6 |
| Rice | 20 | 0 | 2 | 0 | 0 | 10 | 0 |
| Gram | 15 | 0 | 1 | 0 | 0 | 5 | 6 |
| Dal | 5 | 0 | 2 | 3 | 0 | 9 | 0 |
| Milk | 6 | 0 | 2 | 6 | 0 | 10 | 0 |
| Vegetable Oil | 10 | 0 | 5 | 0 | 2 | 8 | 0 |
| Sugar | 3 | 0 | 4 | 0 | 0 | 14 | 0 |
| Salt | 1 | 0 | 1 | 0 | 0 | 3 | 0 |
| | 100 | | | | | | |

Compute the weighted average of the price relatives using the weights given in the table.

(b) Estimate, by simple interpolation, the annual rate of life insurance premia applicable to ages 25 years and 31 years, from the data given below :—

| Age of insured years | annual premium per Rs. 1000 Rs. |
|---|---|
| 20 | 24.27 |
| 24 | 25.81 |
| 28 | 27.72 |
| 32 | 29.96 |

### GROUP B

3. (a) From the equation $y = -.005 - .005x + 1.025x^2$, calculate the values of $y$ corresponding to the values $x = 0, 0.5, 1, 2, 2.5$ and 3. Draw a smooth curve through the points corresponding to the values $x$ and $y$.

(b) Estimate the area of the portion bounded by the curve as drawn above, the $y$ axis and the straight line $y = 5$.

4. Cost of production under different components are given below for a factory for nine years.

| year | Cost of production per unit (Rs.) | | | | |
|---|---|---|---|---|---|
| | raw materials | labour | capital charge | overhead | total |
| 1948 | 14.3 | 10.1 | 2.1 | 3.1 | 29.6 |
| 1949 | 16.9 | 10.8 | 2.4 | 3.6 | 33.7 |
| 1950 | 17.4 | 12.2 | 2.4 | 5.8 | 37.8 |
| 1951 | 19.8 | 13.6 | 3.6 | 5.5 | 42.5 |
| 1952 | 24.8 | 15.8 | 3.4 | 6.0 | 50.0 |
| 1953 | 38.8 | 16.8 | 3.8 | 6.6 | 66.0 |
| 1954 | 44.1 | 18.6 | 3.5 | 6.2 | 72.4 |
| 1955 | 45.0 | 19.4 | 3.8 | 6.4 | 74.6 |
| 1956 | 46.7 | 18.5 | 3.0 | 6.8 | 75.0 |

Represent the data graphically and obtain from the graph, the different cost components for 1st January 1955, assuming that the figures refer to the middle of the corresponding years.

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(a) Answers to the different groups are to be given in separate books.

(b) Figures in the margin indicate full marks.

(c) Use of calculating machines is permitted.

### GROUP A

1.  The following is an account of the accidents (killed and injured), that happened to passengers in five different railways (A, B, C, D, E) in a particular year.

Present the information in a suitable tabular form and find out the total number of accidents in the 5 railways due to various causes.

In A, 12 people were killed and an equal number were injured, while in B and C only 10 and 4 people were injured but none killed. In D as many as 39 people were injured and 28 killed while in E 9 people were killed and 10 injured. These were all cases of accidents due to 'falling between trains and platforms'.

Accidents due to 'crossing' of the lines at railway stations' were fortunately not as numerous. In E however 6 people were injured and 5 killed while in C and D only 4 and 2 people were killed and 2 and 1 injured. A had only one case of injury and 3 deaths.

'Closing the carriage doors' did result in serious injuries but happily no deaths. 33 people were injured in C, 2 in E and 4 in A.

The largest number of accidents however happened due to 'falling or jumping out of running trains', the total number of passengers involved in these accidents being 253, 239, 141, 131 and 101 in C, E, B, D and A respectively. These included 35 deaths in C, 37 deaths in E, 26 deaths in B, 30 deaths in D and 27 deaths in A.

.                                                                                          (15)

2.  The following table gives the frequency distribution of 645 rural households in Western India, according to their average level of monthly expenditure in April-June 1951.

| Level of expendi- ture in Rs. | Frequency |
|---|---|
| Below 100 | 142 . |
| 100— 200 | 323 |
| 200— 300 | 119 |
| 300— 400 | 25 |
| 400— 500 | 21 |
| 500— 600 | 8 |
| 600— 700 | 3 |
| 700— 800 | 2 |
| 800— 900 | 1 |
| 900—1000 | 1 |

Compute the mean, median, interquartile range, standard deviation and $\beta_1$ of this distribution.                                                                (35)

The following table gives the frequency distribution of yield of dry bark in Oz. (*Y*) and the age in years (*X*) of 157 cichona plants.

Obtain the linear regression equation of *Y* on *X* and the coefficient of correlation between *Y* and *X*.

Frequency distribution of yield and age of cinchona plants

| Age in years (X) | Yield in ounces (Y) | | | | | |
|---|---|---|---|---|---|---|
| | 4—7 | 8—11 | 12—15 | 16—19 | 20—23 | 24—27 |
| 3— 4 | 2 | — | — | | — | — |
| 5— 6 | 3 | 6 | 6 | 1 | — | — |
| 7— 8 | 3 | 7 | 10 | 5 | — | — |
| 9—10 | | 8 | 15 | 10 | 10 | — |
| 11—12 | | | 12 | 19 | 15 | 5 |
| 13—14 | | | 2 | 4 | 10 | 4 |

Calculate the mean value of *y* for each class interval of *x*.

Plot these mean values against *x* on a graph paper and show the regression line of *y* on *x* on the same graph. (35)

### GROUP B

3. The average yields of a certain crop in maunds per acre during the period 1931 to 1951 are given below. Fit a curve of the form

$$y = a + bx + cx^2$$

to the data. Calculate the standard error of estimate (i.e., root mean square deviation from regression).

| Year (x) | average yield in mds. per acre (y) | Year (x) | average yield in mds. por acre (y) |
|---|---|---|---|
| 1931 | 27.1 | 1941 | 58.2 |
| 1932 | 32.1 | 1942 | 49.2 |
| 1933 | 52.5 | 1943 | 59.5 |
| 1934 | 56.0 | 1944 | 48.1 |
| 1935 | 60.6 | 1945 | 78.5 |
| 1936 | 57.1 | 1946 | 33.4 |
| 1937 | 74.8 | 1947 | 57.2 |
| 1938 | 61.0 | 1948 | 60.2 |
| 1939 | 67.3 | 1949 | 37.5 |
| 1940 | 53.2 | 1950 | 52.1 |
| | | 1951 | 48.4 |

Calculate the estimated values. (30)

*Or,* In order to determine the effect of initiative and parental encouragement upon the intelligence of 11-year old children, 48 children were tested to determine their

degree of initiative and extent of parental encouragement, and subsequent tests of intelligence gave the following intelligence quotients :—

| Initiative | Parental encouragement | Intelligence quotients |
|------------|------------------------|------------------------|
| High | High | 107, 126, 122, 129, 117, 128, 103, 117, 132, 139, 122, 121. |
| High | Low | 99, 95, 79, 94, 122, 117, 99, 102, 110, 116, 121, 96. |
| Low | High | 86, 89, 96, 101, 81, 90, 113, 79, 89, 82, 91, 74. |
| Low | Low | 104, 107, 93, 92, 82, 87, 100, 80, 102, 103, 85, 69. |

Complete the analysis of variance table in the form below and test whether (i) initiative is related to intelligence and (ii) parental encouragement is effective.

| Source | Analysis of Variance Table | | | | |
|--------|------|------|------|-----|----|
| | D.F. | S.S. | M.S. | F. | * |
| Initiative | | | | | |
| Parental encouragement | | | | | |
| Interaction Between Groups | | | · | | |
| Within groups | | | | | |
| Total | | | | | |

(30)

4. The following table gives the results of tensile strength tests of portland cement with different admixtures. Set up the table of analysis of variance and test whether there is any significant difference between the tensile strengths of the different mixtures.

| mixture | tensile strength after duration of | | | |
|---------|-------|--------|--------|---------|
| | 1 day | 3 days | 7 days | 28 days |
| A | 517 | 638 | 653 | 664 |
| B | 514 | 582 | 593 | 700 |
| C | 432 | 565 | 635 | 718 |
| D | 505 | 547 | 610 | 660 |
| E | 465 | 540 | 574 | 692 |
| F | 368 | 532 | 582 | 737 |
| G | 437 | 514 | 592 | 640 |

(20)

(a) Answers to the different groups are to be given in separate books.

(b) Figures in the margin indicate full marks.

(c) Use of calculating machines is permitted.

### GROUP A

1. The following table gives the frequency distribution of the annual number of telephone calls made by members of a sample of 990 residence telephone subscribers in a city.

(i) Calculate the mean and standard deviation of the data and fit a normal cruve.

(ii) Sketch the fitted curve and the histogram in the same graph.

(iii) Find the theoretical frequencies in all the cells and examine whether the fit is satisfactory.                                    (40)

| annual number of telephone calls | number of subscribers |
|---|---|
| 50—100 | 1 |
| 100—150 | 9 |
| 150—200 | 19 |
| 200—250 | 38 |
| 250—300 | 50 |
| 300—350 | 95 |
| 350—400 | 85 |
| 400—450 | 115 |
| 450—500 | 132 |
| 500—550 | 144 |
| 550—600 | 116 |
| 600—650 | 79 |
| 650—700 | 54 |
| 700—750 | 31 |
| 750—800 | 13 |
| 800—850 | 7 |
| 850—900 | 2 |
| | 990 |

2. From the following table of values of $U(x,y)$, compute the values of $U$ for $x = 2.7$, $y = 17$ and $x = 2.3$, $y = 12$.

| y x | 10 | 15 | 20 |
|---|---|---|---|
| 3 | 14.21 | 16.11 | 16.32 |
| 2.5 | 12.27 | 13.41 | 13.72 |
| 2 | 10.41 | 11.22 | 12.11 |

(10)

*Or,* The classification of a sample of 455 households from a city by community and income is given below.

| Community | Income group | | | Total |
|---|---|---|---|---|
| | poor | middle Class | well-to-do | |
| A | 140 | 100 | 15 | 255 |
| B | 130 | 50 | 20 | 200 |
| Total | 270 | 150 | 35 | 455 |

Examine whether there is any association between community and income. (10)

## GROUP B

3. Solve the equation
$$(4.5)^{3x}(6.4)^{x-2} = (7.8)^{x+4}(0.4857(2.43)^{x-2})$$ (10)

4. The following table gives the number of passengers carried and the total number of passenger miles flown in each month by the Indian Airlines Corporation in their scheduled internal services between April 1955 and December 1956. Represent graphically the following time series, viz., (i) number of passengers carried, (ii) total number of passenger-miles flown and also comment on these graphs.

CIVIL AVIATION : Passengers carried and passenger miles flown.

| Year | month | passengers carried (hundreds) | passenger-miles flown (thousands) |
|---|---|---|---|
| 1955 | April | 345 | 14,023 |
| | May | 370 | 15,002 |
| | June | 334 | 13,329 |
| | July | 315 | 12,772 |
| | August | 294 | 12,101 |
| | September | 289 | 12,176 |
| | October | 344 | 14,187 |
| | November | 378 | 17,014 |
| | December | 423 | 19,273 |
| 1956 | January | 402 | 17,743 |
| | February | 397 | 17,634 |
| | March | 434 | 19,207 |
| | April | 408 | 18,258 |
| | May | 427 | 18,650 |
| | June | 351 | 15,361 |
| | July | 352 | 15,110 |
| | August | 356 | 15,781 |
| | September | 356 | 16,018 |
| | October | 445 | 19,572 |
| | November | 438 | 20,262 |
| | December | 468 | 21,063 |

(15)

5. For each of the following items write the name of at least one publication from which you can get the required information. For each of the publications indicate also the name of the publishing authority and its periodicity of publication namely weekly, monthly etc.

1. Raw cotton consumed by cotton mills in March 1957 in Bombay.
2. Number of third class passengers booked in Eastern Railway during June 1955.
3. Gross amount of Import duty collected in all the ports of India in the month of October 1956 on cinematograph films, not exposed.
4. Amount of Tea exported to Sudan during July 1956.
5. Number of cheques cleared in Delhi in May 1957.
6. Working class cost of living index in Jamshedpur in June 1957.
7. Irrigated area under wheat in India in 1951.
8. Number and amount of Foreign Money order paid in India in 1955.
9. Total productive capital employed in Factories in the State of Assam in 1951.
10. Value of outturn of timber and firewood in Bihar forests during 1952-53.
11. Total quantity and value of tea exported from India in 1956.
12. Number of books published in Indian languages in 1953.
13. Number of educational institutions in India and scholars attending them in 1952-53.                                                                    (25)

PART IC: SECTION I

Time: 4 *Hours*  Full *Marks*: 100

(a) Answers to the different groups are to be given in separate books.

(b) Figures in the margin indicate full marks.

(c) Use of Calculating machines is permitted.

## GROUP A

1. (a) Calculate the values of

$$\text{(i)} \quad \frac{n!}{r!(n-r)!} q^r (1-q)^{n-r}$$

$$\text{(ii)} \quad \frac{e^{-M} m^r}{r!}$$

for integral values of $r$ ranging from 2 to 10 and for $q = 0.005$ and 0.047 where $m = nq$ and $n = 1000$.

(b) The relation between $y$ and $\theta$ is given by $y = \frac{1}{2} \log \frac{1+\cos\theta}{1-\cos\theta}$. Find the values of $y$ for $\theta = 0°$ to $90°$ at intervals of $10°$.

Represent these values on a graph and determine from the graph the value of $\theta$ for which $y = 2$.  (25)

*Or,*

Calculate the values of $y$ for $x = 17, 32, 47, 62, 77$ from the relation

$$y = y_0 \left(1 + \frac{x - 26.75942}{a_1}\right)^{m_1} \times \left(1 - \frac{x - 26.75942}{a_2}\right)^{m_2}$$

where $y_0 = \frac{1000}{a_1 + a_2} \cdot \frac{m_1{}^{m_1} m_2{}^{m_2}}{(m_1 + m_2)^{m_1 + m_2}} \cdot \frac{\Gamma(m_1 + m_2 + 2)}{\Gamma(m_1 + 1)\Gamma(m_2 + 1)}$

$a_1 = 1.99638$
$a_2 = 13.52728$
$m_1 = .40983$
$m_2 = 2.77698$  (25)

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2. The table below gives 11 readings of $t$ (which is a function of temperature) and corresponding values of specific heat of water $(c)$.

| $t$ | $c$ |
|------|--------|
| $-1.0$ | 1.0075 |
| $-0.8$ | 1.0008 |
| $-0.6$ | 0.9974 |
| $-0.4$ | 0.9971 |
| $-0.2$ | 0.9974 |
| 0.0 | 0.9983 |
| 0.2 | 0.9995 |
| 0.4 | 1.0012 |
| 0.6 | 1.0032 |
| 0.8 | 1.0057 |
| 1.0 | 1.0086 |

Taking $t$ as the independent variable fit (i) a second degree curve and (ii) a third degree curve.

Do you find the third degree curve to be a better fit?

Draw the curve which you consider to be a better fit and show the observed values also on the same graph. (25)

### GROUP B

3. The following table gives the test results conducted on 6 aluminium alloys for their resistance to corrosion in a chemical plant atmosphere. 4 sites were chosen in the factory and on each of them a plate made from each alloy was exposed for a year. The plates were then submitted to 4 observers for inspection. Analyse the data and prepare a suitable analysis of variance table.

| Site | Observer | Alloy | | | | | |
|------|----------|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| I | A | 5 | 5 | 5 | 4 | 6 | 6 |
| | B | 4 | 5 | 5 | 4 | 5 | 3 |
| | C | 7 | 7 | 7 | 7 | 8 | 5 |
| | D | 6 | 5 | 4 | 5 | 7 | 6 |
| II | A | 8 | 7 | 7 | 7 | 5 | 4 |
| | B | 7 | 8 | 6 | 7 | 6 | 5 |
| | C | 9 | 9 | 9 | 9 | 8 | 6 |
| | D | 8 | 8 | 7 | 7 | 5 | 5 |
| III | A | 4 | 4 | 5 | 3 | 4 | 3 |
| | B | 1 | 3 | 3 | 2 | 5 | 2 |
| | C | 5 | 5 | 5 | 6 | 6 | 4 |
| | D | 3 | 3 | 7 | 2 | 3 | 3 |
| IV | A | 6 | 5 | 6 | 5 | 6 | 4 |
| | B | 1 | 3 | 6 | 5 | 5 | 4 |
| | C | 5 | 5 | 7 | 6 | 8 | 7 |
| | D | 5 | 3 | 5 | 3 | 5 | 3 |

(20)

4. Body weight in pounds (y), heights in inches ($x_1$) and waist girth in inches ($x_2$) of 25 individuals are given below :—

| Body weight (lbs.) | Height (inches) | Waist girth (inches) |
|---|---|---|
| 106 | 66 | 25 |
| 106 | 64 | 27 |
| 100 | 68 | 24 |
| 129 | 66 | 28 |
| 131 | 66 | 29 |
| 135 | 72 | 30 |
| 116 | 66 | 27 |
| 105 | 67 | 25 |
| 145 | 66 | 32 |
| 108 | 67 | 25 |
| 116 | 66 | 30 |
| 126 | 66 | 29 |
| 180 | 66 | 40 |
| 117 | 66 | 28 |
| 113 | 66 | 27 |
| 123 | 67 | 31 |
| 111 | 67 | 26 |
| 102 | 64 | 25 |
| 106 | 64 | 26 |
| 104 | 65 | 24 |
| 111 | 63 | 26 |
| 104 | 65 | 24 |
| 136 | 66 | 33 |
| 143 | 68 | 32 |
| 148 | 68 | 33 |

Obtain the regression equation of $y$ on $x_1$ and $x_2$ and compute the multiple correlation coefficient. Also calculate the partial correlation coefficient $r_{yx_1 \cdot x_2}$ and test the significance of the partial and multiple correlation coefficients.                    (30)

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(a) Answers to the different groups are to be given in separate books.

(b) Figures in the margin indicate full marks.

(c) Use of calculating machines is permitted.

## Group A

1. *Either*,

The following values of $f(x,y)$ being given find $f(42,52)$ and $f(37,48)$

$$f(35,55) = 10.020, \quad f(35,50) = 11.196, \quad f(35,45) = 12.019,$$

$$f(40,55) = 9.796, \quad f(40,50) = 10.894, \quad f(40,45) = 11.641,$$

$$f(45,55) = 9.583, \quad f(45,50) = 10.591, \quad f(45,45) = 11.243. \tag{20}$$

*Or,*

An agricultural experiment was conducted on the Latin square plan to test the effect on yield due to change of treatment (5 kinds) and also due to variation of soil in each of two perpendicular directions. The results are set out in the Latin square below in which letters correspond to treatments, while rows and columns correspond to the two perpendicular directions. Are the effects on yield significant ?

| A | 7.4  | D | 8.9  | E | 5.8  | B | 12.0 | C | 14.3 |      |
|---|------|---|------|---|------|---|------|---|------|------|
| C | 11.8 | B | 6.5  | A | 8.7  | E | 7.6  | D | 7.9  |      |
| D | 10.1 | C | 17.9 | B | 9.0  | A | 8.5  | E | 7.1  |      |
| E | 8.8  | A | 10.1 | C | 15.7 | D | 11.1 | B | 7.4  |      |
| B | 11.8 | E | 8.8  | D | 14.3 | C | 18.4 | A | 10.1 | (20) |

2. In an experimental sampling, 342 samples were drawn from a certain population and a statistic $T$ was calculated for each sample. The frequency distribution of the $T$ values is given below.

| $T$      | Frequency | $T$      | Frequency |
|----------|-----------|----------|-----------|
| 0— 2     | 4         | 14—16    | 14        |
| 2— 4     | 23        | 16—18    | 18        |
| 4— 6     | 51        | 18—20    | 3         |
| 6— 8     | 69        | 20—22    | 4         |
| 8—10     | 59        | 22—24    | 3         |
| 10—12    | 57        | 24—26    | 1         |
| 12—14    | 35        | 26—28    | 1         |

Determine the appropriate Pearsonian curve that may be fitted to the data, obtain the values of the constants in the equation of the curve. (30)

3. (a) The following table shows the mean temperature in Alipore for different months of the years 1950 to 1953 :—

|           | 1950 | 1951 | 1952 | 1953 |
|-----------|------|------|------|------|
| January   | 69.5 | 67.1 | 69.7 | 67.5 |
| February  | 73.3 | 74.1 | 76.4 | 75.0 |
| March     | 81.3 | 81.0 | 80.0 | 85.5 |
| April     | 88.3 | 87.1 | 86.1 | 89.8 |
| May       | 87.3 | 89.7 | 87.3 | 89.5 |
| June      | 86.5 | 87.1 | 87.7 | 86.3 |
| July      | 84.3 | 84.7 | 83.9 | 84.9 |
| August    | 84.2 | 85.4 | 84.4 | 84.8 |
| September | 84.6 | 85.1 | 84.3 | 84.4 |
| October   | 81.1 | 84.3 | 81.9 | 82.1 |
| November  | 73.3 | 76.0 | 75.6 | 74.9 |
| December  | 68.9 | 70.1 | 68.7 | 71.1 |

(i) Calculate the seasonal indices for different months.

(ii) Plot the deseasonalised data on a graph paper.

(b) The following table gives the price-relatives of food items for April 1957 with 1939 as base and the weights corresponding to these items. Calculate the index number of food prices.

| items             | weights | Price-relatives |
|-------------------|---------|-----------------|
| Rice              | 7       | 518             |
| Wheat             | 13      | 619             |
| Other food grains | 26      | 528             |
| Pulses            | 9       | 430             |
| Mutton            | 5       | 350             |
| Milk              | 8       | 331             |
| Ghee              | 5       | 311             |
| Potatoes          | 5       | 242             |
| Onions            | 1       | 528             |
| Edible oil        | 7       | 740             |
| Salt     ·        | 1       | 115             |
| Sugar             | 5       | 288             |
| Tea               | 1       | 438             |    (30)

4. From the publications supplied, collect the index numbers of wholesale prices of (i) raw materials and of (ii) finished goods for United Kingdom, United States and India for the latest available ten years.

Represent the figures graphically and comment on the movement of these prices in the above countries.    (20)