

INDIAN STATISTICAL INSTITUTE
 Research and Training School
 One-year evening course in Statistics (1965-66)

QUESTION PAPERS

Serial Number	Date	Subject
<u>Final Examination - Part I:</u>		
1	10. 3. 66	Paper I: Group A. <u>Descriptive Statistics (Theory)</u> Paper I: Group B. <u>Official Statistics</u>
2	11. 3. 66	Paper II: Group A. <u>Probability</u> Paper II(b): <u>Tests of Significance (Theory)</u>
3	14. 3. 66	Paper III(a): <u>Vital Statistics (Theory and Practical)</u> Paper III(b): <u>Index Numbers and Time Series</u>
4	15. 3. 66	Paper IV: Group A: <u>Descriptive Statistics (Practical)</u> Paper IV: Group B: <u>Tests of Significance (Practical)</u>
<u>Final Examination - Part II:</u>		
5	24. 8. 66	Paper I: <u>Analysis of Variance and Theory of Inference</u>
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7	27. 8. 66	Paper III: <u>Economic and Industrial Statistics</u>
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INTERNATIONAL STATISTICAL EDUCATION CENTRE - CALCUTTA
Nineteenth Term (July 1965 - April 1966)

QUESTION PAPERS

<u>Serial Number</u>	<u>Date</u>	<u>Subject</u>
<u>Mid-Term Examination</u>		
1	6. 1. 66	Numerical Mathematics
2	6. 1. 66	Demography (Theory and Practical)
3	11. 1.66	Probability
4	12. 1. 66	Auxiliary Mathematics
5	28. 3. 66	Large Scale Sample Surveys (NSS)
6	30. 3. 66	<u>Statistical Quality Control</u> (Specialisation)
7	30. 3. 66	Demography (Specialisation)
8	30. 3. 66	Econometrics (Specialisation)
9	30. 3. 66	Data Processing (Specialisation)
10	2. 4. 66	Sample Surveys (Specialisation)

INDIAN STATISTICAL INSTITUTE
Research and Training School
One-year evening course in Statistics (1965-66)
Final Examination - Part I

(Answer different groups in different booklets)

Date: 10-3-66

Time: 5.30-9 p.m.

Paper I: Group A. Descriptive Statistics (Theory)

Time: 2 hours

Maximum marks: 80

- N.B. (i) Attempt any four questions.
(ii) All questions are of equal value.

1. Describe briefly different types of bar diagrams ^{and} pie charts and indicate their uses.
- 2.a) What are ^{the} different measures of location of a distribution? Which of them is the most commonly used? Why?
- b) For a distribution with the density function

$$p(x) = \frac{\sigma^m}{\Gamma(m)} x^{m-1} e^{-\alpha x}, \quad (\alpha > 0, m > 0, x \geq 0),$$

= 0 otherwise;

calculate the arithmetic mean.

3. Define the terms (i) range, (ii) mean deviation about a given point c , (iii) standard deviation, (iv) semi-inter-quartile range, (v) percentiles. What are these measures supposed to represent?
- 4.a) Define (i) Hypergeometric, (ii) Binomial and (iii) Normal distributions.
- b) Obtain the moment generating function of the Binomial distribution and hence, or otherwise, calculate its first two central moments.
- 5.a) Define (i) total correlation coefficient, ρ_{12} , (ii) multiple correlation coefficient, $R_{1.23}$, (iii) partial correlation coefficient $\rho_{12.3}$ for variables X_1, X_2 and X_3 .
- b) Explain clearly the concept of regression. What do you understand by the statement that the regression is linear?

Paper I: Group B: Official Statistics

Time: $1\frac{1}{2}$ hours

Maximum marks: 40

Note: Answer Question 1 (which is compulsory) and any TWO from the rest. Figures in the margin indicate full marks.

1. Explain clearly the decentralised statistical system in India. What are the different statistical units placed under the Cabinet Ministry and what are their functions? Name ONE important publication of EACH such unit and mention the periodicity of publication. (16)
2. Describe briefly the various stages of operation of the 1961 Population Census of India. What items of information were collected? Give details. (12)
Comment on the utility of population statistics.

Please Turn Over

3. What are the various types of agricultural statistics collected in India ? Name ONE important publication for EACH type mentioning the periodicity of publication. Describe briefly the method of collection of agricultural statistics relating to area and yield rates. (12)
4. Give a brief review of industrial statistics in India with particular reference to the Censuses and Sample Surveys conducted in this connection. Name the publications giving estimates of industrial production. (12)
5. What is NSS ? How was it initiated in our country ? What are the different fields of information explored through NSS ? Give a brief account of the subjects covered under the socio-economic inquiries in one of the recent rounds [(round to be specified)] of NSS. (12)
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INDIAN STATISTICAL INSTITUTE
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One-year evening course in Statistics (1965-66)
Final Examination - Part I
Paper II.
(Answer different sections in different
booklets)

Date: 11.3.66.

Maximum marks: 100

Paper II: Group A. PROBABILITY

Time: 2 hours.

Maximum marks: 60

1. Each of the following statements is either true or false. If it is true, prove it; otherwise, give a counter example to show that it is false. (15)
Attempt any five only

- i) The probability of occurrence of at least one of two events is the sum of the probabilities of each of the two events.
- ii) Mutually exclusive events are independent.
- iii) For any two events A and B, $P(A \cap B)$ cannot be less than either $P(A)$ or $P(B)$.
- iv) The conditional probability of A given B is always greater than $P(A)$.
- v) If the occurrence of an event A implies the occurrence of another event B then $P(A)$ cannot exceed $P(B)$.
- vi) If a random variable takes only the values 0 and 1, then all its moments about origin exist and are equal.
- vii) If the variance of a random variable is zero, then the random variable is always zero with probability one.
- viii) If the expectation of the product of two random variables is the product of their expectations, then the variables are independent.

- 2.a) Define the moment generating function (m.g.f.) of a random variable X with the probability density function $f(x)$: (2)

- b) If X is distributed according to the normal distribution with mean μ and s.d. σ , find its m.g.f. (6)

- c) X_1, X_2, \dots, X_n are independently distributed random variables, each having the distribution $N(\mu, \sigma)$. Derive the probability density function of

$$\bar{X} = \frac{1}{n} \sum_{i=1}^n X_i \quad (7)$$

3. Let x, y be jointly distributed with the probability density function $p(x, y) = 2 - x - y$ ($0 \leq x \leq 1, 0 \leq y \leq 1$)
= 0 elsewhere

Find the marginal and conditional distributions. Are the two random variables independent? (15)

Please Turn Over

4. EITHER

- a) State (i) the law of large numbers, and (ii) the central limit theorem. (No proof is required). (6)
- b) m objects are distributed at random in n cells, all possible arrangements being equally likely ($m > n$). Find the probability that there is at least one object in every cell. (9)

Or

From a basket containing 2 good and 2 bad oranges, 2 are taken out at random and kept apart. If one orange selected at random from these 2 is found to be bad, what is the probability that this was the only bad one in the chosen two? (15)

Paper II (b): Tests of Significance (Theory)

Attempt as many questions as possible Time: $1\frac{1}{2}$ hours
Maximum marks: 40

1. Explain by means of an example what do you understand by 'Normal approximation' to the binomial distribution.
A die is rolled 500 times. The occurrence of 3 or 4 is defined as a success. Obtain probable limits to the number of successes beyond which you would suspect a bias in the die. (10)
2. Describe the test procedure that you will adopt in the following situations:
- a) $H_0: \mu_1 = \mu_2$ $H_1: \mu_1 > \mu_2$ on the basis of two independent samples of size n_1 and n_2 respectively that come from $N(\mu_1, \sigma)$ and $N(\mu_2, \sigma)$.
- b) $H_0: \sigma = \sigma_0$ $H_1: \sigma \neq \sigma_0$ on the basis of n independent random observations that come from $N(\mu, \sigma)$.
- c) testing independence in a 2×2 contingency table. (15)
3. The average number of deaths in the river Cauvery per month was 3.5. The number of deaths in the first month after introducing some safety measures came down to 3. Can this be attributed to chance? (10)
4. Write short notes on the following:
- a) level of significance,
b) large sample test versus small sample test,
c) large sample test for equality of proportions in several binomial populations.
d) Snedecor's F test. (16)

INDIAN STATISTICAL INSTITUTE
 Research and Training School
 One-year evening course in Statistics 1965-66
 Final Examinations (Part I)

(Answer different sections in different groups)

Date: 14.3.66

Maximum marks: 100

Time: 6 - 9 pm.

Paper III(a): Vital Statistics (Theory and Practical)

Time: 2 hours

Maximum marks: 50

(Answer Question 1 which is compulsory and any two of the remaining)

1. Describe a life table.

Calculate the complete expectation of life at age 100 from the following table:

x	l_x	P_x
100	204	0.76832
101	-	0.94775
102	-	0.65037
103	-	0.59843
104	-	0.51521
105	-	0.50351
106	-	0.43328
107	-	0.09530

(18)

2. Write short notes on any three of the following:

- (a) gross reproduction rate
- (b) rate of natural increase
- (c) stable population
- (d) infant mortality rate

(16)

3. Write down the equation of the logistic curve.

What are the different methods of fitting it to the actual population data? Describe one of them in detail.

(16)

4. What are the different methods of population projection?

Explain the component method of population projection, by using the constant age specific mortality and fertility rates over time.

(16)

5. Discuss briefly the method adopted by the Jensen Actuary for the construction of Indian Life Tables (1941-50) from the successive census returns.

(16)

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INDIAN STATISTICAL INSTITUTE
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 One-year evening course in Statistics, (1965-66)
 Final Examination Part I

Paper III(b): Index Numbers and Time Series

Date: 14.3.66

Time: 2 hours
 Maximum marks: 60

1. (a) Explain how Laspeyres' and Paasche's Index Numbers can be derived as weighted arithmetic means of the price relatives. Establish their relation with Fisher's Ideal Index Number. Show that the first two index numbers do not satisfy the 'time reversal' and 'factor reversal' tests.
- (b) The average wage of a road worker per day was Rs 1.19 in 1940 and Rs 2.15 in 1957. The Consumer Price Index Numbers for these years were 95.5 and 123.5. Show that the real wage increased by about 50% in 1957 as compared with the wages in 1940. (10)
2. (a) Describe the main components of a time series.
- (b) Determine the weights of a moving average system of length five in order to fit a quadratic trend. Show that the same system of weights holds to fit a cubic trend also. (10)
3. Compute the Consumer Price Index Number for August 1960 from the following figures:

(Average prices for September 1939 = 100)

Groups	Weights proportional to total expenditure	Group Index Number (August 1960)
Food	40	805
Fuel and lighting	9	568
Clothing	13	459
House-rent	10	120
Miscellaneous	8	725

4. The quarterly production of coal in thousands of tons for a period of five years are given below:

Year	Quarters			
	1	2	3	4
1954	35.20	39.17	34.81	36.11
1955	36.90	41.88	38.16	40.80
1956	36.10	40.05	39.15	43.00
1957	40.18	44.25	39.12	45.81

- Calculate the trend by four-quarterly moving averages and also the seasonal corrections for each quarter. (15)

INDIAN STATISTICAL INSTITUTE
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One-year evening course in Statistics - 1965-66
Final Examination - I term

Paper IV

Date: 15.3.66

Maximum marks: 100

Time: 5-9 p.m.

(Answer different groups in different booklets)

Group - (a) Descriptive Statistics (Practical) Time: 2 hrs.
Max. marks: 50

Attempt all questions. Maximum marks are indicated
on the right margin.

1. In a competitive examination, the distribution of scores in a certain subject is known to be normal with mean 50 and standard deviation 10.
- a) What percentage of students score 60 or more ?
- b) If we are interested in choosing candidates with scores u or more, how should u be determined so that only 10 per cent of the candidates are selected ? $(6 + 9) = (15)$

2. E.I.MEN

From the results given below, calculate

- i) the regression line of Y on X .
- ii) the correlation coefficient between X and Y . $(6 + 9) = (15)$
- $$n = 48 \quad \Sigma X = 768.0 \quad \Sigma Y = 291.1$$
- $$\Sigma XY = 4612.04 \quad \Sigma X^2 = 12,170.48 \quad \Sigma Y^2 = 1791.03$$

OR

In a partially destroyed laboratory record of an analysis of correlation data, the following results alone are legible.

Variance of $X = 9$.

The regression equations are:

$$\begin{aligned} 4X - 5Y + 33 &= 0 \\ 20X - 9Y &= 107 \end{aligned}$$

What are: a) the mean values of X and Y
b) the s.d. of Y , and
c) the coefficient of correlation between X and Y .

3. In a precision bombing attack there is a 50 per cent chance that any bomb will strike the target. Two direct hits are required to destroy the target completely. What is the chance that the target will be destroyed completely if 10 bombs are dropped ? (10)
4. Suppose that the number of telephone calls that an operator receives between 0900 and 0905 hours in a day follows a poisson distribution with mean 3. Find the probability that (a) the operator will receive no calls in that period tomorrow; (b) in the next 3 days the operator will receive a total of 1 call in that period. $(4 + 6) = (10)$

Group (b): Tests of significance (Practical) | Time: 2 hrs.
(Attempt as many questions as you can) | Max. marks: 50

1. Data given below refer to the muscle weights of left leg (X_i) and right leg (Y_i) of 16 rabbits taken at random. Examine whether the means of muscles of right and left legs of rabbits are equal.

Please Turn Over

Rabbit No.	X_1	Y_1	Rabbit No.	X_1	Y_1
1	5.0	4.9	9	5.3	5.2
2	4.8	5.0	10	5.3	5.5
3	4.3	4.3	11	5.3	5.5
4	5.1	5.3	12	5.9	5.9
5	4.1	4.1	13	6.5	6.8
6	4.0	4.0	14	6.3	6.3
7	7.1	8.0	15	6.6	6.6
8	5.9	6.3	16	6.2	6.3

(18)

2. Measurements on the length of hind femur of males of two species of desert locusts were taken and the following statistics were computed. Do you not think that the two species differ significantly in respect of the standard deviations of the hind femur?

<u>Species</u>	<u>Sample size</u>	<u>Mean</u>	<u>Standard deviation</u>
Gregaria	13	24.21	1.15
Kakko Swarm	9	24.92	1.64

(9)

3. A random sample of students in a co-educational college were asked whether they suffered from headache. The data classified by sex is given below. Does this support the hypothesis that headache is more common amongst girl students?

	<u>Suffer from headache</u>		
	<u>Yes</u>	<u>no</u>	<u>total</u>
Boys	153	141	297
Girls	133	167	300
Total	286	311	597

(9)

4. Out of 10 fossils discovered 3 and 7 were identified as belonging to male and female. Is this compatible with sex ratio 1:1? (9)
5. The number of accidents in a main road in U.S.A. in three successive months were 35, 32 and 29. Should this improvement be ascribed to chance? (9)
6. Estimates of the percentage of employed persons in a certain city below. Is the difference in the two estimates due to sampling fluctuations? (9)

Survey A - sample size 2350, percentage of employed persons 39.66

Survey B - sample size 1975, percentage of employed persons 38.60. (9)

INDIAN STATISTICAL INSTITUTE
Research and Training School

One-year Evening Course in Statistics : 1965-66

Final Part II - Examination

Paper I : Analysis of variance and theory of inference

Answer Groups A and B in separate booklets

Date : 24 August, 1966

Full Marks - 100

Time : 3 hours

Group A : Analysis of Variance

1. (a) Explain the terms 'estimable linear parametric function' and 'best estimate.' (2)
- (b) Y_1, Y_2, Y_3 are three random variables with
- $$E(Y_1) = \theta_1 + \theta_2$$
- $$E(Y_2) = \theta_2 + \theta_3$$
- $$E(Y_3) = \theta_3 - \theta_1, \text{ and}$$
- $$V(Y_1) = V(Y_2) = V(Y_3) = \sigma^2 > 0, \text{ and } Y_1, Y_2, Y_3 \text{ are}$$
- independent observations on Y_1, Y_2, Y_3 respectively :
- (i) Examine whether θ_2 is estimable. (2)
- (ii) Show that $\theta_1 + 3\theta_2 + 2\theta_3$ is estimable. (2)
- (iii) Obtain the best estimate of $\theta_1 + 3\theta_2 + 2\theta_3$. Find the variance of the best estimate. (5)
2. Write down the analysis of variance table for a two-way classification of r rows and c columns with n observations per cell. Indicate how you will test the hypothesis that there is no difference in the effects of the row sub-classes. (7)
3. (a) Describe the method of least squares, with special reference to multiple regression analysis. Are the least square estimates of the regression coefficients the best linear estimates? (5+2)
- (b) Describe the analysis of variance procedure for testing the significance of a regression coefficient. (5)
4. Class records (20)

Group B : Elements of theory of Statistical Inference

5. (a) Explain the term 'unbiased estimate' of a parameter. (2)
- (b) Obtain the Cramer-Rao lower bound for the variance of an unbiased estimator. (5)

6. (a) Obtain the maximum likelihood estimate of the parameter in a Poisson distribution, based on a random sample of size n . (4)
- (b) Derive the moment estimators and the maximum likelihood estimators for the mean and standard deviation of a normal population, given a random sample of size n . (6)
7. Derive the likelihood ratio test criterion for the hypothesis $H_0 : \mu = \mu_0$ against $H_1 : \mu = \mu_1$ based on a random sample of size n drawn from a normal population with mean μ and variance σ^2 . Explain the testing procedure. (6)
8. Write short notes on any two of the following : (6)
- (i) Sufficient Statistics
 - (ii) Power of a test
 - (iii) Confidence intervals
9. Class records. (20)

POLAN STATISTICAL INSTITUTE
Research and Training School

One-year Evening Course in Statistics : 1965-66

Final Part II - Examination

Paper II : Sample Survey and Design of Experiments

Answer Groups A and B in separate booklets

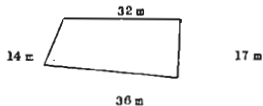
Date : 25 August, 1966

Full Marks - 100

Time : 3 hours

Group A : Sample Survey

1. (a) Explain the advantages of sampling over complete enumeration. (3)
- (b) How will you proceed to take a random cut of 5m x 10m from a field with dimensions



- (4)
- (c) What is systematic sampling? Write the expression for an unbiased estimate of the Population mean, from a sample selected linear systematically. (2+4)
2. What is meant by the precision of an estimate? Describe any one method of sampling which will increase the precision of the estimate, making use of available auxiliary information, at the estimation stage.
3. Either (2+5)
- What is stratified sampling? Derive Neyman's allocation for a simple random sample of size n , when there are k strata of sizes N_1, N_2, \dots, N_k and sampling is without replacement. Also derive the expressions for the variance of the estimate of population mean. (2+5+3)
- Or
- Discuss the method of systematic sampling and bring out its advantages and disadvantages. Derive an expression for the variance of the mean of a systematic sample. (5+5)
4. Class records. (20)

Group B : Design of Experiments

(Attempt any three questions from the first 4 questions 5-8)

5. (a) Describe the layout, the model and the analysis of variance of a randomized blocks design.
- (b) Explain how you would make use of the analysis of variance table to test
- (i) equality of all the treatment effects,
- (ii) equality of two specified treatment effects.
- (c) Obtain the expression for the efficiency of the randomized block design compared with that of completely randomized block

6. (a) What are (i) main effect, (ii) interaction, (iii) confounding, (iv) partial confounding in relation to a factorial experiment ?
- (b) Construct a 2^4 design in blocks of 2^2 units so as to leave all the main effects unconfounded. (4+6)
7. (a) What is meant by a Latin Square experiment ?
- (b) Explain how you will analyse the data of such an experiment.
- (c) How will you compare the effects of two specified treatments in a Latin Square experiment ?
- (d) Point out the advantages and disadvantages of Latin Square as compared to a randomized block design. (2+3+2.5+2.5)
8. (a) When is a design said to be balanced ? (2)
- (b) Define a balanced incomplete block design. (2)
- (c) With the usual notations, show that
- (i) $bk = vr$ (3)
- (ii) $r(k-1) = \lambda(v-1)$ (3)
- for a balanced incomplete block design.
9. Class records (20)

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INDIAN STATISTICAL INSTITUTE
Research and Training School

One-year Evening Course in Statistics : 1968-69

Final Part II - Examination

Paper III : Economic and Industrial Statistics

Answer Groups A and B in separate booklets

Date : 27 August, 1968

Full Marks - 100

Time : 3 hours

Group A : Economic Statistics

1. Explain any four of the following concepts :

- (a) net value added
- (b) constant prices and market prices
- (c) personal disposable income
- (d) gross domestic product
- (e) transfer payments
- (f) capital gains

(10)

2. Either

What are the factors that you would take into consideration in estimating the national income of a country ? Illustrate your answer with reference to India.

Or

State the main objectives of the first three five-year plans of India. Critically examine the achievements during these plan-periods with special reference to agriculture and industry.

(10)

3. Either

Explain the concept of a production function. Discuss the problems that arise in estimating such a function statistically.

Or

Distinguish between time-series data and family budget data. Discuss how you would utilise the latter type of data to derive income elasticity of demand for a particular commodity of household consumption.

(10)

4. Class records.

(20)

Group B : Industrial Statistics

(Answer any two questions from questions 5, 6 and 7)

5. What do you understand by Statistical Quality Control ? What are the most common working tools in SQC ? Give a short account of the application of SQC techniques.

(10)

6. Outline the procedure for setting up control charts for the following :
(i) average and range, (ii) fraction defective and (iii) number of defects, with varying sample sizes.

Explain the theoretical basis and use of constructing the 3 sigma limits in a control chart.

(10)

7. What is 'acceptance sampling plans' ? What is the role of acceptance inspection in the improvement of 'product quality' ? What is O-C curve of a single - sampling plan ? (10)
8. Let X be the length of a product measured in mm, and upper specification limit be 120 mm.
- a) If X has mean 113 mm and standard deviation 3.5 mm what is ' π ' (proportion of defective) ?
 - b) If mean changes to 115.35, variability remaining constant, what is π now ?
 - c) If variability changes to 4.5, mean remaining same (i.e. 113 mm) what is π ?
 - d) If $\sigma = 0.04$, $C = 3.5$ what is μ (mean) ? (10)
9. Class records . (20)

INDIAN STATISTICAL INSTITUTE
Research and Training School

One-year Evening Course in Statistics : 1965-66

Final Part II - Examination

Paper IV : Samples Surveys and Design of Experiments (Practical)

Answer Groups A and B in separate booklets

Date : 29 August, 1966

Full Marks - 100

Time : 4 hours

Group A : Sample Surveys

1. The following table gives the agricultural population and agricultural yield of 25 tehsails in the rural sector of an Indian State. Draw three ~~simple random~~ samples of 5 tehsails each, one SRS with replacement, one SRS without replacement, and the other with probability proportional to agricultural population. Based on the samples selected as above obtain estimates of the total agricultural yield in the rural sector. Obtain also estimates of the variances of the three estimates. Comment on the results.

sl. no. of tehsail	agr. yield of corn (in 100 kg.)	agr. population (in 100 no.)	sl. no. of tehsail	agr. yield of corn (in 100 kg.)	agr. po- pulation (in 100 no)
1	106	52	14	146	68
2	160	77	15	164	82
3	179	87	16	115	87
4	142	66	17	110	88
5	160	80	18	30	18
6	174	86	19	206	101
7	230	113	20	109	53
8	177	108	21	157	74
9	131	64	22	141	65
10	242	120	23	258	127
11	138	69	24	221	106
12	201	93	25	140	67
13	162	76			

(24)

2. Class records.

(10)

Group B : Design of Experiments

3. In an experiment to study the effects of glass type (I, II) and phosphor type (A, J, C) on the brightness of a TV tube screen, the following data on the current (amperes) necessary to produce a certain brightness was obtained. Analyse the effect of the two factors (glass and phosphors) and their interactions.

(12)

class type	phosphor type		
	A	B	C
I	20	30	27
	20	31	28
II	23	26	22
	21	24	23

4. Analyse the following balanced incomplete block experiment and report your findings.

Blocks	Treatments and yields		
I	(1)	(3)	(4)
	14	15	10
II	(4)	(2)	(1)
	21	11	12
III	(1)	(4)	(3)
	18	32	23
IV	(2)	(3)	(4)
	21	27	31

(12)

5. Analyse the following 2^3 factorial experiment.

Block	treatment and yield				Block	treatment and yield			
I	nk	(1)	pk	np	II	p	npk	n	k
	150	179	135	130		153	202	183	182
III	nk	np	pk	(1)	IV	n	k	p	npk
	156	120	161	159		101	130	188	210

(12)

6. Class records.

(24)

INDIAN STATISTICAL INSTITUTE
Research and Training School

One-year Evening Course in Statistics : 1965-66

Final Part (i) - Examination

Paper V : Economic Statistics and Industrial Statistics (Practical)

Answer Groups A and B in separate booklets

Date : 30 Aug. 66, 1966

Full Marks - 100

Time : 4 hours

Group A : Economic Statistics

1. In finding returns to scale in Electricity Supply, the following corrected sums of squares and products were obtained :

	$(x - \bar{x})$	$(y' - \bar{y})$	$(z - \bar{z})$
$(x - \bar{x})$	0.001014	- 0.034014	0.144101
$(y - \bar{y})$		0.02366	- 0.002121
$(z - \bar{z})$			0.012123

where $x = \log$ (total output), $y = \log$ (labour input)

and $z = \log$ (capital input)

Fit the Cobb - Douglas production model and verify whether returns to scale are constant.

(12)

2. Using constant elasticity formulation, obtain the Engel curve for the rice consumption from the following data :

Monthly Income (Rs.) of household.	Size of the household	Monthly expenditure on rice. Rs.
144.25	5	24.00
160.75	5	30.00
185.00	7	43.00
165.00	5	37.00
141.50	7	33.00
132.00	2	9.00
152.00	6	30.00
242.50	8	40.00
109.25	8	30.00
173.25	4	33.00
220.50	7	43.00
112.50	5	43.00
340.50	8	48.00
139.25	6	39.00
208.00	7	41.00
296.25	7	38.00
247.50	6	35.00
104.25	8	51.00
220.00	9	70.00
260.50	6	53.00

(12)

3. With the help of following data calculate personal disposable income and personal savings :

	(Rs. crores)
Gross national product	= 510
Indirect taxes	= 46
Corporate taxes	= 22
Inventory adjustment in the corporate sector	= 1
Foreign branch profits	= 1
Government budget deficit	= 6
Personal direct taxes	= 53
Transfer payments to persons (within state)	= 32
Capital consumption allowance	= 34
Undistributed profits of the corporate sector	= 7
Gross investment	= 72

(6)

4. Class records .

(20)

Group B : Industrial Statistics

1. The following table gives the results of inspection of 100 - yd. pieces of woollen goods :

Piece No.	No. of Defects	Piece No.	No. of defects
1	3	13	5
2	3	14	5
3	6	15	4
4	3	16	3
5	0	17	4
6	1	18	5
7	3	19	1
8	5	20	1
9	7	21	5
10	8	22	0
11	4	23	1
12	10	24	1

Analyse and comment .

(11)

2. (a) A sample of 100 articles is taken from a manufacturing process and 20 were found to be defective. Calculate 95% confidence limits for the percentage of defectives in the process.

- (b) A random sample of 4 is to be selected from a lot of 12 articles, 3 of which are defective. What is the probability that the sample will contain exactly one defective ?
- (c) An acceptance plan calls for the inspection of a sample of 115 articles out of a lot of 3000. If there are 6 or less defectives in the sample the lot is accepted, with 7 or more it is rejected. If a lot of 5 defectives is submitted, what is the probability that it will be rejected ?
(4+4+5)
3. For the single sampling plan $n = 150$, $a = 2$, calculate $L(p)$ (probability of acceptance of a lot) for $p = 0.05$, 0.50 and 0.10 .
(5)
4. Class records . (20)

INTERNATIONAL STATISTICAL EDUCATION CENTRE - CALCUTTA
Nineteenth Term (July 1966 - April 1966)

Mid-Term Examination
Numerical Mathematics

Maximum Marks-50

Date: 6.1.66.

Time: 2 hrs.
10 A.M. to 12 Noon.

(Answer as many questions as you can)

1. (a) Explain the process of interpolation.
- (b) Derive Newton's formula for forward interpolation.
- (c) Estimate by Newton's formula for interpolation, the expectation of life at age 14 from the following data.

<u>Age in years</u>	<u>Expectations of life in years</u>
10	35.4
15	32.2
20	29.1
25	26.0
30	23.1

[4+8+8]

2. The following table gives the values of a function $f(x)$ for a certain equidistant values of x . Find the value of $f(x)$ when $x = 0.524$.

<u>x</u>	<u>f(x)</u>
0.51	0.5292487
0.52	0.5378987
0.53	0.5464611
0.54	0.5549392
0.55	0.5633233
0.56	0.5716157

[8]

3. The following are the annual premiums in a certain Life Insurance Company for a policy of Rs.500 payable at death with an agreed bonus.

<u>Age next birth day</u>	<u>Annual premiums</u>
25	Rs. 24.62
30	Rs. 27.62
35	Rs. 31.50
40	Rs. 36.37
45	Rs.42.31

Calculate the premiums at age 32.

[8]

4. (a) What is numerical integration?
- (b) Derive trapezoidal rule and Simpson's $1/3$ rule.
- (c) From the data given in Chamber's tables, evaluate, $\int_1^2 (\log_{10} x) dx$

[3+8+10]

5. Solve the following system of linear equations.

$$\begin{aligned} 1.6x + 0.5y + 3z &= 25.24 \\ 0.5x + 3y + 0.25z &= 16.67 \\ 3x + 0.25y + 2z &= 18.36 \end{aligned}$$

[12]

INTERNATIONAL STATISTICAL EDUCATION CENTRE - CALCUTTA
Nineteenth Term: (July 1965 - April 1966)

Mid-Term Examination
Demography (Theory and Practical)
Full marks: 100

Date: 8.1.66.

Time: 2 hrs.
2 P.M. - 4 P.M.

1. Discuss briefly any three of the following:

- a) Infant mortality rate
b) Perinatal mortality rate
c) 'de facto' and 'de jure' population enumeration
d) the uses of vital statistics to a public health administrator

[40]

2. The following table gives data on population and deaths in two towns A and B observed in a certain year.

age (in years)	Town A		Town B	
	population	deaths	population	deaths
under 2	3000	192	8000	300
2 - 9	10000	70	12000	78
10 - 19	10000	40	10000	38
20 - 59	32500	260	25000	190
60 & over	8500	510	8000	460

- Calculate a) the age specific death rates and the crude death rates,
b) the standardized death rate for Town B taking the population of Town A as the standard.

[40]

3. Listed below are the annual birth rates per 1000 population in 1938-40 and 1953-55 for a few Latin American countries. State some of the plausible reasons for the increase in natality (birth rate) in these countries.

Country	1938-40	1953-55
El Salvador	44.6	48.0
Guatemala	47.3	50.5
Chile	32.0	34.4
Mexico	44.1	45.9
Argentina	<u>23.8</u>	<u>24.2</u>

[20]

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INTERNATIONAL STATISTICAL EDUCATION CENTRE - CALCUTTA
Nineteenth Term (July 1965 - April 1966)

Mid-Term Examination
Probability

Date: 11.1.'66

Maximum marks 100

Time: 2 hrs.
10 A.M. - 12 Noon.

(All questions carry equal marks)

1. (a) For each of the following random experiments, write down the list of possible results:
- (i) A coin and a die are thrown together and the top faces of each observed.
 - (ii) From a large number of families containing not more than three children, one is chosen and the sex of each child recorded in descending order of age.
 - (iii) A coin is tossed until either a head appears or four tosses are made. The results of the successive tosses are recorded.
- (b) For each of the following random experiments calculate the number of possible results:
- (i) From a box containing 10 tickets numbered from 1 to 10, three tickets are drawn one by one, without being returned to the box, and the numbers recorded in succession.
 - (ii) From a large group of persons, in which the minimum age is 20 maximum age 30, four persons are chosen and their age on the last birthday recorded.
2. A sample space consists of 3 points x, y, z . In each of the following cases, certain numbers are shown against some of the sets of the sample space. Examine if numbers can similarly be associated with the other sets in such a manner that, together with the numbers given, a probability system can be written. In cases where this is possible, write down such a system, and in cases where this is not possible, give your reasons.

	Set	Number associated with the set
(a)	$\{x\}$	$2/3$
	$\{x, y\}$	$1/2$
(b)	$\{x, y\}$	$3/5$
	$\{x, z\}$	$4/5$
(c)	$\{y, z\}$	$1/2$

(Contd...)

3. (a) From a group of 4 boys and 4 girls, 4 are selected at random. Find the probability that
- (i) there are no boys.
 - (ii) the number of boys is greater than the number of girls.
- (b) From a box containing 10 tickets numbered from 1 to 10, five are drawn at random. Find the probability that all these have even numbers on them.
4. (a) In a lottery, names of five persons are written on five slips and kept in a box. Slips are drawn one by one 10 times, each time the name is read and the slip returned to the box. What is the probability that the name of each person appears at least once ?
- (b) Six identical balls are thrown at random into six boxes, each box being capable of containing all the six balls. What is the probability that box no.1 will get 3 balls ?

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INTERNATIONAL STATISTICAL EDUCATION CENTRE - CALCUTTA
Nineteenth Term (July 1965 - April 1966)

Mid-Term Examination
Auxiliary Mathematics
Maximum Marks - 100

Date: 12.1.66.

Time 2½ hrs.
10 A.M. - 12.30 P.M.

(Answer as many questions as you can)

1. Evaluate the following:

(a) $\frac{(3^2)_4}{(3!)^2}$ [2]

(b) $\left\{ \begin{matrix} 10 \\ 3 \end{matrix} \right\} + \left\{ \begin{matrix} -8 \\ -4 \end{matrix} \right\}$ [2]

(c) $\log_e 251.132$ [3]

(d) $\log_3 720 + \log_{720} 3 + 2 \left(\left(\frac{8}{27} \right)^{2/3} \right)$ [4]

2. Solve

(a) $4x - 5 = 5(x - 4)$ [2]

(b) $9x^2 - 84x + 787 = 0$ [4]

(c) $8x^2 + x - 1 = 0$ [4]

3. (a) State the binomial theorem for a positive integral index. [3]

(b) Under what conditions on p and q does the sum $\sum_{r=0}^n \binom{n}{r} p^r q^{n-r}$ equal unity? [2]

4. (a) If $e^x = \sum_{r=0}^{\infty} \frac{x^r}{r!}$, write down the expansion of

(i) $e^{-x^2/2}$ (ii) e^{xy} [2+2]

(b) What is the coefficient of $x^3 y^3$ in the expansion of $e^{2 + \sqrt{xy}}$? [4]

(c) Expand $\frac{e^x - e^{-x}}{2}$ in terms of x and hence sum the series

$$\frac{8}{3!} + \frac{32}{5!} + \frac{128}{7!} + \frac{512}{9!} + \dots$$
 [3+7]

4. (a) y is a function of x denoted by $y = f(x)$, explain clearly the meaning of $\frac{dy}{dx}$. [5]

(b) Show from first principles that $\frac{d}{dx} e^x = e^x$ or $\frac{d}{dx} \log_e x = \frac{1}{x}$ [8]

4. (c) Differentiate the following with respect to x
 (i) $6x^2 - 7x + 5$ (ii) $x e^x$ (iii) $(x+2) \log_e x$ and (iv) $\log_e(x + \frac{1}{x})$ [2+3+3+5]
5. (a) Given that $(1+x)^{-1} = 1 - x + x^2 - x^3 + \dots$ under certain conditions on x ,
 (i) Derive an expansion for $(1+x)^{-2}$ by differentiating the expression in (a)
 (ii) Derive an expansion for $\log_e(1+x)$ by integrating the expressions in (a). State clearly the conditions under which the expansions in (i) and (ii) are valid. [2+2+1]
 (b) (i) Write down the expansion of $\frac{1}{2} \log_e \frac{1+x}{1-x}$.
 (ii) Hence express $\log_e \frac{5}{3}$ as the sum of an infinite series. [3+6]
6. (a) What is integration? Why should a statistician learn the process of integration? [5]
 (b) Find the area between the x -axis and the curve $y = x^2$ bounded by the lines $x = \frac{1}{2}$ and $x = 1$. [8]
 (c) Integrate the following with respect to x .
 (i) $4x^2 - 8 + 5x$ (ii) e^{-x} (iii) $(x+2)(2-x)$ and (iv) $\log_e x$ [2+2+2+5]
7. (a) What is the meaning of $\Gamma(n)$? [2]
 (b) Noting that $\Gamma(\frac{1}{2}) = \sqrt{\pi}$ and $\Gamma(n) = (n-1)\Gamma(n-1)$, prove that the function given by $f(x) = \frac{1}{\sqrt{2\pi}} e^{-x^2/2}$ is a probability density function. [5]
 (c) Prove that the variance of the standard normal distribution is unity. [5]

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INTERNATIONAL STATISTICAL EDUCATION CENTRAL-CALCUTTA
Nineteenth Term (July 1965 - April 1966)

Final Examination
Large Scale Sample Surveys (NSS)
Full Marks - 100

Date: 28.3.66.

Time: 2½ hrs.
2 P.M. to 4.30 P.M.

(All questions carry equal marks.
Answer 8 questions 3 from each
group. Answer for the two groups
to be given in separate answer
books.)

GROUP - A

- 1.(a) Describe briefly how the rural strata have been formed in the 20th round of the NSS.
- (b) Describe how the total number of sample villages and urban blocks are allocated to the different states in the NSS.
2. Why the current rates of births and deaths are obtained through the median of sample survey in India? Discuss in detail the method of enumeration followed in the National Sample Survey of India.
3. From a set of simple questions for the purpose of determining the labour force status of a person. The reference period being the seven days preceding the day of enquiry. Briefly discuss also how the answers to the questions may be utilised for the specific purpose.
- 4.(a) Define visible, disguised and potential underemployment.
- (b) "The prospects for studies of potential underemployment are less encouraging than for studies of visible and disguised underemployment". Justify the above statement.
5. A survey was conducted to examine the optimum reference period for collecting data on morbidity. In the survey a number of households was visited for the enquiry in each calendar month on each calendar day. On the first visit (1st calendar day of the month) the data on morbidity were collected for the preceding calendar month with the date of onset and recovery, if terminated. On the second and subsequent visits the reference period was the calendar day preceding the day of visit.
You have been asked to analyse the data. What tabulation do you propose to take to study the objective of the survey. Define the rates you propose in the tabulation.
6. Define "enterprise households". What are the different types of enterprises followed by the members of a household. Describe how you can estimate the national income generated from small scale manufacture sector.

P. T. O.

GROUP - B

- 7.(a) Define the term 'household' and 'household consumption' as used in the NSS- consumer expenditure enquiry.
- (b) Give an idea of the NSS consumer expenditure inquiry stating broadly (i) items covered (ii) type of data collected and reference period used (iii) procedure of imputation of values as adopted in case of non monetised consumption (iv) purposes for which the data are used.
8. Prepare a brief questionnaire for a sample survey on land holdings which is intended to cover the following information:-
- (a) area distribution of household ownership holdings and extent of land leased out by households.
- (b) proportion of area sown under cereal crops to total area possessed (i.e. land owned plus land leased in minus land leased out) by households.
- Specify the method of collection of data, reference period for collecting different items of information and definitions adopted in the survey.
9. What items would you include in your schedule of enquiry for a Capital Formation Survey? How would you treat the used assets including land while supplying an estimate for capital formation at the national level?
10. Indicate the chief features of the Annual Survey of industries with particular reference to its scope and coverage.
11. What are the different types of frames used for selection of sample plots in a village for the land utilisation survey in the NSS. Give the order of your preference for the different types of frames stating reasons.

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INTERNATIONAL STATISTICAL EDUCATION CENTRE - CALCUTTA
Nineteenth Term (July 1965 - April 1966)
Final Examination

Statistical Quality Control (Specialization)

Full Marks - 100

Date - 30. 3. 1966

Time 3 hours
2 p.m. to 5

Examinees may refer to their own note-book and the statistical table distributed by the lecturer.

1. The following table is a record of the room temperature of a chemical factory "x", and a quality of the product "y". The specification of y is $40 \pm \dots$

x	y	x	y	x	y	x	y
21.5	60	23.0	65	23.0	55	27.0	25
21.5	70	23.5	34	25.0	43	27.0	17
22.0	65	24.0	44	25.5	25	27.5	28
23.0	38	24.0	34	25.5	29	28.5	17
23.0	65	24.5	34	26.5	32	29.0	6

- Draw the scatter diagram. (15)
- Compute the mean and standard deviation of y. (15)
- Find the percentage of "out-of-specification" from the mean and standard deviation of y, assuming that the distribution of y is normal. (Use the normal distribution table). (15)
- Compute the standard deviation of y after the installation of an air conditioner at the factory, which will keep the room temperature x constant. (Hint: At first you should compute the correlation coefficient of x and y). (15)
- Draw the regression line $y = a + by$ on your scatter diagram, and find the room temperature x to meet the specification of y. (15)

2. A selector of telephone consists of three kinds of plates and the standard deviations of their thicknesses are given in the following table:

Name of plate	Number of plates used in a selector	Standard deviation of a plate
Bress terminal	20	15 micron
Small insulator	20	25 micron
Large insulator	10	30 micron

Compute the standard deviation of the thickness of the selector which is made by assembling the plates at random. (25)

INTERNATIONAL STATISTICAL EDUCATION CENTRE - CALCUTTA
Nineteenth Term (July 1965 - April 1966)

Final Examination
Specialisation - Demography
Full Marks - 100

Date: 30.3.66.

Time: 3 hrs.
2 P.M. to 5 P.M.

1. Write short notes on:

- (a) Crude birth rate (b) Total fertility rate
(c) Net reproduction rate

[20]

2. Table 1 gives the age distribution for female population (1961) for a certain community 'X'. The female life table population (1961) for the same community is shown in Table 2. Compute the age distribution for the female population for community 'X' in 1971 under the following assumptions

- i) the mortality condition remains unchanged for the period 1961-71
ii) the General fertility rate (G.F.R.) falls linearly from 160 per thousand (1961) to 150 per thousand (1971).

$$\text{[G.F.R. per thousand]} = \frac{\text{Total number of births}}{\text{Number of females in the age group 15-50}} \times 1000$$

- iii) the proportion of female births to total births remains constant throughout the decade 1961-71 (= .47)

Table 1: Age distribution of female population 1961.

Age group	No. of females
0 - 5	1392
5 - 10	1331
10 - 15	1159
15 - 20	1033
20 - 25	930
25 - 30	830
30 - 35	725
35 - 40	690
40 - 45	488
45 - 50	410
50 - 55	338
55 - 60	266
60 - 65	194
65 - 70	123
70 +	181
Total	10,000

Table 2: Life table population for females 1961.

Age group x to x+5	Life table pop. in the age group x to x+5
	$\frac{L_x}{5}$
0 - 5	399,226
5 - 10	346,852
10 - 15	320,558
15 - 20	315,006
20 - 25	305,308
25 - 30	290,516
30 - 35	268,050
35 - 40	230,302
40 - 45	212,070
45 - 50	184,129
50 - 55	155,201
55 - 60	126,328
60 - 65	98,083
65 - 70	71,442
70 +	66,030

3. Describe Reed and Merrell or Greville's method of constructing an abridged life table.

[25]

4. Discuss briefly how a statistical evaluation of the disease pattern in a community could be made.

[20]

INTERNATIONAL STATISTICAL EDUCATION CENTRE - CALCUTTA
Nineteenth Term (July 1965 - April 1966)

Final Examination
Econometrics - (Specialisation)
Full Marks-100

Date: 30.3.66.

Time: 3 hrs.
2 P.M. to 6 P.M.

(Answer the following questions
All questions carry equal marks.)

1. What is the Pareto law of income distribution? Write down the density function representing the relative frequencies of such distribution. Do the data given in the following table follow the Pareto distribution? Obtain the Pareto coefficient from the given data by the method of least squares taking a suitable subsistence value of income.

Table: Showing percentage of families by monthly family income of Delhi.

monthly family income (Rs)	percentage of families
0 - 60	0.16
60 - 75	0.29
75 -100	1.31
100 -150	0.59
150 -200	19.47
200 -300	25.09
300 -500	26.86
500 -750	8.38
750 -1000	3.68
1000 -1500	3.16
1500 & above	2.01
all classes	100.00

2. What is Cobb-Douglas production function? How would you devise a statistical test for the existence of return to scale in production (increasing, constant and decreasing). Associate the order of homogeneity with the sum of the exponent. Fit a Cobb-Douglas production function to the following Indian time series data. Interpret the estimates of the exponent of the production function.

year	index at constant price		index of employees
	output	capital	
1956	100	100	100
1957	101	105	105
1958	101	111	101
1959	107	145	108
1960	116	162	109
1961	131	186	112
1962	140	240	119

3. Write what you know about demand curve? What is constant elasticity Engel's Curve? Show that the exponent of the curve is the elasticity. Do the following data obey the rule of constant elasticity Engel Curve? Obtain also the estimate of elasticity from the data given by the method of least squares.

Table: Showing average family income and expenditure on food by monthly family income of Delhi.

monthly family income (₹)	average family income (₹)	average family expenditure on food (₹)
0 - 60	51.80	33.38
60 - 75	63.64	37.37
75 - 100	83.91	67.58
100 - 150	131.99	88.31
150 - 200	172.02	101.68
200 - 300	241.12	132.67
300 - 500	374.32	178.38
500 - 750	591.69	228.20
750 -1000	868.45	261.64
1000 -1500	1134.34	327.04
1500 & more	2734.51	384.00

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INTERNATIONAL STATISTICAL EDUCATION CENTRE - CALCUTTA
Nineteenth Term (July 1965 - April 1966)

Final Examination
Specialisation - Data Processing
Maximum marks-100

Date: 30.3.66.

Time: 3 hrs.
2 P.M. to 5 P.M.

(Attempt all questions. Figures in the margin indicate full marks.)

1. For each of the following, determine the type of quantity and whether it is valid or invalid. If invalid give reasons.
(a) - 42.326. (b) SPEED (+1) (c) 75 E - 9
(d) MAX (N * 3 - 4) (e) INTEREST [10]
2. Show below are a number of mathematical expressions and corresponding FORTRAN expressions. All contain at least one error. Point out the errors and write correct expressions.

	Mathematical expression	Fortran expression
(a)	$(X + Y)^4$	X + Y ** 4
(b)	$\frac{X+2}{Y+4}$	X+2.0/Y+4.0
(c)	$\frac{A \times B}{C + 2}$	AB / (C + 2.)
(d)	$\left(\frac{X}{Y}\right)^{N-1}$	(X / Y) ** N-1
(e)	$\frac{A}{B} + \frac{C \times D}{F \times G \times H}$	A / B + CD / FGH [15]

3. Write the form in which the following constants, used in FORTRAN statements, are stored internally. (modulus and mantissa being 6 and 11 respectively)
(a) 624 (b) -2345671 (c) .42. (d) +32.42
(e) 426314.1236695 [10]
4. State the value of A or I stored as the result of each of the following arithmetic statements and whether the result is in fixed or floating point form.
(a) A = 2 * 6 + 1 (b) A = 2 / 3 (c) I = 2 * (10 / 4)
(d) A = 2. * (10. / 4.) (e) I = 10 / 4 + 5 / 4 [15]
5. Examine the following FORTRAN statements and list the errors, if any. Give the correct statements.
(a) RATE = (DIST ** T ** V) ** W (b) AT(B) = 4(T + 3 / 4 * V)
(c) DIMENSION, X (15, I) Y(10) (d) GO TO (48, 52, 34) B
(e) IF (J - B(H,N), 25, 30, 30) (f) DO, 8 A = I - 1, 60
(g) X(0) = Y(1) - Y(5) / 4T * C - 15 (h) IF SENSELIGHT, 8. 45, 40
(i) SUM = 4.0 * I / (A - B * FLOATF (J)) (j) IF (SENSE SWITCH 4) 11,12,13 [30]
6. By including a Dimension statement write a FORTRAN programme to form the sum and mean of the 50 elements of a one-dimensional array named AGE and place them in ASUM and AVER respectively. Assume that the values of the elements of the array are already stored. [20]

INTERNATIONAL STATISTICAL EDUCATION CENTRE - CALCUTTA
Nineteenth Term (July 1966 - April 1966)

Final Examination
Sample Surveys (Specialisation)
Full Marks -100

Date: 2 April 1966.

Time: 3 hrs.
2 P.M. to 5 P.M.

(Answer any FOUR questions from Q.1-6.)

1. Write a short note on ratio estimation. When is the ratio estimate more efficient than the unbiased estimate? [20]
2. What are the advantages and disadvantages of multi-stage sampling? Give the expressions for Y and $V(Y)$ in a two-stage design with simple random sampling with replacement at the first stage and simple random sampling without replacement at the second stage. [20]
3. Describe the general features of the National Sample Survey, (NSS) [20]
4. Describe the sample design and the estimation procedure of the 20th round of the NSS. [20]
5. Describe what items of information are collected in the population schedule 1B. What extra items you would suggest to collect and why? Define the terms: birth-rate, death-rate, infantile mortality rate, fertility rate. [20]
6. Describe the Urban Labour Force Enquiry of the 20th round. [20]
7. Practical on formation of rural strata (20 marks reserved).
