6. Types of survey (the aspects outlined in Section 5 should be covered)
   (a) Censuses of human populations; demographic problems;
   (b) Surveys of social and economic conditions of human populations;
   (c) Surveys of industry and economic institutions;
   (d) Market research and opinion surveys;
   (e) Agricultural censuses and surveys, including crop estimation and forecasting.

7. Pilot surveys

The design and use of pilot surveys in the planning of large scale surveys, and in the evolution of field procedure and training of investigators.

8. Critical statistical analysis of survey results

More advanced methods of handling survey data. Comparison of survey results with information from other sources. Methods of estimating the effects of a factor, freed from the effects of extraneous factors. Limitation of this procedure and of conclusions that can be drawn from survey data.

## SYLLABUS FOR AN ADVANCED (PROFESSIONAL) COURSE IN STATISTICAL SAMPLING

BY P. C. MAHALANOBIS

This course is designed to suit the requirements of advanced students who have already had basic training in statistical methods, and desire to qualify as professional sampling statisticians. The level and scope of such previous training have been indicated in Part 1 of the syllabus. The topics are, of course, neither mandatory nor exhaustive; and persons with considerable practical experience of sampling surveys should also be able to take the subsequent parts of the course with profit.

*Part 1. Prerequisites in statistical methods*

(1) Elements of probability theory; definitions; total probability and compound probability; binomial and multinomial probability; Bernoulli's theorem; Poisson and normal distributions; mathematical expectation; law of large numbers; continuous probability; central limit tending theorems (without proof).

(2) Least square methods; adjustment of observations; accuracy of interpolated and extrapolated results.

(3) Graduation of frequency data by Pearsonian and other types of curves; graduation of time-series like data by polynomials etc.

(4) Study of frequency data; measures of location, dispersion, skewness, and kurtosis; binomial, Poisson, and normal distributions with important properties; bivariate and multivariate normal distributions; total, multiple, and partial correlation and other measures of association and regression.

(5) Theory of estimation: basic concepts of consistency, efficiency, sufficiency, and maximum likelihood, important formulæ and theorems (without proof); the theory of information (without proof); fiducial probability and confidence interval (without proof); basic concepts of tests of hypotheses, and important theorems of statistical inference (without proof).

(6) Tests of significance: mathematical derivation of the distribution of $t$, $F$, $z$, and $\chi^2$ (chi-square) with applications; distribution of $r$ (coefficient of correlation) and its use for both $\rho=0$ and $\rho\neq 0$; tests of significance for regression coefficients (with proof); Fisher's $z$-transformation for $r$; tests of significance for multiple and partial correlations (without proof).

(7) Analysis of variance; basic concepts; orthogonality; important theorems.

(8) Design of experiment: basic concepts; randomized blocks; Latin squares; factorial experiments; confounding.

(9) Statistical quality control: basic concepts and procedures; control charts; elements of sequential analysis (without proof).

*Part 2. The design of sample surveys.*

(1) Basic concepts: fields of enquiry; "frame" for surveys; elementary units; sample-units of different types and varying sizes as an aggregate of sample-units; domains of study. Distinction between random-like and non-random (or patterned) space-fields.

(2) Method of selecting sample-units: the principle of random selection; procedures equivalent to random selection; systematic (determinate-interval) selection; procedures not equivalent to random sampling such as quota or purposive selection.

(3) Various types of design: stratification, multistage; multiphase; correlated variate; combination of multistage and multiphase sampling.

(4) Cost (in terms of labour, money and material resources) and accuracy (or margin of error) determined by the design of the survey. Relation between cost and accuracy. The general problem of design, namely, to secure either

(a) maximum accuracy at any desired level of cost, or

(b) minimum cost at any desired level of accuracy.

(5) Estimation problems for different types of design; sampling bias; sampling errors. Study of the variance function (including the case of varying size of sample units).

(6) Components of cost: enumeration; journey; inspection; supervision; statistical analysis; overhead. Cost in terms of labour; different grades of labour. Cost in relation to material equipment and resources.

(7) Non-sampling errors: investigator bias; discrepancies arising from the form of ascertainment; physical fluctuations; mistakes at the stage of processing of the material.

(8) The use of inter-penetrating networks of samples for the control of non-sampling errors; analogy with design of experiments; residual errors (by the analysis of variance); internal errors; external errors.

(9) Pilot surveys: series of surveys on a gradually expanding scale for the improvement of the design and for training of staff and organization of the sampling organization; pilot studies in conjunction with standard surveys; use of model sampling experiments.

(10) Successive (repeated) surveys; different forms with duplicated sample-units over time; the use of control charts in connection with successive surveys.

(11) Surveys for purposes of mapping, problems of stratification; utilization of information becoming available at each step; the design of experiment with a continuous variate.

(12) Accuracy of the results; comparison of internal and external errors; errors arising from adjustments; comparison with information from independent sources; deficiencies arising from non-response, lack of records, etc.