

<b>Semester</b>	<b>SEVEN</b>
<b>Course</b>	<b>Major</b>
<b>Paper Code</b>	<b>C4ST230731T</b>
<b>Paper Title</b>	<b>Advanced Sampling Techniques &amp; Experimental Design</b>
<b>No. of Credits</b>	<b>6</b>
<b>Theory / Practical /Composite</b>	<b>Theory</b>
<b>Classes per week</b>	<b>4</b> <b>Module I: 3 periods/week</b> <b>Module II: 1 period/week</b>
<b>Module</b>	<b>2</b>

### Course Outcomes for Module I

<p>1. <b>Remember</b> the fundamental concepts, terminology, and assumptions of systematic sampling, cluster sampling, two-stage sampling, ratio–regression methods, PPS sampling, and special techniques such as RRT and snowball sampling.</p>
<p>2. <b>Understand</b> the principles and procedures involved in systematic sampling (with and without linear trend), cluster and two-stage sampling, use of auxiliary variables, PPS sampling, and randomized response techniques.</p>
<p>3. <b>Apply</b> appropriate estimators for population mean, total, and variance in systematic, cluster, two-stage, ratio, regression, double sampling, and PPS sampling schemes.</p>
<p>4. <b>Analyze</b> the efficiency and performance of different sampling designs by comparing systematic sampling with SRS and stratified sampling, and two-stage sampling with cluster and direct sampling.</p>
<p>5. <b>Evaluate</b> the suitability of ratio, regression, Hartley–Ross, Horvitz–Thompson, Hansen–Hurwitz, and Desraj estimators under varying survey conditions and availability of auxiliary information.</p>
<p>6. <b>Create</b> a comprehensive survey design by selecting and justifying suitable advanced sampling techniques, including PPS and special sampling methods, for real-life data collection problems.</p>

### Course Outcomes for Module II

<p>1. <b>Remember</b> the definitions, classifications, and key properties of incomplete block designs and response surface designs.</p>
<p>2. <b>Understand</b> the structure, applications, and theoretical foundations of balanced and imbalanced incomplete block designs and response surface methodology.</p>
<p>3. <b>Apply</b> the principles of incomplete block designs and first-order response surface models, including the method of steepest ascent or descent, in experimental situations.</p>
<p>4. <b>Analyze</b> experimental data using second-order response surface models, canonical analysis, and concepts of rotatability and orthogonality.</p>

<b>5. Evaluate</b> the effectiveness and applicability of incomplete block designs and response surface designs in optimizing experimental outcomes.
<b>6. Create</b> suitable experimental layouts using incomplete block designs and response surface methodologies to address practical research and industrial problems.

### Syllabus

Unit/Module	Content	No. of lectures	CO mapping	Cognitive levels
<i>Module I</i>				
<i>Unit 1</i>	<b>Systematic Sampling:</b> Technique, estimates of population mean and total, variances of these estimates ( $N=n \times k$ case). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections. Basic idea of modification of the scheme for $N \neq n \times k$ case.	4	CO1 CO2 CO3 CO4	K1 K2 K3 K4
<i>Unit 2</i>	<b>Cluster and Two-stage sampling:</b> Technique (equal cluster sizes), estimation of population mean and its variance. Motivation of two-stage sampling, description of the scheme, estimation of population mean and variance of the estimate. Estimation of sample sizes (f.s.u. and s.s.u.). Comparison among two-stage, cluster and direct sampling.	10	CO1 CO2 CO3 CO4	K1 K2 K3 K4
<i>Unit 3</i>	<b>Use of Auxiliary variable:</b> Ratio and Regression methods of estimation in simple random sampling. Description of the scheme and suggested estimator of the population mean/total. Comparison of these estimators with usual mean per unit estimator. Hartley-Ross estimator. Modification of the scheme and estimator when population total/mean of auxiliary variable is unknown. Double sampling.	10	CO1 CO2 CO3 CO5	K1 K2 K3 K5
<i>Unit 4</i>	<b>Probability Proportional to Size Sampling:</b> Concepts of probability proportional to size (PPS) sampling, selection of samples with and without replacement, estimation of population total and variance using Horvitz-Thompson, Hansen-Hurwitz and Desraj estimator.	10	CO1 CO2 CO3 CO6	K1 K2 K3 K6
<i>Unit 5</i>	<b>Some Special sampling techniques:</b> Warner's model and estimation of	5	CO1 CO2 CO6	K1 K2 K6

	population proportions using randomized response technique(RRT). Snowball sampling.			
<b>Module II</b>				
<b>Unit 1</b>	<b>Incomplete Block Designs (IBD):</b> Definition and application. Balanced and imbalanced IBD. Properties and construction of balanced IBD.	6	CO1 CO2 CO3 CO5 CO6	K1 K2 K3 K5 K6
<b>Unit 2</b>	<b>Response surface design:</b> Introduction, First order model and method of steepest ascent/descent. Second order model and canonical analysis. Rotatability and orthogonality. Applications.	7	CO1 CO2 CO3 CO4 CO5 CO6	K1 K2 K3 K4 K5 K6

### Reading/Reference list

1. Cochran, W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.
2. Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. Asok, C. (1984). Sampling Theories of Survey with Application, IOWA State University Press and Indian Society of Agricultural Statistics.
3. Murthy, M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
4. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.
5. Goon A.M., Gupta M.K. and Dasgupta B. (2008): Fundamentals of Statistics, Vol-II, World Press.
6. Dean, A. and Voss, D. (2006): Design and Analysis of Experiments. Springer.
7. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
8. Dey, A. (1986) : Theory of Block Designs. Wiley Eastern Limited.
9. Montgomery, D. C. (2008): Design and Analysis of Experiments. John Wiley.
10. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.

### Evaluation

	CIA: 30 End-Sem: 70 Total: 100	
Paper Structure for Semester Exam	<b>Module 1 ( 55 marks)</b>	<b>Module 2 (15 marks)</b>
	Short questions (5 marks each): 2 out of 3 Long questions (15 marks each): 3 out of 5	Long questions (15 marks each): 1 out of 2

CO	CO Description for Module I	Cognitive levels
CO1	<b>Remember</b> the fundamental concepts, terminology, and assumptions of systematic sampling, cluster sampling, two-stage sampling, ratio–regression methods, PPS sampling, and special techniques such as RRT and snowball sampling.	K1
CO2	<b>Understand</b> the principles and procedures involved in systematic	K2

	sampling (with and without linear trend), cluster and two-stage sampling, use of auxiliary variables, PPS sampling, and randomized response techniques.	
<b>CO3</b>	<b>Apply</b> appropriate estimators for population mean, total, and variance in systematic, cluster, two-stage, ratio, regression, double sampling, and PPS sampling schemes.	K3
<b>CO4</b>	<b>Analyze</b> the efficiency and performance of different sampling designs by comparing systematic sampling with SRS and stratified sampling, and two-stage sampling with cluster and direct sampling.	K4
<b>CO5</b>	<b>Evaluate</b> the suitability of ratio, regression, Hartley–Ross, Horvitz–Thompson, Hansen–Hurwitz, and Desraj estimators under varying survey conditions and availability of auxiliary information.	K5
<b>CO6</b>	<b>Create</b> a comprehensive survey design by selecting and justifying suitable advanced sampling techniques, including PPS and special sampling methods, for real-life data collection problems.	K6

<b>CO</b>	<b>CO Description for Module II</b>	<b>Cognitive levels</b>
<b>CO1</b>	<b>Remember</b> the definitions, classifications, and key properties of incomplete block designs and response surface designs.	K1
<b>CO2</b>	<b>Understand</b> the structure, applications, and theoretical foundations of balanced and imbalanced incomplete block designs and response surface methodology.	K2
<b>CO3</b>	<b>Apply</b> the principles of incomplete block designs and first-order response surface models, including the method of steepest ascent or descent, in experimental situations.	K3
<b>CO4</b>	<b>Analyze</b> experimental data using second-order response surface models, canonical analysis, and concepts of rotatability and orthogonality.	K4
<b>CO5</b>	<b>Evaluate</b> the effectiveness and applicability of incomplete block designs and response surface designs in optimizing experimental outcomes.	K5
<b>CO6</b>	<b>Create</b> suitable experimental layouts using incomplete block designs and response surface methodologies to address practical research and industrial problems.	K6