DEPARTMENT OF STATISTICS
PANJABUNIVERSITY,CHANDIGAR160014(INDIA)
(Estted. under the Panjab University Act VII of 1947-
Enacted by the Govt. of India)

List of courses for Pre-Ph.D. Semester-I & II from Session 2017-18

Sr.No.	Name of Course
1.	Research Methodology
2.	Topics in Inference
3.	Order Statistics
4.	Decision Theory
5.	Reliability Theory-I
6.	Reliability Theory-II
7.	Survival Analysis
8.	Actuarial Statistics
9.	Advanced Topics in Stochastic Processes
10.	Bayesian Inference
11.	Renewal Theory
12.	Inference under Order Restrictions
13.	Advanced Topics in Multivariate Analysis
14.	Income Distributions and Inequalities

Any other course which the Board of Control may decide to offer.

Note: The Board of Control will decide as to which amongst the list of courses are to be offered in each semester.

1. Research Methodology : 4credits

Introduction to Research: Meaning of research, types of research, role of research, process of research, ethics of research, characteristics of interest in research. Questionnaire: Construction and administration. Measurement scales, Guttman Scales, Likert Scale, Thurston Scale, Semantic Differential Scale, Multi-Dimensional Scaling and the Q Sort Technique. Research problem and review of literature. Various sampling techniques, research designs for comparative treatments. Modeling of binary response variables. Analysis, report writing and presentation.

Determination of sample size for different sampling schemes.

Introduction to R programming. Numerical integration, computation, random number generation and simulation using R. Use of Mathematica package for problem solving.

Books :

1. Research Methodology Methods & Techniques : R.C.Kothari (2014), New Age Publications.
2. Research Methodology : M.N. Borse (2005)
3. Sampling Theory and Methods : M.N. Murthy(1977)
4. Sampling Theory of Surveys with Application : Sukhatme et. Al. (1984)
5. Design and Analysis of Experiments : D.C. Montgomery (2001)
6. Statistics using R : Sudha Purohit, Sharad. D. Gore, Shailaja R. Deshmukh, Narosa Pub. House, (2008)
7. Probability and Statistics with R : Maria Dolores Ugrate, Ana F. Militino, Alan T. Aaruholt, CRC Press (2008)
8. Mathematical Statistics with Mathematica : Colin Rose, Murray D. Smith, Springer (2001)

2. Topics in Inference: 3 credits

Introduction to simultaneous inference, error rates, Bonferroni inequality, p-mean significance levels, basic techniques of multiple comparisons and their geometrical interpretation for the case of two means.

Studentized range, Scheffe's F-projections, Bonferroni t-statistics, studentized maximum modulus, many-one t-statistics, Duncan's multiple range test, Newman-Keuls test, Fisher's LSD test, Tukey's gap-straggler-variance test, two-sample confidence intervals of predetermined length, and improved Bonferroni inequality.

Many-one sign statistics, k-sample sign statistics, many-one rank statistics, k-sample rank Statistics, signed-rank statistics, Kruskal-Wallis rank statistics, Friedman rank statistics and permutation test.

Multivariate techniques : Single population with covariance scalar unknown, single population with covariance matrix unknown.

References:

1. Miller, R.G. (Jr.) (2012) : Simultaneous Statistical Inference, Springer-Verlag, Chapters 1,2,4,5 (Sections 5.1 and 5.2).
2. Hochberg, Y. and Tamhane, H.C. (2009) : Multiple Comparison Procedures, John Wiley, New York.
3. Federer, W.T. (1946) : Experimental Design, Oxford and IBH, Chapter 1-II.

Additional References:

1. Hsu, J.C. (1996) : Multiple Comparisons, Theory and Methods, Chapman and Hall (New York).
2. Gupta, S.S. and Panchapakesan, S. (2002) : Multiple Decision Procedures-Theory and Methodology of selecting and Ranking Populations, John Wiley and Sons (New York).

3. Order Statistics : 3 credits

Introduction to Order Statistics; Basic Distribution Theory: Distribution of a single order statistic, joint distribution of two or more order statistics, distributions of the range, quasi-range and extremal quotient, order statistics of a discrete parent, distribution-free confidence intervals for quantiles, distribution free tolerance intervals, conditional distributions, order statistics as a Markov Chain and characterizations, order statistics for independent non-identically distributed variates; Expected values and Moments: General relations, application to normal distribution, the discrete case, recurrence relation;

Bounds and Approximations of order statistics: Distribution-free bounds for the moments of order statistics and of the range, bounds and approximations by orthogonal inverse expansion, bounds for the expected value of order statistics in terms of quantiles of the parent distribution, bounds in case of dependent variates, approximations to moments in terms of the inverse cdf and its derivates; Further Distribution theory: Studentization, statistics expressible as maxima, random division of an interval, linear functions of order statistics, order statistics for dependent variates, concomitants of order statistics.

References :

1. H.A. David & H.N. Nagaraja (2003) : Order Statistics, Third Edition, John Wiley and Sons.
2. B.C. Arnold, N. Balakrishnan, H.N. Nagaraja (1992) : A First Course in Order Statistics. John Wiley and Sons, New York.

4. Decision Theory : 3 Credits

Statistical decision problem. Non-randomized, randomized and behavioral decision rules, utility and subjective probability, Bayes rules, minimax rules. Admissibility of a decision rule, completeness and minimal completeness of a class of decision rules. The minimax theorem. Complete class theorem solving for Minimax Rules.

Essentially Complete Classes of Rules based on Sufficient Statistics, Continuity of the Risk Function, Admissibility of $\bar{X}$ as an estimate of the mean of a Normal Distribution using squared Error Loss.

Invariant Decision Problem, Invariant Decision Rules, Relation between Randomized Invariant and Behavioral Invariant Decision Rules, Admissible and Minimax Invariant Rules. Minimax Estimates of Location Parameters, Minimax Estimates for the parameters of a Normal Distribution.

References:

1. Ferguson T.Z. (1967) : Mathematical Statistics: A Decision Theoretic Approach. Ch.1-4, Academic Press.
2. Berger, J.O. (1985). : Statistical Decision Theory and Bayesian Analysis, Springer Verlag, New York.
3. DeGroot, M.H. (2004). : Optimal Statistical Decisions, McGraw Hill.

5. Reliability Theory – I: 3 credits

Reliability concepts and measures: components and systems, coherent systems, reliability of coherent systems, cuts and paths, modular decomposition, bounds on system reliability, structural and reliability importance of components.

Life distributions and associated survival, conditional survival and hazard rate functions. Exponential, Weibull, gamma life distributions and estimation of their parameters.

Notions of ageing. IFR IFRA, NBU, DMRL, NBUE, and HNBUE classes; their duals and relationships between them. Closures of theses classes under formation of coherent systems, convolutions and mixtures.

Partial orderings: convex, star, stochastic, failure rate and mean-residual life orderings. Univariate shock models and life distributions arising out of them.

Maintenance and replacement policies, availability of repairable systems.

REFERENCES:

1. Barlow R.E. and Proschan F. (1985) : Statistical Theory of Reliability and Life Testing, Holt, Rinehart and Winston.
2. Lawless, J.F. (1982) : Statistical Models and Methods of Life Time Data, John Wiley Models, Marcel Dekker.
3. Shaked, M. and Shanthikumar, J.G. (2007) : Stochastic Orders & Their Applications, Academic Press.

ADDITIONAL REFERENCES:

1. Nelson, W (1982): : Applied Life Data analysis; John Wiley Stochastic orders and their Application, Academic Press.

2. Zacks, S. (1992) : Introduction to Reliability Analysis: Probability Models and Statistical Methods, Springer Text in Statistics.

3. Deshpande J.V. and Purohit S. G (2016) : Life Time Data: Statistical Models and Methods 2nd Edition, World Scientific.

6. Reliability Theory – II : 3 credits

Bivariate Exponential distribution derived from fatal and non-fatal shock models, Bivariate Poisson distribution, Multivariate dependence.

Availability Theory: System Availability under various models, Maintenance through spares and repair, Limit Distributions for series and parallel system.

Some further concepts of positive ageing: NBUFR, NBUFRA, DVRL, NDVRL , Relations of positive ageing properties of length biased and equilibrium distributions with the original distributions.

Orderings of life distributions: hazard rate ordering, Likelihood ratio ordering, dispersive ordering.

References:

1. Barlow, R.E. and Proschan, F. (1985) : Statistical Theory of Reliability and Life Testing, Ch.5, 7, 8 (section 8.1).

2. Ross, S.M. (2008) : Stochastic Processes, Ch.8 (sec.8.3, 8.4, 8.5)

3. Shaked, M. and Shanthikumar, J.G. (2007) : Stochastic Orders & Their Applications, Academic Press.

7. Survival Analysis: 3 credits

Concepts of Type-I (time), Type-II (order) and random censoring likelihood in these cases. Life distributions, exponential Gamma, Weibull, lognormal, Pareto, linear failure rate. Inference for exponential, Gamma, Weibull distributions under censoring.

Failure rate, mean residual life and their elementary properties. Ageing classes and their properties, bathtub failure rate.

Estimation of survival function – Actuarial estimator, Kaplan Meier estimator, Tests of exponentiality against non-parametric classes: Total time on Test, Deshpande Test.

Two sample problem: Gehan test, Log rank test. Mantel-Haenszel test,
Cox's proportional hazards model, competing risks model.

References:

1. Cox, D.R. and Oakes, D. (1984) : Analysis of Survival Data, Chapter 1,2,3,4, Taylor and Francis.
2. Crowder, M.J. (2001) : Classical Competing Risks, Chapman & Hall, CRC London.
3. Miller, R.G. (1998) : Survival Analysis, Second Edition, Wiley Interscience.
4. Deshpande J.V. and Purohit S. G (2016) : Life Time Data: Statistical Models and Methods 2nd Edition, World Scientific.

Additional Reference:

1. Gross, A.J. & Clark, V.A. (1976) : Survival Distributions-Reliability applications in Bio-medical Sciences, Chapters 3,4 John Wiley and Sons.
2. Kalbfleisch, J.D. and Prentice, R.L. (1980) : The Statistical Analysis of Failure time Data, John Wiley and Sons.
3. Mahesh K. B. Parmar and Machin David (1999) : Survival Analysis : A Practical Approach, Wiley.

8. Actuarial Statistics : 3 credits

Loss distributions: Modelling of individual and aggregate losses, moments, fitting distributions to claims data, deductibles and retention limits, proportional and excess-of-loss reinsurance.

Risk Models:
Models for individual claims and their sums, Distribution of aggregate claims, Compound distributions and applications. Introduction to credibility theory.
Survival function, curatate future lifetime, force of mortality. Multiple life functions, joint life and last survivor status. Multiple decrement model.

Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor.

Assurance and annuity contracts: Definitions of benefits and premium, various types of assurances and annuities, present value, formulae for mean and variance of various continuous and discrete payments.

Calculation of various payments from life tables: Principle of equivalence, net premiums, prospective and retrospective provisions/reserves.

References:

1. Bowers, N.L., Gerber, H.U., Hickman, J.C. (1965) : Actuarial Mathematics, 2nd ed., Society of Actuaries, USA.
2. Klugman, S.A., Panjer, H.H., Willmot G.E. (1984): Loss Models: From data to decisions.

9. Advanced Topics in Stochastic Processes: 3 credits

Introduction and basic properties of Brownian motion; Reflection principle, quadratic variation, Kolmogorov-Feller differential equations,

Markov processes and their generators,

Filtration theory, martingales with illustrations, stopping theory and martingale convergence theorem, Concentration inequality for martingales;

Stochastic integration and Ito calculus; Applications to finance. Black-Scholes formula.

Statistical inference for Stochastic processes.

References:

1. Cox, D.R. & Miller, H.D.: The Theory of Stochastic Process, Chapman and Hall Ltd.
2. Adke, S.R. and Manjunath, S.M: An Introduction to Finite Markov Processes, Willey estern.
3. Bhat, B.R.: Stochastic Models: Analysis and Applications, New Age International, India.
4. Cinlar, E.: Introduction to Stochastic Processes, Prentice Hall.
5. Feller, W.: Introduction to Probability Theory and its Applications, Vol.1, Wiley Eastern.
6. Harris, T.E.: The Theory of Branching Process, Springer-Ver-lag.
7. Hoel, P.G. Port S.C. and Stone, C.J.: Introduction to Stochastic Processes, Houghton Miffin & Co.
8. Jagers, P. : Branching Processes with Biological Applications, Willey.
9. Karlin, S. and Taylor, H.M.: A First Course in Stochastic Processes, Vol.1, Academic Press.

10. Bayesian Inference : 3 credits

Subjective interpretation of probability in terms of fair odds; Subjective prior distribution of a parameter; Bayes theorem and computation of posterior distribution.

Natural conjugate family of priors for a model. Conjugate families for exponential family models, and models admitting sufficient statistics of fixed dimension. Mixtures from conjugate family, Jeffreys' invariant prior. Maximum entropy priors.

Utility function, expected utility hypothesis, construction of utility function, St. Petersburg Paradox. Loss functions: (i) bilinear, (ii) squared error, (iii) 0-1 loss, and (iv) Linex.
Elements of Bayes Decision Theory, Bayes Principle, normal and extensive form of analyses.

Generalized maximum likelihood estimation. Bayes estimation under various loss functions. Evaluation of the estimate in terms of the posterior risk, Pre posterior analysis and determination of optimal fixed sample size. Linear Bayes estimates. Empirical and Hierarchical Bayes Methods of Estimation. Bayesian interval estimation: Credible intervals, HPD intervals, Comparison with classical confidence intervals.

Bayesian testing of hypotheses, specification of the appropriate form of the prior distribution for a Bayesian testing of hypothesis. Prior and posterior odds. Bayes factor for various types of testing hypothesis problems. Lindley's method for Significance tests, two sample testing problem for the parameters of a normal population. Finite action problem and hypothisis testing under "O-Ki" loss, function. Large sample approximation for the posterior distribution. Lindley's approximation of Bayesian integrals.

References:

1. Aitchison, J. and Dunsmore, I.R. (1975). Statistical Prediction Analysis, Cambridge University Press.
2. Bansal, A. K. (2007). Bayesian Parametric Inference, Narosa Publishing House, New Delhi.
3. Berger, J.O. (1985). Statistical Decision Theory and Bayesian Analysis, Springer Verlag, NewYork.
4. Box, G.E.P. and Tiao, G.C. (1973). Bayesian Inference in Statistical Analysis, Addison & Wesley.
5. DeGroot, M.H. (2004). Optimal Statistical Decisions, McGraw Hill.
6. Leonard, T. and Hsu, J.S.J. (1999). Bayesian Methods, Cambridge University Press.
7. Lee, P. M. (1997). Bayesian Statistics: An Introduction, Arnold Press.
8. Robert, C.P. (2001). The Bayesian Choice: A Decision Theoretic Motivation, Second Edition, Springer Verlag, New York.

11. Renewal Theory : 3 credits

Introduction to Renewal Processes, Examples of Renewal Processes, Distribution of number of renewals, Renewal Function and its properties, Basic Renewal Theorem, Renewal equation.
Stopping Time, Wald's Equation, Elementary Renewal Theorem, Central Limit Theorem for Renewal Processes. Key Renewal Theorem and Applications.

Alternating Renewal Processes, Excess or residual life at t, age at t, Limiting Mean Excess.
Delayed Renewal Processes, Renewal Reward Processes,

Stationary Renewal Processes, Cumulative and Related Processes.

References:

1. Ross S.M. (1983) : Stochastic Processes, John Wiley & Sons.
2. Medhi J. (2017) : Stochastic Processes, New Age International.
3. Karlin S. and Taylor M.M. (1975) : A First Course in Stochastic Processes, Academic Press.

12. Inference Under Order Restrictions : 3 credits

Introduction to Isotonic Regression, Isotonic Regression over a simply ordered finite set, Generalized isotonic regression problems.

Estimation under order restrictions: Isotonic estimation of regression, maximum likelihood and Bayesian estimation of ordered parameters in exponential families, maximum likelihood estimation of stochastically ordered distributions.

Test for testing the equality of ordered means, Likelihood Ratio Tests in Normal Case.

Estimation of unimodal densities, maximum likelihood estimation for distributions with monotonic failure rate.

Isotonic tests for Goodness of Fit, tests for exponentiality against monotone failure rate alternatives.

References:

Barlow R. E., Bartholomew D.J., Bremner J.M. and Brunk H. D (1972): Statistical Inference under Order Restrictions, John Wiley & Sons.

13. Advanced Topics in Multivariate Analysis : 3 credits

Multivariate Normal Distributions, Hypothesis Testing for one, two or more mean vectors. Multivariate Regression Analysis, Advanced Model Comparison Methods: c-Statistics and PRESS Statistics, Use of Dummy variables in multivariate regression, Standardized regression and Ridge Regression models. Probit and Logit models. Panel data regression. Cluster Analysis

Hierarchical Regression, Control Variables, Moderated Regression, Mediated Regression, Testing Mediation by Regression. Multivariate Analysis of Variance (MANOVA), Multivariate Analysis of Covariance (MANCOVA). Principal Component and Explanatory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA). Path Analysis and Basics of Structure Equation Modelling (SEM).

References:

1. Anderson, T.W (2003): An Introduction to Multivariate Analysis, Wiley
2. Bowerman, B.L. and O'Connell, R.T. (1994) : Linear Statistical Models, Second Edition
3. Malhotra, N.K. and Satyabhushan,D. (2011) : Marketing Research, 6th Edition, Pearson
4. Brian Everitt and Torsten Hothorn :An Introduction to Applied Multivariate Analysis April, 2011, Springer
5. Randall E. Schumacker: Using R With Multivariate Statistics ,Sep 2015, Springer.

14. Income Distributions and Inequalities : 3 credits

Size Distribution of Income: A Review. Distribution Patterns and Descriptive Analysis: Income distribution functions: The Pareto Law. Pareto-Levy Law, week Pareto Law, A family of Distribution Functions, Champernowne's Distribution, Lognormal Distribution.

Inequality of Income:, Lorenz Curve Mathematically & its derivation for some well-known Income Distribution functions, Symmetricity of Lorenz curve and Lemmas for necessary and sufficient conditions.

Measurement of Inequality: Axiom for Inequality Comparison, The Gini Index and the Relative Mean Difference, Gini Index and Lorenz Curve, Welfare interpretation of Gini Index, Relative mean Deviation and Related Measures, Kakwani measure of inequality, measures not Directly Related to the Lorenz Curve.

Lorenz Curves and Social Welfare Comparison: Lorenz Dominance, Generalized Lorenz Dominance, The Atkinson Theorem for Lorenz comparison and Shorrocks theorem for Generalised Lorenz Dominance.

Rawlsian Approach to Inequality & Inequality Neutrality Approach. Social Welfare when generalized Lorenz curves cross once.

Important Inequality curves & their Comparison: Bonferroni Curve , Absolute Lorenz Curve and Cummulative mean income curve and their dominance. Interrelationships between various orderings.

References:

1. Nanak C. Kakwani (1980) : Income Inequality and Poverty, Methods of Estimation and Policy Applications , A World bank Publication.
2. Peter J. Lambert (2001) : The Distribution and Redistribution of Income
3. Aman Ullah,David T. A. Giles (2003) : Handbook Of Applied Economic Statistics

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Dated: 31.05.2017

Proceedings of the meeting of Board of Control in Statistics held on 31 .05.2017 at 10.45 a.m. in the office of the Chairperson, Department of Statistics, Panjab University. Chandigarh. The following members were present:

1. Prof. Amar Nath Gill
2. Prof. Sangeeta Chopra
3. Prof. Narinder Kumar
4. Prof. Suresh K. Sharma
5. Dr. Anju Goyal
6. Prof. Kanchan K. Jain, Chairperson

The members of Board examined the M.Phil syllabi sent by Head, Department of Statistics, C.C.S. University, Meerut. After discussing the equivalence of Ms. Ritu Kumari's M. Phil course to Pre-Ph.D. course, the board recommends that the course contents of M.Phil course done by Ms. Ritu Kumari are equivalent to one-semester Pre-Ph.D. course offered in the Department at the time of her enrolment.

(Prof. Kanchan K. Jain)
Chairperson

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1. Prof. Kalpana K. Mahajan
2. Prof. Amar Nath Gill
3. Prof. Sangeeta Chopra
2. Prof. Narinder Kumar
3. Prof. Suresh K. Sharma
4. Dr. Anju Goyal
5. Prof. Kanchan K. Jain, Chairperson

The members of Board discussed and unanimously recommended the courses of syllabi for Two Semester Pre-Ph.D. course in the subject of Statistics from the session 2017-18, Semester I from January 2018 to May 2018 and Semester II from July 2018 to Nov. 2018 respectively.

(Prof. Kanchan K. Jain)
Chairperson

DEPARTMENT OF STATISTICS
PANJAB UNIVERSITY, CHANDIGARH

Syllabus for Pre-Ph.D. course in the subject of Statistics for the period 2017 – 2019.

The following courses will be offered:

RM : Research Methodology	**4 credits**
Course I	**3 credits**
Course II	**3 credits**
JC: Journal Club (Non- credit course)	
Course III	**3 credits**
Course IV	**3 credits**

All courses will have 5 hours per week of teaching hours. The course JC will have 2 hours per week.

Examination Scheme:

There will be one midterm of marks and final paper of marks except for JC course. JC is a non-credit course, only alphabetic grades S (Satisfactory) and U (Unsatisfactory) will be assigned on the basis of performances of the candidates .

Duration of Semester:

Semester-I : Jan. 2018 to May 2018
Semeser-II : July 2018 to Nov. 2018

	Paper	Credits
Semester-I		
	Research Methodology	**4**
	Course-I	**3**
	Course-II	**3**
Semester-II	**Course-III**	**3**
Semester-III	**Course-IV**	**3**
	Journal Club(JC)	**Non Credit**

Note: Courses will be offered from the list of course(Appendix-I)

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List of courses for Pre-Ph.D. Semester-I & II from Session 2017-18

Sr.No.	Name of Course
	Research Methodology
2.	Topics in Advanced Probability
3.	Topics in Stochastic Processes
4.	Renewal Theory
5.	Topics in Inference
6.	Decision Theory
7.	Reliability Theory-I
8.	Reliability Theory-II
9.	Bayesian Infrence
10.	Survival Analysis
11.	Advanced Topics in Multivariate Analysis
12.	Income Distributions and Inequalities
13.	Inference under Order Restrictions
14.	Order Statistics
15.	Actuarial Statistics

Any other course which the Board of Control may decide to offer.

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