Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD
Syllabus of Ph.D.
Entrance Test 2024

Subject: Statistics.

The syllabus for PET Examination is based on M.Sc. (Statistics) syllabus semester I to IV with equal weight for each units. The research component is also included.

Sr. No.	Name of The Unit	Detailing
01	**Unit-I**: Research Methodology.	Meaning of research, Objectives of research, types of research, Significance of Research, Research approaches, Research methods versus Methodology, Research and Scientific methods, Research process, Criteria for good research. Defining the research Problem: What is a research problem, selecting the problem, necessity of the defining the problem, techniques involved in defining a problem. Measurements and Scaling Techniques: Quantitative and Qualitative data, Classification of measurement scales, Goodness of measurement scales, Sources of error in measurement, Techniques of developing measurement tools, Scale classification bases, Scaling techniques, Types of scales – ordinal, nominal, ratio, interval. Multidimensional techniques and deciding the scales, types of variables. Designs of sample surveys: sample design, sampling and non sampling errors, sample survey verses census survey, types of sampling designs, non probability sampling, probability sampling, complex random sampling designs. Research design: Meaning, need and features of research design, Important component related to research design, research design for exploratory research studies, Descriptive and diagnostic research studies, hypothesis testing research studies. Experimental designs: Before and after without control design, After–only with control design, Before and after with control design, Different research designs. Paper writing and Report Generation **:**Basic concept of research paper/thesis writing and report generation, writing research abstract, introduction, Review of literature, results/conclusion, concept of Bibliography and References, Significance of report writing, steps of report writing, types of research reports, methods of presentation of report, formats of publication in research journal.
Subject Specific:		
02	**Unit-II: Probability Theory, Probability Distributions,**	**Probability Theory**: Fields, sigma fields, Borel sigma fields, Convergence in distribution, Convergence in probability, Almost sure convergence and convergence in quadratic mean and their inter-relations. Slutsky's theorem, Monotone convergence theorem, Fatou's Lemma, Dominated convergence theorem.

	Stochastic processes.	Distribution Functions, independence, Borel zero-one law.,expectation and moments, Convergence of Sequence of Random variables, Characteristic function, Law of Large Numbers, Central Limit Theorems and their application. **Probability Distributions**: Discrete and continuous probability distributions and their properties. Sampling distributions, Order statistics **Stochastic processes**: Markov Chain, Poisson process, Branching process, Brownian Motion Process (BMP Wiener Process), renewal process, Birth and death process.
03	**Unit-III: Sampling Techniques, Design of experiments.**	**Sampling Techniques**: SRSWR, SRSWOR, Stratified sampling, Systematic sampling, PPS, Cluster, Two stage, Multistage sampling, Double Sampling. Estimators: Ratio and Regression estimators, Horvitz and Thomson estimator, Desraj, Murthy estimators. **Design of experiments**: Theory of estimation, Estimability of linear parameters, One way ANOVA , Two way ANOVA, CRD, RBD, LSD, analysis of co-variance, Factorial Experiments, Confounding, spilt plot design, strip plot design, BIBD, PBIBD.
04	**Unit-IV: Statistical Inference, Mathematical Analysis.**	**Statistical Inference**: Point Estimation, Characteristics of good estimators, Concept of completeness and sufficiency, MVUE, MLE and method of moments, testing of hypothesis, Interval estimation, Non-parametric tests. Consistent estimators, CAN estimators, one parameter and multi parameter exponential family of distributions, Cramer's family of distributions, Likelihood ratio Test (LRT), Large sample tests, variance stabilizing transformations, censored and truncated distributions. **Mathematical Analysis** : supremum and infimum of set of real numbers, applications of Bolzano-Weierstrass theorem, Heine-Borel theorem Improper integral , Riemann Integrals,Quadratic forms, Characteristic roots and vectors and their properties, Generalized inverse, Moore – Penrose generalized inverse and all basic properties. Hermitian matrices and its properties.
05	**Unit-V: Regression Analysis, Multivariate Analysis, Operations Research, Industrial Statistics.**	**Regression Analysis**: Correlation, Simple and multiple Linear Regression, Robust Regression, Logistic Regression, Generalized linear Model, Multicollinearity, Ridge regression, non-linear regression. **Multivariate Analysis** : Multivariate Normal Distribution, Quadratic forms and their distributions, applications of Hotelling's T^2 statistic and it's applications, Properties of Wishart Distribution,partial and multiple correlation, MANOVA, Principal component analysis, Classification and discriminant analysis, Cluster analysis, Factor analysis.

		Operations Research: L.P.P., Transportation & Assignment problem, Non- linear programming problem, quadratic programming problem, inventory management, sequencing and scheduling, Game theory, Replacement models, PERT& CPM, Queuing models, . **Industrial Statistics**: Quality Systems, Control charts for attribute and variables, Moving average and exponentially weighted moving average (EWMA) charts. Cusum charts, Acceptance sampling plans for attribute and variables, methods of forecasting, Reliability Theory, Coherent System, Minimal path and cut sets, time series analysis and different methods of forecasting.

Reference Books:

Unit 01:

1) Kothari C.R, (2004): Research Methodology (Methods and Techniques) New age Publisher.
2) Bendat and Piersol, (2010) Random data : analysis and measurement procedures, Willey Interscience.
3) John W Creswell, Research design, SAGE Publications INC.

Unit 02:

Text Books:

Probability Theory:

1. Bhat, B.R. (2000), Modern Probability Theory, New Age International Pub.
2. Basu, A.K. (1999), Measure Theory and Probability , Prentice Hall of India.
3. Athreya K. B. and Lahiri S. (2006). Probability Theory Vol. 41, Trim series, (Hindustan Book Agency).
4. Billingsley, P. (1986). Probability and Measure, John Wiley

Probability Distributions:

1) Rohtagi V.K. (2012**):** An introduction to probability theory and mathematical statistics **,**Wiley eastern, 2nd ed.
2) AnirbanDasgupta (2010) Fundamentals of Probability: A First Course. Springer Texts in Statistics

StochasticProcesses :

1. Bhat, B.R. (2000) Stochastic Models : Analysis and Applications. New Age International Publications, New Delhi.
2. Medhi, J. (1982) Stochastic Process, Wiley Eastern.
3. Ross, S.M. (2000) Introduction of Probability Models, 7thedn. (Academic Press).

Reference Books:

Probability Theory:

1. Ash, Robert (1972): Real Analysis and Probability, Academic Press.
2. Kingman, J.F.C. and Taylor, S.J. (1996). Introduction to measure and probability, Cambridge University Press. Feller, W. (1969). Introduction to Probability and its Applications Vol.II (Wiley
Eastern Ltd.)

3. Gnedenko, B. V. (1988). Probability Theory (Mir. Pub.)
4. Gut, Allan (2005), Probability: A Graduate Course. (Springer, New York)

Probability Distributions:

1) Mukhopadhy .P (1996): Mathematical Statistics, New central book agency,
2) DudewiczE.J.and Mishra S.N. (1988): Modern Mathematical statistics, Wiley Int. student's Edition.

Stochastic Processes :

1. Adke, S.R. and Manjunath, S.M. (1984) An Introduction to finite Markov processes. Wiley Eastern.
2. Karlin, S. and Taylor, H.M. (2012) A first course in Stochastic Processes, Vol.1, Academic Press.

Unit 03:

Text Books:

Sampling Techniques:

1) Sukhatme et al (1984) :Sampling Theory of Surveys with Applications, lowa State University Press and IARS.
2) Murthy M.N. (1977) : Sampling Theory and Methods, Statistical Publishing .
3) Singh, D. And Choudhary F.S. (2009) Theory and Analysis of Sample Survey Designs, New age International Publishers .Society, Calcutta.
4) MukhopadhyayP.(1996): Inferential problems in Survey Sampling. New Age International.
5) Cochran(1977), W.G.: Sampling Techniques. (3rd / Edition,)Wiley.
6) Des Raj and Chandak (1998) :Sampling Theory ,Narosa.

Linear model and Design of experiments:

1) Montgomery D.C. (2004): Design and Analysis of Experiments , John and Wiley
2) Das M.N and Giri (2006): Design and Analysis of Experiments, Eastern Wiley
3) Joshi D.D. (1987): Linear Estimators and Design of Experiments, Wiley eastern
4) Kshirsagar A.M. (1983) : A course in Linear Models. Marcel Dekker Inc New York.

Reference Books:

Sampling Techniques:

1) Hedayat A.S. and Sinha B.K.(1991): Design and Inference in Finite Population Sampling. Wiley.
2) Choudhary, A. and Mukerjee, R. (1988): Randomized Response Theory and Techniques, New York: Marcel Dekker Inc.

Linear model and Design of experiments:

1) Giri N. (1986): Analysis of Variance, South Asia publication.
2) Peterson R.G. Design and Analysis of Experiments, Marcel Dekker Inc New York
3) AlokDey (1986): Theory of Block Design, Eastern Wiley

Unit 04:

Text Books:

Statistical Inference:

1) Kale B.K. and Murlidharan(2015) : A first course on parametric inference, Narosa Publishing House.
2) Rohatgi V. and Ehsanes Saleh A. K. MD (2012): An introduction to Probability and Mathematical Statistics, Wiley Eastern Ltd., New Delhi Student Edition.
3) Casella G. &beregarR.L.(2002) : Statistical Inference,2nd edition.
4) Dudewitz E.J. and Mishra S.N. (1988) : Modern Mathematical Statistics, John Wiley.

Mathematical Analysis :

1) Malik S.A. and Arora S. (1991) : Mathematical Analysis. Wiley Eastern Ltd. 2nd Edn.

2) Deshpande J.V. (1981) : Textbook of Mathematical Analysis. Tata MC-Graw Hill.
3) Rudin Walter (1976) : Principles Mathematical Analysis. Mc- Graw Hill
4) Searle, S.R.(1982) : Matrix algebra useful for statistics. John Wiley and sons Inc
5) Biswas S.(1984) : Topics in algebra of matrices. Academic publications.

Reference Books:

Statistical Inference:

1) George Casella, Roger L. Berger(2001): Statistical Inference,2nd edition, Duxbury Advanced Press.
2) Lehmann E.L. (1988) : (latest) Theory of Point Estimation (Student edition),John Wiley.
3) Lehmann E.L. (2000): Theory of Point Estimation (Student edition),John Wiley.
4) Lehmann E.L. (1986) :Testing Statistical hypothesis (Student edition),John Wiley.
5) Rao C.R. (2012) : Linear Statistical Inference and its Application, Wiley series, John Wiley & Sons, Inc.
6) Zacks.S.(1971) : Theory of Statistical Inference, John Wiley and sons, New York.

Mathematical Analysis :

1) Apostoal T.M. (1985) ; Mathematical Analysis. Narosa, Indian Ed.
2) Hadley G.(1987) : Linear Algebra. Narosa Publishing house.
3) HoffimanK.andKunze.R. (1971) : Linear algebra. 2nd Ed Prentice hall Inc.
4) Bartle G.R. &Sherbert D.R. (2000) : Introduction to Real analysis. John wiley& Sons

Unit 05:

Text Books:

Regression Analysis:

1) Montogomery D.C. et al (2012): Introduction to linear regression Analysis. Wiley.
2) Draper N.R and Smith H (1998): Applied Regression analysis 3rd Ed. Wiley.

Multivariate Analysis :

1) Anderson T.W.(1983), Introduction to multivariate analysis (John Wiley)
2) Richard A. Johnson, Dean W. Wichern(2002), Applied Multivariate Statistical Analysis. (Prentice hall Inc.)
3) Kshirsagar A.M. (1972), Multivariate Analysis. (Marcel Dekker)
4)K.C. Bhuyan (2005), Multivariate Analysis and its application, New Central book agency Ltd

Operations Research:

1) Hiller and Lieberman Operations Research concepts and cases, Tata macgraw Hill
2) A. Ravindran, D.T. Phillips, J.J. Solberg. (2001) Operations Research Principles and practices, 2nd ed. John wiley and sons.
3) TahaH.A.(1976) Operations Research, An introduction, 2nd ed., Macmillan, New York.
4) TahaH.A.(2006): Operations Research, An introduction, 8 Ed Prentice Hall.
5) Sharma J.K (2003) Operations Research theory and application, Macmillan business books.

Industrial Statistics:

1) Montoegmory, D.C (1985) : Statistical Process Control, John Wiley.
2) Montoegmory, D.C (2007) :Introduction to Statistical Quality Control, Wiley.
3) Logothetis N. (1992) :Managing Total Quality, Prentice Hall of India.
4) Suddhendu Biswas (2003) : Statistics of Quality Control, New Central Book Agency.
5) Wetherill G.B. and Brown D.W. Statistical Process Control, theory and practice chapman and Hall.
6) Sinha S.K.(1986): Reliability and Life Testing, Wiley Estern Limited.

7) Barlow R.E. And Proschan F. (1985): Statistical Theory of methods reliability and Life Testing Holt Rinehart and Winston.
8) K. Muralidharan and A. Syamsundar (2012): Statistical Methods for Quality, Reliability and Maintainability, PHI Learning PVT, India
9) Miller R.G. (1981) : Survival Analysis, Wiley.
10) Elandt-Johnson R.E., Johnson N.L. (1980) : Survival Model and Data Analysis, John Wiley and Sons.

Reference Books:

Regression Analysis:

Montgomery Book may be added here on Regression Analysis

1) Weisbers S (1985): Applied linear Regression, Wiley.
2) Cook R.D.F Weisberg S. (1982): Residual & influence in regression, Chapman & hall
3) Gunst N.R .and Mason R.I. (1980): Regression analysis and its Applications of Data Oriented Approach, Marcel and Dekker.

Multivariate Analysis :

1). C. R. Rao (2002), Linear Statistical Inference and its applications. (Wiley Eastern)
2) Morrison D.F. (1976), Multivariate Statistical Methods. (McGraw Hill)
3) MuriheadR.J.(1982), Aspects of Multivariate Statistical Theory (J. Wiley)
4) Seber G.A.F. (1984), Multivariate Observations(Wiley)
5) Sharma S. (1996), Applied multivariate techniques. (Wiley)
6) Srivastva M.S. and Khattri (1979), An introduction to Multivariate Statistics. (North Holland)

Operations Research:

1) Sharma J.K (2003) Operations Research theory and application, Macmillan business books.
2) Premkumar Gupta and D. S Hira Operations Research, S. Chand Publication
3) HadelyG.(1969) Linear programming, Addison Wesley.
4) Wagner H. M. (1975) Principles of Operations Research, 2nd ed. Prentice Hall, Englewood cliffs.
5) KantiSwarup , Manmohan and P.K. Gupta (2010): Operations Research, S. Chand Publication
6) Gross D. and Harris C.M. Fundamentals of queuing theory.

Industrial Statistics:

1) Mahajan M. S. (2013) : Statistical Quality Control. Dhanpat Rai & Co. (P) LTD. Delhi.
2) Phadke, M.S.(1989) : Quality Engineering through Robust Design Pretic Hall.
3) Oakland J.S. (1989) : Total Quality management, Butterworth Heinemann.
4) Mittag H.J. and Rinne.H. (1993) :Statistical process control John Wiley.
5) Bain L.J. And Engethaardt (1991): Statistical Analysis of Reliability and Life Testing models Marcel Derkker.
6) Mahajan M. S. (2013) : Statistical Quality Control. Dhanpat Rai & Co. (P) LTD.
7) MontegomeryD.C.(1996): Introduction to Statistical Quality Control, Wiley.
8) Nelson W.(1982) : Applied Life Data Analysis John Wiley.
9) Zacks S. (1992) :Introduction to reliability analysis Probability Models and statistical Methods Springer overflag.