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॥ असतो मा सद्गमय तमसो मा ज्योतिर्गमय ॥

North Maharashtra University, Jalgaon

Syllabus for M.Sc. (Part-II)

STATISTICS

(Semester III & IV)

W.E.From June, 2003

॥ अंतरी पेटवू ज्ञानज्योत ॥

NORTH MAHARASHTRA UNIVERSITY, JALGAON.

Syllabus for M.Sc.-II (Statistics) with specialization in Industrial Statistics.

[W. E. From June, 2003]

Syllabus Structure

Semester-III

Course No.	Title of the Course	Contact hours / week			Marks Distributions for Examinations					
					Internal		External		Total	
		Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr
ST-301	Asymptotic Inference	04	--	04	40	--	60	--	100	--
ST-302	Design, Planning and Analysis of Experiments	04	--	04	40	--	60	--	100	--
ST-303	Total Quality Management (TQM) Statistical Process Control (SPC) and Reliability	04	--	04	40	--	60	--	100	--
ST-304	Optional Course	04	--	04	40	--	60	--	100	--
ST-305	Practicals- III	--	06	06	--	40	--	60	--	100

Semester-IV

Course No.	Title of the Course	Contact hours / week			Marks Distributions for Examinations					
					Internal		External		Total	
		Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr
ST-401	Optimization Techniques	04	--	04	40	--	60	--	100	--
ST-402	Actuarial Statistics	04	--	04	40	--	60	--	100	--
ST-403	Optional Course	04	--	04	40	--	60	--	100	--
ST-404	Technical Communications and Practicals-IV	--	06	06	--	40	--	60	--	100
ST-405	Project	--	04	04	--	--	--	100	--	100

Th: Theory Pr: Practicals /Project L: Lectures M: Marks

General Instructions to Teachers and Paper Setters/ Examiner

1. Each Theory Course required 60 lectures each of one hour.
2. Each Practical Course required 90 laboratory periods each of one hour.
3. Teacher should follow syllabus as well as time schedule given in the syllabus for all topics. Variation up to 4/5 hours (more or less) may be acceptable.
4. Each external examination theory question paper should contain 8 questions of 12 marks each. Student will be asked to answer 5 questions out of 8 questions. Each external examination practical question paper should contain 6 questions each of 15 marks and student will be asked to answer any 4 questions. Paper Setter may consider sub parts such as ((a), (b), (c)...) in each question.
5. Question paper should generally be uniformly distributed over the syllabus.

Examination Pattern:

Number of Internal Tests and Time duration:

Concern Teacher in consultation with Head of the Department may conduct 2 or 3 tests of 40 marks (2 Hrs.) for Internal Examination of all Theory and Practical courses. Head of the Department well in advance will declare detailed Timetable.

External Examination:

University will conduct external examinations at the end of each semester. Each course except project will have examination of 60 marks (3 Hrs). Practical examination will be conducted before Theory examination. Timetable for external examinations will be declared by University office well in advance. Project vivo-voce will be arranged in the third/fourth week of May.

Standard of Passing:

To pass any course, the candidate has to secure at least 40% marks in the internal as well as in the external examinations.

The candidate failed in Internal or External or in both examinations shall have to appear for subsequent Internal or External or both Examinations respectively for that course.

॥ अंतरी पेटवू ज्ञानज्योत ॥

NORTH MAHARASHTRA UNIVERSITY, JALGAON
Syllabus for M.Sc.-II (Statistics) with specialization in Industrial Statistics

[W.E.From June, 2003]

Detailed Syllabi

ST-301: ASYMPTOTIC INFERENCE

- Review of convergence in probability and convergence in distribution, Cramer and Slutsky's Theorems.
- Consistent Estimation of real and vector parameter. Invariance of Consistent estimator under continuous transformation.
- Consistency of estimators by method of moments, and method of percentiles, Mean squared error criterion.
- Asymptotic relative efficiency, Error probabilities and their rates of convergence, Minimum sample sizes required to attain given level of accuracy.
- Consistent Asymptotic Normal (CAN) estimator, Invariance of CAN estimator under differentiable transformation.
- CAN property of estimators obtained by moments and percentiles.
- CAN estimators obtained by moment and MLE method in one parameter exponential family, Extension of multiparameter exponential family,
- Examples of consistent but not asymptotically normal estimators from Pitman family.
- Method of maximum likelihood, CAN estimators for one-parameter Cramer family, Cramer-Huzurbar theorem, Solution of likelihood equations, Method of scoring, Newton-Raphson and other iterative procedures.
- Fisher Lower Bound to asymptotic variance, extension to multiparameter cases (without proof.) Multinomial distribution with cell probabilities depending on a parameter.
- MLE in Pitman Family and Double Exponential distribution, MLE in censored and truncated distribution.
- Likelihood Ratio Test (LRT), Asymptotic distribution of LRT statistic, Wald Test, Rao's score test, Pearson \chi^2 test for Goodness of fit, Barlett's Test for homogeneity of variances. Large Sample Tests and confidence intervals based on CAN estimators, Variance stabilizing transformation and large sample tests. Consistency of Large Sample Tests. Asymptotic power of large sample tests.

REFERENCES

Kale, B.K (1999) A first Course on Parametric Inference, Narosa Publishing House.
Rohatgi V.(1988). An Introduction to Probability and Mathematical Statistics. Wiley Eastern Ltd. New Delhi (Student Edition.)

ADDITIONAL REFERENCES

Lehmann, E.L. (1986). Testing statistical hypotheses (Student Edition).
Rao, C.R. (1973): Linear Statistical Inference.
Dudewicz, E.J. and Mishra, S.N.(1988), Modern Mathematical Statistics. Wiley Series in Prob. Math. Tat. John Wiley and Sons, New York (International Student Edition)
Ferguson, T.S. (1996) A course on Large Sample Theory. Chapman and Hall, London.

ST-302: DESIGN, PLANNING AND ANALYSIS EXPERIMENTS

- Randomization, replications, local control one way and two-way classification with unequal and equal number of observations per cell (with/without interactions). Connectedness, balancedness, orthogonality, BIBD, Analysis of covariance in a general Gauss -Markov model, applications to standard designs (ANOCOVA).
- Random effect models for one way classification.
- 2^k Full factorial experiments: diagrammatic presentation of main effects and first order interactions model, analysis of single as well as more than one replicates using ANOVA.
- Total confounding of 2^k design in 2^p blocks, $p \geq 2$. Partial confounding in 2^p blocks, p=2,3. Fractional factorial experiments. Resolution of a design, (III, IV & V), aberration of a design.
- Concept of rotatable design. Central composite designs, 3^2 designs: contrasts for linear and quadratic effects, statistical analysis of 3^2 design.
- Response surface methodology (RSM): linear and quadratic model, stationary point, ridge systems, multiple responses, blocking in RSM.
- Taguchi (orthogonal array) methods: concept of loss function, S/N ratio, linear graphs ANOM inner and outer arrays ANOVA.

REFERENCES

Kshirsagar A.M. (1983) Linear Models (Marcel Dekkar).
John P.W.M.(1971) Linear Models (John Wiley Ltd.)
Montogomery D.C. (2001) Design and Analysis of Experiments (John Wiley)
Ogawa J.(1974) Statistical Theory of the Analysis jof Experimental Design (Marcel Dekker).
Phadke, M.S. (1989) Quality Engineering through Robust Design, Prentice Hall.

ST-303: TOTAL QUALITY MANAGEMENT (TQM), STATISTICAL PROCESS CONTROL (SPC) AND RELIABILITY

- Quality Systems: ISO 9000 standards, QS 9000 standards. Concept of six-sigma and the "Define-Measure-Analyse-Improve-Control" Approach. Precision and accuracy in measurement systems. Estimation of Measurement Uncertainty.
- Total Quality Management, Process Analysis and Optimization.
- Basic concept of process monitoring and control.
- Concept of systematic variation, random variation, stable industrial processes.
- General theory and review of control charts for attribute and variable data: O.C. and A.R.L. of control charts.
- *X-bar and R, X-bar and S, X and MR, p, np, u, c, control charts.*
- Control by gauging: Moving average and exponentially weighted moving average charts; Cu-sum charts using V-masks and decision intervals.
- General idea of Economic designing of control charts, Duncan's model for Economic control chart.
- Capable process. Process Capability
- Process Capability Indices: *Cp, Cpk and Cpm* for bilateral and unilateral quality characteristics.
- Connection between proportion of nonconforming and *Cp*

- Estimations. confidence intervals and tests of hypotheses relating to Cp for Normally distributed characteristics.
- Multivariate quality control; use of control ellipsoid and of utility functions.
- Acceptance sampling plans: single, double and sequential sampling plans for attributes and their properties. Curtailed double sampling plans, operating characteristics functions and other properties of the sampling plans. Sampling plans with rectification.Designing of sampling plan. Dodge-Romig acceptance sampling plans.
- Plan for inspection by variables for one-sided and two-sided specifications; AQL based sampling plans.
- Elements of Reliability:

  Components and systems, binary coherent structure k-out-of –n: G structure, bridge structure. Cuts and Paths, minimal path sets and minimal cut sets. Reliability of coherent system, bonds on system reliability. structural and reliability importance of components.

REFERENCES

Montgomery, D.C. (1985) Introduction to Statistical Quality Control; Wiley.
Ott, E.R. (1975) Process Quality Control; McGraw Hill
Wetherill, G.B. (1977) Sampling Inspection and Quality Control, Halsted Press.
Wetherill, G.B. and Brown, D.W. Statistical Process Control, Theory and Practice; Chapman and Hall.
Logothetis, N.(1992). Managing Total Quality; Prentice Hall of India.
Oakland J.S. (1989). Total Quality Mangement; Butterworth-Heinemann.
Mittag H.J. and Rinne H.(1993). Statistical Methods of Quality Assurance.
Barlow R.E. and Proschan F. (1985) Statistical Theory of Reliability and Life Testing; Holt, Rinehart and Winston.
Lawless J.F. (1982) Statistical Models and Methods of LifeTime Data; John Wiley.

ST-304: Optional Course
(See the list of optional courses)

ST-305: PRACTICALS - III

(By using statistical software or programming language.)

1. Practicals based on course ST-301 and ST-303.

- Consistent estimators, CAN estimators.
- Maximum likelihood estimators, method of moments estimators and their asymptotic distributions.
- MLE by methods of scoring..
- Comparing MSE's of different estimators.
- Likelihood Ratio Tests.
- Performance of test of hypothesis, computing power function of test and plotting them.
- Plotting variable and attributes control charts
- Process capability analysis.
- Accessing normality of the data.
- Single and double sampling plans for variable data.

2. **Practical based on course ST-302**

- Analysis of variance: Two-way classification with unequal number of entries per cell.
- Analysis of covariance for one way and two ways classified data.
- Analysis of 2^4, $2^5 \cdot 3^2$ factorial experiment.
- Analysis of BIBD.
- Fractional replications, Total and partial confounding.
- Fitting first and second order response surface model, Central composite design, contour plots.

3. **Practicals based on Internet:**

- Introduction, E-mail, web-site, Cyber space, World Wide Web (www),Accessing the internet, Online statistical exercises, Search data sets related to specified topic, Search topics on specified topics.

4. **Practicals based on optional course ST-304.**

(To be designed according to optional courses by the concerned teacher.)

ST-401: OPTIMIZATION TECHNIQUES

- Linear programming: convex sets, supporting and separating hyperplanes, standard linear program and basic feasible solution, simplex algorithm and simplex method, two phase method, graphical solution, Charnes'M-technique. Duality in linear programming, duality theorems, dual simplex method with justification, sensitivity and parametric LPP.
- Transportation and assignment algorithms, balanced and unbalanced transportation problems, degeneracy, Hungarian method of assignment, transshipment problems.
- Integer linear programming Gomory cut method branch and bound method, fractional cut method, Network flows, maximal flow in the network, labeling technique, connection between network flow and transportation matrix solution.
- Nonlinear programming Quadratic programming Kuhn-Tucker conditions, Algorithms (Wolfe's Beale's and Fletcher's) for solving quadratic programming problem.

Books Recommended:

1. Kambo N.S. (1991) Mathematical Programming Techniques Affiliated East West Press Pvt. Ltd.
2. Hadley G. (1987) Linear Programming.
3. Taha H.A. (1992) Operations Research 5th ed. (Macmillan).

ST-402: ACTUARIAL STATISTICS

Section I - Probability Models and Life Tables.

- Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curtate future lifetime, force of mortality.
- Life table and its relations with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables.
- Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws.
- Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations.
- Distribution of aggregate claims, compound Poisson distribution and its applications. Distribution of aggregate claims, con ,ound Poisson distribution and its applications.

Section II - Insurance and Annuities.

- Principles of compound interest: Nominal and effective rates of interest and discount force of interest and discount, compound interest, accumulation factor, continuous compounding.
- Life insurance: Insurance payable at the moment of death and at the end of the year of death level benefit insurance, endowment insurance, differed insurance and varying benefit insurance, recursions, commutation functions.
- Life annuities: Single payment, continuous life annuities, discrete life annuities life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and approtionable annuities-due.
- Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportionable premiums, commutation functions, accumulation type benefits.
- Payment premiums, approtionable premiums, commutation functions acumulation type benefits.
- Net premium reserves: Continuous and discrete net premium reserve, reserves on a semicontinuous basis, reserves based on true monthly premiums, reserves on an apportionable or discounted continuous basis, reserves at fractional duration, allocations of loss to policy years, recursive formulates and differential equations for reserves commutation functions.
- Some practical considerations: Premium that includes expenses-general expenses types of expenses per policy expenses.
- Claim amount distributions, approximating the individual model stop-loss insurance.

REFERENCES

N.L.Bowers, H.U. Gerber, J.C. Hickman, D.A.Jones and C.J.Nesbitt. (1986) . 'Actuarial Mathematics' Society of Actuarias, Ithaca, Illois U.S.A. Second Edition (1997).
Section I - Chapter 1,2,3,8,9,11
Section II- Chapter 4,5,6,7,13,14.

ADDITIONAL REFERENCES

Spurgeon E.T. (1972) Life Contingencies, Cambridge University Press.
Neil, A. (1977) Life Contingencies, Heineman.

ST-403: Optional Course
(See the list of optional courses)

ST-404: TECHNICAL COMMUNICATIONS AND PRACTICALS - IV

- **Technical Communications.(40 marks Internal Exam)**

There will 15 lectures for students. Objective of this topic is to improve communication/presentation skills of the student. Each student will have to prepare his/her presentation/lecturer based on any topic from Statistics and deliver / present it before all students and teachers of the department. Their performance will be evaluated on their presentation for 40 marks.

Practicals-IV (60 marks External Practical Exam)
(Based on software and computer programming)

- Graphical solution to LPP
- Simplex method and dual Simplex method.
- NLPP using Langrangian multiplier.
- Solving Quadratic programming problem using Kuhn-Tucker conditions.
- Quadratic programming.
- Transportation and Assignment problem.
- Practicals based on Acturial Statistics.
- Practicals based on optional course ST-403.
  (to be formulated by concerned teacher based on optional course.)

ST-405: PROJECT

- **Project duration:** 1st December to 15th May. (Students may start their preliminary work after second semester only.)
- **Project Guide:** Teachers from the Department and/or organization where student is going to visit for field work or training.
- **Fieldwork:** Student will be given weekly one day off during last semester for industrial work /data collection/survey or any other fieldwork involved in the project.
- **Project Topic:** Students in consultation with the guide will decide Project Topic. Topic may be decided after completion of second or third semester. Project work may be carried out in a group of students depending upon the depth of fieldwork involved.
- **Project report:** Project report should be submitted in typed form with binding by 15th May (or within 15/20 days after external theory exams.)
- **Project evaluation:** Project evaluation will be based on
  (i) Project report(60marks)
  (ii) Presentation by student or group of students. (20 marks)
  (iii) Viva voce (20 marks)

  Two examiners will evaluate project work.

Detailed syllabi of optional courses

STATISTICAL ANALYSIS OF CLINICAL TRIALS

- Introduction to clinical trials: the need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, overview of Phase I-IV trials, multi-center trials.
- Data management: data definitions, case report forms, database design, data collection systems for good clinical practice.
- Design of clinical trials: parallel vs.cross-over designs, cross-sectional vs.longitudinal designs, review of factorial design, objectives and endpoints of clinical trails, design of Phase I trials, design of single-stage and multi-stage Phase II trails, design and monitoring of Phase III trials with sequential stopping, design of bioequivalence trials.
- Reporting and analysis: analysis of categorical outcomes from Phase-I-III trials, analysis of survival data from clinical trails.
- Surrogate endpoints: selection and design of trials with surrogate endpoints, analysis of surrogate endpoint data.
- Meta-analysis of clinical trials.

Note on Practicals: Each practical session should correspond to 2 teaching hours/week in the Practical course. Practical work should be done on statistical packages or using high level languages as taught in the core course.

REFERENCES

S.Paintadosi.(1997) Clinical Trials: A Methodologic Perspective. Wiley and Sons.

C.Jennison and B.W.Turnbull (1999). Group Sequential Methods with Applicatons to clinical Trials, CRC Press.

L.M.Friedman, C.Furburg, D.L.Demets (1998). Fundamentals of Clinical Trials, Springer Verlag.

J.L.Fleiss (1989) The Design and Analysis of Clinical Experiments. Wiley and Sons.

E.Marubeni and M.G.Valsecchi (1994). Analyzing Survival Data from Clinical Trials and Observational studies, Wiley and Sons.

JAVA PROGRAMMING

- Introduction to JAVA:
  Programming Tool, JAVA and Internet, Comparison with C++, Power of JAVA
- JAVA language structure:
  Comments, Data types, variable operators, strings, control flow statements, arrays and class methods.
- Object Oriented Programming Structure in JAVA:
  Objects and classes: Inheritance, Interfaces and inner classes.
- Graphics Programming:
  Creating a closeable Frame layout, Displaying Information in a Frame, Graphics Objects, Text and Fonts, colors, Drawing Shapes from Lines, Drawing Rectangle and ovals, Filling shapes, Paint Mode, images.

- Event Handling:
  Basics of Event handling AWT Event Hierarchy, Semantic and low-level events in the AWT, Event handling summary, individual events, separating GUI and application code, multicasting advanced Event Handling.
- User interface Components with Swing:
  Model-View-Controller Design Pattern, Layout management, Text input, choice controls, Scroll bars. Menus, dialog boxes.
- Applets:
  Applet Basics, the applet HTML tags and attributes, pop-up windows in applets, multimedia, Applet context.
- Exception Handling:
  Dealing with errors, catching exceptions, JDB debugger.
- Streams and Files:
  Streams complete stream zoo, ZIP file stream, putting streams to use, object streams, File management.

Note on Practicals: Each practical session should correspond to 2 teaching hours/week in the Practical course.

REFERENCES

Core Java Vol.I (Addison-Wesley) Sun Press
Core Java Vol.II (Addison-Wesley) Sun Press
Thinking in JAVA Bruce Eckel, Addison-Wesley, ISBN: 9814035750
The Complete Reference JAVA-2 (Third Edition) Patrick Naughton, Herbert Schildt.
TATA McGRAW HILL.

KNOWLEDGE DISCOVERY AND DATA MINING

- Review of classifications methods from multivariate analysis; classification and decision trees.
- Clustering methods form both statistical and data mining viewpoints; vector quantization.
- Unsupervised learning from univariate and multivariate data; dimension reduction and feature selection.
- Supervised learning from moderate to high dimensional input spaces; artificial neural networks and extensions of regression models, regression trees.
- Introduction to databases, including simple relational databases, data warehouses and introduction to online analytical data processing.
- Association rules and prediction; data attributes; applications to electronic commerce.

Note on Practicals: Each practical session should correspond to two teaching hours/week in the Practical course. Practical work should be done on statistical packages or using high level languages as taught in the core course.

REFERENCES

A.Berson and S.J.Smith (1997). Data Warehousing. Data Mining and OLAP McGraw Hill.
L.Breiman, J.H.Freidman,R.A.Olshen, and C.J.Stone (1984). Classification and Regressin Trees. Wadsworth and Books/Cole.
J.Han and M.Kamber (2000). Data Mining; Concepts and Techniques Morgan Gaufmann.
T.M.Mitchell (1997) Machine Learning, McGraw Hill.
B.D.Ripley (1996). Pattern Recognition and Neural Networks. Cambridge University Press.

STATISTICAL PATTERN RECOGNITION

- Linear classifiers: linear discriminant function (LDF) for minimum squared error, LDF for binary outputs, preception learning algorithm.
- Nearest neighbour decision rules; description, convergence, finite sample considerations, use of branch and bound methods.
- Probability of errors: two classes; normal distribution equal covariance matrix assumptions, Chernoff bounds and Bhattacharya distance, estimation of probability of error.
- Feature selections and extraction: interclass distance measures, discriminant analysis, probabilistic distance measures and principal components.

Note on Practicals: Each practical session should correspond to two teaching hours/week in the Practical course. Practical work should be done on statistical packages or using high level languages as taught in the core course.

REFERENCES

R.O.Duda and P.E.Hart (1973) . Pattern Recognition and Scene Analysis. Wiley.
K.Fukunaga (1990) Introduction to Statistical Pattern Recognition, Second Edition. Academic Press.
G.J.McLachlan (1992). Discriminant Analysis and Statistical Pattern Recognition. Wiley.
B.D.Ripley (1996). Pattern Recognition and Neural Networks. Cambridge University Press.

TIME SERIES ANALYSIS

- Time series as discrete parameter stochastic process. Auto covariance and autocorrelation functions and their properties.
- Exploratory Time Series Analysis Tests for trend and Seasonally. Exponential and Moving Average Smoothing. Holt and Winters smoothing. Forecasting based on smoothing, Adaptive smoothing.
- Detailed study of the stationary processes: (1) Moving average (MA), (2) Auto regressive (AR). (3) ARMA and (4) AR integrated MA (ARIMa) models Box-Jenkins models. Discussions (without proof) of estimation of mean auto covariance and autocorrelation funcitons under large sample theory. Choice of AR and MA periods. Estimation of ARIMA model parameters. Forecasting Residual analysis an diagnostic checking. Use of computer packages like SPSS.
- Spectral analysis of weakly stationary process: Periodogram and correlogram analyses. Computations based on Fourier transform. Spectral decomposition of weakly AR process and representation as a one-sided MA process-necessary and sufficient conditions. Implication in prediction problems.

Use of software package is desirable:

1. Exploratory Analysis.
2. Smoothing.
3. Numerical exercises on MA and AR models Forecasting.
4. Numerical exercises on ARMA and ARIMA models Forecasting.
5. Numerical exercises on Box-Jenkins models.
6. Residual analysis and diagnostic checking.
7. Computations based on Fourier transform.
8. Periodogram analysis and interpretation.
9. Correlogram analysis and interpretation.

Note on Practicals: Each practical session should correspond to two teaching hours/week in the Practical course. Practical work should be done on statistical packages or using high level languages as taught in the core course.

REFERENCES

Box, G.E.P and Jenkins G.M. (1976). Time Series Analysis-Forecasting and Control, Holden-day San Francisco.

Anderson. T.W. (1971). The Statistical Analysis of Time Series Wiley, N.Y.

Montgomery, D.C. Johnson L.A (1977) Forecasting and Time Series Analysis, AcGraw Hill.

Kendall, Sir Maurice and Ord, J.K. (1990). Time Series (Third Edition), Edward Arnold.

Brockwell,P.J. an dDavis R.A. Tiem Series: Theory and Methods (Second Edition) Springer-Verlag.

ADDITIONAL REFERENCES

Fuller, W.A (1976) . Introduction to statistical Time series , John Wiley N.Y.

Granger, C.W.J. and Newbold (1984) Forecasting Econometric Time Series, Third Edition, Academic Press.

Preistley, M.B. (1981) Spectral Analysis & Time Series, Griffin, London.

Kendall, M.G. and Stuart A. (1966). The Advanced Theory of Statistics, Volume 3, Charles Griffing, London.

Bloomfield, P.(1976) Fourier Analyses of Time Series-An Introduction Wiley.

Granger, C.W.J. and Hatanka M. (1964) . Spectral Analysis of Economic Time Series, Princeton Univ. Press, N.J.

Koopmans, L.H (1974), The Spectral Analysis of Time series, Academic Press.

Nelson C.R. (1973) Applied Time series for Mangerial Forecasting, Holden-Day.

Findley, D.F. (Ed.) (1981) Applied Time Series Analyses II, Academic Press.

ECONOMETRICS

- Nature of econometrics. The general linear model (GLM) and its extensions. Ordinary least squares (OLS) estimation and prediction. Use of dummy variables and seasonal adjustment. Generalized least squares (GLS) estimation and prediction, Heteroscedastic disturbances. Pure and mixed estimation. Grouping of observations and of equations.

- Auto correlation, its consequences and tests. Theil BLUS procedure Estimation and prediction Multicollinearity problem, its implications and tools for handling the problem. Ridge regression.
- Linear regression with stochastic regressor. Instrumental variable estimation. Errors in variables. Autogressive linear regression. Distributed lag models. Use of principal components, canonical correlations and discriminant analyses in econometrics.
- Simultaneous linear equations model. Examples, identification problem, restrictions on structural parameters-rank and order conditions. Restrictions on variances and covariances.
- Estimation in simultaneous equations models. Recursive systems, 2SLS Estimators, Limited Information estimators, K-class estimators, 3 SLS estimation, Full information maximum likelihood method. Prediction and simultaneous intervals. Monte Carlo studies and simulation.

LAB WORK (Assignments of 2 hrs each)

Use of software packages is desirable.

1. OLS estimation and prediction in GLM.
2. Use of dummy variables (dummy variable trap) and seasonal adjustment.
3. GLS estimation and prediction.
4. Tests for heteroscedasticity: pure and mixed estimation.
5. Tests for autocorrelatin. BLUS procedure.
6. Ridge regression.
7. Industrumental variable estimation.
8. Estimation with lagged dependent variables.
9. Identification problems checking rank and order conditions.
10. Estimation in recursive systems
11. Two SLS estimation.
12. Simulation studies to compare OLS, 2SLS, LISE and FIML methods.

Note on Practicals: Each practical session should correspond to two teaching hours/week in the Practical course. Practical work should be done on statistical packages or using high level languages as taught in the core course.

REFERENCES

Apte PG (1990) Text book of Econometrices. Tata McGraw Hill.
Cramer J.S. (1971):Empirical Econometrics. North Holland.
Gujrathi D (1979):Basic Econometrics, McGraw Hill.
Intrulligator MD (1980) :Econometric Models-Techniques and applicatins, prentice Hall of India.
Johnston J.(1984) :Econometric methods, Third edition, McGraw Hill.
Klein, L.R. (1962) :An Introduction to Econometrics, Prentice Hall at India.
Koutsoyiannis, A (1979): Theory of Econometrics. Macmillan Press.
Malinvaud E(1966): Statistical methods of Econometrics, North Hollnad.
Srivastava, V.K. and Giles D>A>E (1987): Seemingly unrelated regression equaitons models, Maicel Dekkar.
Theil, H.(1962):Introduction to the theory and practice of Econometrics, John Wiley.
Walters A. (1970) AN introducitn to Econometrics, Mcmillan an dCo.
Wetherill, G.B. (1986):Regression analysis with applications, Chapman Hall.

NONPARAMETRIC AND SEMIPARAMETRIC METHODS

- Empirical distribution function, Gilvenko Cantelli Theorem, Kolmogorov Goodness of fit test.
- One sample U-statistics, Kernel and symmetric kernel, Two sample U-statistics, Asymptotic distribution of U-statitics, UMVUE property of U-statistics, Asymptotic distribution of linear function of order statistics.
- Rank tests, Locally most powerful rank tests, Linear rank statistics an their distributional properties under null hypothesis, Pitman's asymptotic relative efficiency.
- One sample location problem, sign test and signed rank test, two sample Kolmogorov Smirnov tests. Two sample location and scale problems. Wilcoxon-Mann-Whitney test, normal score test, ARE of various tests based on linear rank statistics. Kruskal-Wallies K sample test.
- Cox's Proportional Hazards Model, rank test (partial likelihood) for regression coefficients. Concepts of jackknifing method of Quenouille for reducing bias, Bootstrap methods, Confidence intervals.

Note on Practicals: Each practical session should correspond to two teaching hours/week in the Practical course. Practical work should be done on statistical packages or using high level languages as taught in the core course.

REFERENCES

Davison, A.C. and Hinkley, D.V.(1997): Bootstrap methods and their application, Cambridge University Press.

Gibbons, J.D. (1985): Nonparametric statistical inference, (2nd ed., Marcel Dekkar, Inc.

Randles, R.H. and Wolfe, D.A. (1979): Introduction to the theory of nonparametric statistics, John Wiley & Sons, Inc.

ADDITIONAL REFERENCES

Fraser, D.A.S. (1957): Nonparametric methods in statistics, John Wiley & Sons, Inc.

Hajek, J. and Sidak, Z. (1967): Theory of rank tests, Academic Press.

Puri, M.L. and Sen,P.K. (1971): Nonparametric methods in multivariate analysis, John Wiley & Sons, Inc.

Cox, D.R. and Oakes, D. (1983): Survival analysis, Chapman and Hall.