Department of Statistics, The University of Burdwan

Syllabus for M.Sc. Examination in Statistics, University of Burdwan

w.e.f 2020 – 2022

Semester- I									
Course				Lect. Hr /week	Dur. of Exam (in H)	Marks			Credit
Course code	Type	T/P	Name			I.A.	E.T	Total	
MSST101	Core	T	Mathematical Analysis	4	2	10	40	50	4
MSST102	Core	T	Probability Theory	4	2	10	40	50	4
MSST103	Core	T	Statistical Methods & Measure Theory	4	2	10	40	50	4
MSST104	Core	T	Optimization Techniques & Statistical Quality Management	4	2	10	40	50	4
MSST105	Core	P	R Programming	8	4	10	40	50	4
MSST106	Core	P	Practical Based on MSST102, 103 and 104	8	4	10	40	50	4
					TOTAL				24
Semester- II									
Course				Lect. Hr /week	Dur. of Exam (in H)	Marks			Credit
Course code	Type	T/P	Name			I.A.	E.T	Total	
MSST201	Core	T	Sampling Distributions & Inference - I	4	2	10	40	50	4
MSST202	Core	T	Multivariate Techniques	4	2	10	40	50	4
MSST203	Core	T	Linear Model & Design of Experiments-I	4	2	10	40	50	4
MSST204	Core	T	Operations Research & Reliability Theory	4	2	10	40	50	4
MSST205	Core	P	Practical Based on MSST 201-204	8	4	10	40	50	4
MSST206	Core	P	Python Programming	8	4	10	40	50	4
					TOTAL				24

Semester- III									
Course				Lect. Hr /week	Dur. of Exam (in H)	Marks			Credit
Course code	Type	T/P	Name			I.A.	E.T	Total	
MSST301	Core	T	Inference-II	4	2	10	40	50	4
MSST302	Core	T	Regression Analysis & Design of Experiments-II	4	2	10	40	50	4
MSST303	Core	P	Practical Based on MSST301 & 302	8	4	10	40	50	4
MSST304-1	GE	T	Biostatistics	4	2	10	40	50	4
MSST304-2	GE	T	Elementary Stochastic Process and Time Series	4	2	10	40	50	4
MSST304-3	GE	T	Numerical Methods and Matrix Algebra & Statistical Computing	4	2	10	40	50	4
MSST304-4	GE	T	Business Statistics	4	2	10	40	50	4
MSST305-1	DE	T	Advanced Statistical Methods	4	2	10	40	50	4
MSST305-2	DE	T	Advanced Probability Theory	4	2	10	40	50	4
MSST306-1	DE	P	Practical Based on MSST305-1	8	4	10	40	50	4
MSST306-2	DE	P	Practical Based on MSST305-2	8	4	10	40	50	4
MSST307	**Community engagement activity**	P	----	--	---	20	---		2
					TOTAL				26

Semester- IV									
Course				Lect. Hr /week	Dur. of Exam (in H)	Marks			Credit
Course code	Type	T/P	Name			I.A.	E.T	Total	
MSST401	Core	T	Stochastic Process & Time Series Analysis	4	2	10	40	50	4
MSST402	Core	T	Demography & Sample Survey	4	2	10	40	50	4
MSST403-1	Floating	T	Industrial Statistics (Special-I)	4	2	10	40	50	4
MSST403-2	Floating	T	Biostatistics (Special-I)	4	2	10	40	50	4
MSST403-3	Floating	T	Advanced Mathematical	4	2	10	40	50	4

			Statistics (Special-I)						
MSST404-1	DE	T	Industrial Statistics (Special-II)	4	2	10	40	50	4
MSST404-2	DE	T	Biostatistics (Special-II)	4	2	10	40	50	4
MSST404-3	DE	T	Advanced Mathematical Statistics (Special-II)	4	2	10	40	50	4
MSST405-1	DE	P	Practical Based on MSST401, 402. 403-1 &404-1	8	4	10	40	50	4
MSST405-2	DE	P	Practical Based on MSST401, 402. 403-2& 404-2	8	4	10	40	50	4
MSST405-3	DE	P	Practical Based on MSST401, 402. 403-3& 404-3	8	4	10	40	50	4
MSST406	Project/ Term paper	N.A.	N.A.	4	----	0	50	50	4
					TOTAL				24

T/P: Theory/Practical, DE: Discipline-centric Elective; GE: Generic elective

Detailed Syllabus

MSST101

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST101	Core	T	Mathematical Analysis	10	40	50	4

Mathematical Analysis **50 Marks**

Real number system, cluster points of sets, closed and open sets, compact sets, Bolzano-Weierstrass property and Heine-Borel property (statement and use), sets of real vectors *(10L)*

Sequence, series, convergence, real valued function, limit, continuity, uniform continuity, differentiability of univariate and multivariate functions *(10L)*

Sequence and series of functions, uniform convergence, power series *(5L)*
Riemann integral, Reimann Stieltjes integral, Multiple integral *(10L)*

Complex Plane, Analytic Function, Cauchy-Riemann equations, Statement of Cauchy's integral formula, Laurent's series and calculus of residue *(15L)*

References:

T. M. Apostol : Mathematical Analysis
W. Rudin : Principles of Mathematical Analysis
R. R. Goldberg : Methods of Real Analysis
J.C.Burkill : First Course of Mathematical Analysis
Ahlfors : Complex Analysis

MSST102

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST102	Core	T	Probability Theory	10	40	50	4

Probability Theory **50 Marks**

Axiomatic definition of probability, Conditional probability, Bayes' theorem and subjective probability, Concept of independence *(7L)*

Random variables, distribution function, expectation, moments, cumulants, moment inequalities and probability inequalities, generating functions – m.g.f. and p.g.f. *(8L)*

Basic univariate distributions, Standard discrete and continuous distributions like

uniform, normal, Cauchy, exponential, gamma, beta, Weibull, log-normal, Binomial, Poisson, negative binomial, hyper geometric, Mixture, compound and truncated distributions *(10L)*

Bivariate distributions, Joint, marginal and conditional p.m.f.s and p.d.f.s, Conditional expectation, correlation and regression. Bivariate normal distribution and its properties *(5L)*

Multinomial distribution *(2L)*

Characteristic functions, inversion theorem, uniqueness theorem (statement only) *(4L)*

Sequence of random variables, almost sure convergence, convergence in pth mean, convergence in probability, convergence in distribution, continuity theorem of characteristic function (statement and use). Borel-Cantelli lemma, Weak law and strong law of large numbers for i.i.d. sequences, CLT for i.i.d. case and CLT for independent case (statement and use) *(14L)*

References:

A. K. Basu : Measure theory and Probability
B. R. Bhat : Modern Probability Theory
P. Billingsley : Probability and Measure
J. F. C. Kingman & S. J. Taylor : Introduction to Measure and Probability
W. Feller :Introduction to Probability Theory; Vol. I and II
R. G. Laha & V. K. Rohatgi : Probability theory

MSST103

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST103	Core	T	Statistical Methods & Measure Theory	10	40	50	4

MSST103 –

Statistical Methods **25 Marks**

Scale of measurement, compilation and presentation of data, charts and diagrams, exploratory data analysis *(7L)*

Bivariate data, simple correlation, regression, correlation index, correlation ratio, intra-class correlation, rank correlation *(7L)*

Analysis of categorical data, odds ratio *(4L)*

Multivariate data, multiple regression, multiple and partial correlation *(7L)*

References:

D.C. Hoaglin, F. Mosteller, J. W. Tukey : Understanding Robust and Exploratory Data analysis

A. M. Goon, M. K. Gupta, B. Dasgupta : Fundamentals of Statistics; Vol. I and II

F. E. Croxton, D. J. Cowden, S. Klein : Applied General Statistics

G. W. Snedecor, W. G. Cochran : Statistical Methods

Measure Theory **25 Marks**

Classes of sets, fields, sigma fields, minimal sigma field, Borel sigma field, sequence of sets, limsup and liminf of a sequence of sets. Measure, properties of a measure. Caratheodory extension theorem (statement only), Lebesgue and Lebesgue-Stieltjes measure *(9L)*

Measurable functions, sequence of measurable functions, integration of a measurable function with respect to a measure, monotone convergence theorem, Fatou's lemma, dominated convergence theorem *(10L)*

Radon-Nikodym theorem (statement and use), Product measure and Fubini's theorem (statement and use) *(6L)*

References:

A. K. Basu : Measure theory and Probability
P. Billingsley : Probability and Measure
J. F. C. Kingman & S. J. Taylor : Introduction to Measure and Probability

MSST104

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST104	Core	T	Optimization Techniques & Statistical Quality Management	10	40	50	4

MSST104 –

Optimization Techniques **25 Marks**

Mathematical Programming Problem, formulation of Linear Programming problem, convex set, hyper planes, development of simplex algorithm, artificial variables technique *(7L)*

Duality and its economic interpretation, primal dual algorithm, dual simplex algorithm *(7L)*

Transportation problem *(5L)*

Non-linear programming: Lagrange multiplier technique and Kuhn – Tucker conditions, Quadratic programming *(6L)*

References:

H. A. Taha : Operational Research
D. T. Phillips, A. Ravindran and J. Solberg: Operations Research: Principle and Practice
G. Hadley : Linear Programming
G. Hadley : Non-linear and Dynamic Programming

Statistical Quality Management **25 Marks**

General concept of quality, role of SQM *(2L)*

Rational subgroup and Shewhart's control chart technique (attribute and variable), OC and ARL, modified control chart, cusum control chart for mean *(10L)*

Product control, acceptance sampling plan by attributes, single, double, multiple and sequential sampling plans, OC and ASN functions, AQL and ATI, acceptance sampling by variables, continuous sampling plan *(8L)*

Process capability analysis, Capability indices–C_p, C_{pk} and C_{pm} estimation for normally distributed characteristic *(5L)*

References:

D. C. Montgomery: Introduction to Statistical Quality Control
G. B. Wetherill : Sampling Inspection and Quality Control

MSST105

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST105	Core	P	R Programming	10	40	50	4

MSST105 –

R Programming **50 Marks**

Data types in R.
R Graphics.
Basic statistics using R.
Vector matrix operations :Simple matrix operations; Linear equations and eigen values, Matrix decomposition – LU, QR and SVD; Matrix inverse and G inverse; Finding a basis, orthonormalisation, finding rank.

Linear models : the lm function; ANOVA/ ANCOVA/ regression, models, the summary function, goodness of fit measures, predicted values and residuals; the ANOVA table, confidence intervals and confidence ellipsoids; Multiple testing. Random number generation & Simulations.
Programming in R.
Useful libraries: MASS, optim, maxLik, dplyr, ggplot2.

References:

P. Dalgaard : Introductory Statistics with R, Springer, 2nded, 2008.
J. Maindonald & J. Braun : Data Analysis and Graphics Using R , Cambridge University Press, Cambridge, 2nd edition, 2007.
J.J. Faraway : Linear Models with R,Chapman& Hall/CRC Texts in Statistical Science.

MSST106

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST106	Core	P	Practical Based on MSST102, 103 and 104	10	40	50	4

MSST106- Practical Based on MSST102,103and104 50 Marks

Practical Based on **MSST 102, 103 and 104**

MSST201

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST201	Core	T	Sampling Distributions & Inference - I	10	40	50	4

Sampling Distributions 25 Marks

Functions of random variables and their distributions using Jacobean of the transformation and other tools *(7L)*

Sampling distribution and standard error, Sampling distributions arising from univariate distributions (central and non-central cases) *(8L)*
Order Statistics-their distributions and properties, joint and marginal distributions of order statistics, Distributions of functions of order statistics *(7L)*

Sampling distribution of Simple regression coefficients distributions, simple correlation and multiple correlation distributions (without derivations) (3L)

References:

R. V. Hogg and A. T. Craig : Introduction to Mathematical Statistics
P.G. Hoel, S. C. Port and C. T. Stone: Introduction to Probability Theory
A.M.Goon,M.K.Gupta,B.Dasgupta:AnOutlineofStatisticalTheory;Vol.IandII
N. L. Johnson and S. : Distributions in Statistics; Vols. I, II, III, IV
Kotz H. Cramer : Mathematical Methods of Statistics
S.S. Wilks : Mathematical Statistics

Inference – I **25 Marks**

Properties of estimator, mean square error and minimum MSE estimator, unbiasedness and minimum variance unbiased estimator, Rao-Cramer lower bound of variance, statement of Bhattacharya's bound *(5L)*

Data reduction, sufficiency, factorization theorem and its illustration, concept of minimal sufficiency, Exponential family *(4L)*

Completeness, bounded completeness, Rao-Blackwell and Lehmann-Scheffe theorems *(3L)*

Methods of estimation: method of moments, method of maximum likelihood *(3L)*

Introduction to testing of hypothesis, Null and alternative hypotheses, Simple and composite hypotheses, Two kinds of error, Concepts of level of significance and power of a test, p-value of a test *(4L)*

Neymann Pearson Lemma, Heuristic approach of derivation of tests from Binomial, Poisson, Univariate and Bivariate normal distributions *(6L)*

References:

S. Zacks : The Theory of Statistical Inference
C. R. Rao : Linear Statistical Inference and its Applications
E. L. Lehmann : Theory of Point Estimation
Hogg and Craig : Introduction to Mathematical Statistics
A. M. Goon, M. K. Gupta, B. Dasgupta : Fundamentals of Statistics; Vol. II

MSST202

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST202	Core	T	Multivariate Techniques	10	40	50	4

Multivariate Techniques **50 Marks**

Multivariate normal distribution and its properties, MLEs of parameters *(7L)*

Distribution of sample mean vector, Wishart matrix-its distribution (with out derivation) and properties, Null distribution of Hotelling T^2 statistic and its application (including simultaneous confidence interval), Mahonalobis D^2 statistic, Union-intersection principle (application only) *(10L)*

MANOVA (one way and two way): statement and use, Wilk's Λ criteria *(4L)*

Distribution of QF under normality, Cochran's theorem. *(3L)*

Classification and discrimination procedures for discrimination between two multivariate normal populations- sample discriminant function, tests associated with discriminant functions, probabilities of misclassification and their estimation *(10L)*

Principal components, Canonical variables and canonical correlation *(6L)*

Factor analysis, estimation of factor loading, factor rotation *(6L)*

Cluster analysis *(4L)*

References:

C. R. Rao : Linear Statistical Inference and its Applications

T. W. Anderson : Introduction to Multivariate Analysis
A. M. Khirsagar : Multivariate Analysis
S. S. Wilks : Mathematical Statistics
M. S. Srivastava & C. G. Khatri : Introduction to Multivariate Statistics
R. J. Muirhead : Aspects of Multivariate Statistical Theory
G. A. F. Seber : Multivariate Observations

Goldstein and Dillon : Multivariate Analysis

Anderberg : Cluster Analysis

D. J. Bartholomew, M. Knott : Latent Variable Models and Factor Analysis

MSST203

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST203	Core	T	Linear Model & Design of Experiments-I	10	40	50	4

Linear Model **25 Marks**

A brief review of linear algebra: vector spaces and matrices, characteristics roots and vectors of square matrices, quadratic forms and their canonical reduction, g-inverse *(6L)*

Gauss-Markov model: Estimation space and error space, estimable function, BLUE and related results, BLUEs, Least Square estimation, Gauss- Markov Theorem. Sum of squares due to a test of linear functions. Description of F test for a general linear hypothesis (proof is not required). Linear models for correlated errors *(9L)*

ANOVA: fixed, random and mixed effects model, ANCOVA *(7L)*
Multiple comparison, S-method and T-method of multiple comparison *(3L)*

Reference:

H. Scheffe : Analysis of Variance
A. M. Goon, M. K. Gupta, B. Dasgupta : Fundamentals of Statistics; Vol-II
A. M. Goon, M. K. Gupta, B. Dasgupta :An Outline of Statistical Theory; Vol-II
S. R. Searle : Linear Models
N. C. Giri : Analysis of Variance
C. R. Rao : Linear Statistical Inference and its Applications

Design of Experiments-I **25 Marks**

Basic principles of design, elimination of heterogeneity in one and two directions, CRD, RBD, LSD *(7L)*

Missing plot, Split plot, Strip plot techniques *(8L)*

Factorial experiment, Confounding and balancing in symmetric factorial experiments, Groups of experiments. *(10L)*

References:

H. Scheffe : The Analysis of Variance
D. D. Joshi : Linear Estimation & Design of Experiments
A. M. Goon, M. K. Gupta, B. Dasgupta : Fundamentals of Statistics; Vol.II

MSST204

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST204	Core	T	Operations Research & Reliability Theory	10	40	50	4

Operations Research **25 Marks**

Definition and scope of OR, models and their solutions, decision making under certainty, uncertainty, risk and competition *(3L)*

Game Theory: Games in normal form; pure and mixed strategies; solution of 2×2, m×2, 2×n and m×n zero sum games by dominance principles and graphical method; LP formulation of matrix games; fundamental theorem of matrix game *(5L)*

Analytical structure of inventory problems, EOQ formula of Harris and Wilson and its sensitivity analysis, extension of EOQ formula allowing quantity discounts and shortages, models with random demand, static risk models, ABC analysis *(6L)*

Replacement problems, short term and long term deterministic strategies, stochastic replacement strategies, block, age and random replacement policies, staffing problem, Travelling salesman problem *(5L)*

Queuing models-specifications and effectiveness measure, M/M/1and M/M/C queues and their steady state solutions, waiting time distribution for M/M/1 queue *(6L)*

References:

H. A. Taha : Operational Research
D. T. Phillips, A. Ravindran and J. Solberg : Operations Research: Principle and Practice
C. Gross and C. M. Harris : Fundamentals of Queuing Theory

Reliability Theory **25 Marks**

Reliability concepts and measures, parallel and series system *(5L)*

Life distribution, reliability function, hazard rate, means remaining life, common life distributions *(10L)*
Life testing experiment involving exponential and Weibull distributions (both complete and censored cases), Estimation and confidence interval for reliability, Two models proportional hazard and the location-scale models for exponential and Weibull distributions. *(10L)*

References:

R. E. Barlow and F. Proschan : Statistical Theory of Reliability and Life Testing
J. F. Lawless : Statistical Models and Methods for Lifetime Data

MSST205

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST205	Core	P	Practical Based on MSST 201-204	10	40	50	4

Practical Based on MSST201-204 **50Marks**

Practical Based on MSST201-204

MSST206

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST206	Core	P	Python Programming	10	40	50	4

Python Programming **50 Marks**

Basic Idea; Simple Syntax; Basic Operations; Different Libraries; Function; Loop; Array; Data handling and management; Chart and Diagrams; Random Number Generation from a known and unknown distribution; Simulation; Application in various Statistical field; Idea of Parallel Computing and/or Efficient Programming

MSST301

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST301	Core	T	Inference-II	10	40	50	4

Inference-II **50 Marks**

Randomized and non randomized tests, Neyman- Pearsonian theory of testing of hypothesis, Neyman- Pearson fundamental lemma, Generalised NP lemma MP, UMP, and LMP tests, unbiasedness, UMPU test *(8L)*

Families of distributions with monotone likelihood ratio property, exponential family of distributions *(5L)*

Test for composite hypothesis, similar test and test with Neyman structure, case involving nuisance parameter *(5L)*

Ancillary statistics, Basu's theorem and its applications *(4L)*

Likelihood ratio test for standard univariate continuous distributions. *(5L)*

Large sample tests using variance stabilizing transformations, Pearsonian chi-square *(5L)*

Standard non parametric tests for one and two sample problem and for independence *(7L)*

Theory of interval estimation, UMA, UMAU confidence intervals, shortest expected length confidence interval *(4L)*

Sequential procedures, Wald's SPRT and its properties, fundamental identity, OC and ASN functions, optimality of SPRT *(4L)*

An introduction of inference procedure based on random effects (3L)

References:

E. L. Lehman : Testing of Statistical Hypotheses
Gibbon : Non parametric Inference
T. S. Ferguson : Mathematical Statistics
B. K. Ghosh : Sequential Tests of Statistical Hypotheses
D. A. S. Fraser : Nonparametric methods in Statistics
J. O. Berger : Statistical Decision Theory and Bayesian Analysis
A. Wald : Sequential Analysis

MSST302

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST302	Core	T	Regression Analysis & Design of Experiments-II	10	40	50	4

Regression Analysis **25Marks**

Gauss-Markov regression model and related results *(4L)*

Test of fitness of a model, residuals and their plots, detection of outliers, influential observations, leverage, measures of influences, Cook's distance, Welsch and Kuh measure, Hadis's influence measure *(9L)*
Departure from Gauss-Markov setup: heteroscadasticity, multicollinearity, autocorrelation; non normality: detection and remedies *(9L)*

An introduction of regression analysis with correlated errors. (3L)

References:

R. D. Cook & S. Weisberg :Residual and its Influence in Regression
N. R. Draper & H. Smith : Applied Regression Analysis
J. Johnston : Econometric Methods
H. D. Vinod & A. Ullah : Recent Advances in Regression Methods
D. A. Belsley, Kuh & Welsch : Regression Diagnostics data & sources of collinearity
D. Gujarathi : Basic Econometrics
G. G. Judge, R. C. Hill, W. E. Griffith, H. Lutkepohl & T. C. Lee : The Theory and Practice of Econometrics

Design of Experiments- II **25 Marks**

Analysis of non-orthogonal design, General Block designs and its information matrix(C), Connectedness, Orthogonality and balancing, intrablock analysis of BIBD, resolvable and affine resolvable designs, Recovery of interblock information in BIBD, PBIB design (group divisible only). An introduction of correlated block designs. *(14L)*

Lattice and Youden square designs, Intra block analysis *(4L)*

Introduction to optimality of designs *(4L)*

First-order response surface designs and its extension with correlated errors. (3L)

References:

M. C. Chakraborty : Mathematics of Design and Analysis of Experiments
A. Dey : Theory of Block Designs
D. C. Montogomery : Design and Analysis of Experiments
D. Raghabarao: Constructions and Combinatorial Problems in Design of Experiments

MSST303

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST303	Core	P	Practical Based on MSST301 & 302	10	40	50	4

Practical based on MSST301 & 302 **50 Marks**

Practical based on MSST301 & 302

MSST304-1

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST304-1	GE	T	Biostatistics	10	40	50	4

Biostatistics **50 Marks**

Types of statistical data: primary and secondary data, Classification, Tabulation and Diagrammatic representation of data, Frequency Distribution, Cumulative Distribution and

their graphical representation, Histogram, Frequency Polygon, Frequency Curve and Ogive *(6L)*

Measures of central tendency: Arithmetic geometric and harmonic mean, median and mode *(6L)*

Measures of dispersion: Mean Deviation, Variance, moments, skewness and kurtosis and their measures based on quantiles and moments *(6L)*

Correlation Coefficient and its Properties, Spearman's Rank Correlation Coefficient, Correlation and Regression Analysis- Bivariate and Multivariate, Fitting of Linear and Polynomial equations by the principle of Least Squares. (7L)

Analysis of Variance and Covariance: Bivariate and Multivariate (5L)

Binomial, Poisson and Normal distributions (5L)

Testing of Hypotheses: Null and Alternative hypotheses, Types of Errors, Critical Region, Level of Significance, Power and p-values, Exact tests of hypotheses under Normal set-up for a single mean, a single variance, the equality of two means and the equality of two variances *(10L)*

Chi square test of goodness of fit, Chi square analysis of contingency table. *(5L)*

References:

H. Scheffe : The Analysis of Variance
D. D. Joshi : Linear Estimation & Design of Experiments
N. Ravishankar and D. K. Dey : A First Course in Linear Model Theory
S. C. Gupta and V. K. Kapoor : Fundamental of Mathematical Statistics
A. M. Goon, M. K. Gupta, B. Dasgupta : Fundamentals of Statistics; Vol.II
V. K. Rohatgi and A. K. Md. Ehsanes Saleh : An introduction to Probability and Statistics

MSST304-2

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST304-2	GE	T	Elementary Stochastic Process and Time Series	10	40	50	4

Elementary Stochastic Process **25 Marks**

Introduction, Stationary process, Markov process *(2L)*
Markov chain with finite state space and countable state space, Classification of states, Chapman-Kolmogorov equation, Calculation of n-step transition probability matrix and its limit, Stationary distribution of Markov chain. *(10L)*
Continuous time Markov chains, Poisson process, Pure birth process, pure death process, Birth and death processes, Renewal theory, Elementary Renewal theorem,

Statement and uses of Key Renewal theorem *(10L)*
Branching process, Probability of ultimate extinction and distribution of population size
(3L)

References:

J. L. Doob : Stochastic Processes
S. Karlin & H. M. Taylor :A First Course in Stochastic Process, Vol. I
J. Medhi : Stochastic Processes
D. R. Cox : Renewal Theory
S. Ross : Stochastic Processes

Elementary Time Series Analysis **25 Marks**

Introduction to time series data, Determination of trend and seasonal components, Stationary time series, Variate difference method (9L)
Autocorrelation and partial autocorrelation functions, Correlogram analysis (7L)
Moving Average and Autoregressive processes, Forecasting techniques: Box-Jenkins model (9L)

References:

C. Chatfield : The Analysis of Time Series – An Introduction
G. E. P. Box & G. M. Jenkins :Time Series Analysis–Forecasting and Control
A. Pankratz : Forecasting with Univariate Box-Jenkins Model
N. H. Chen : Time series, applications to finance

MSST304-3

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST304-3	GE	T	Numerical Methods and Matrix Algebra & Statistical Computing	10	40	50	4

Numerical Methods and Matrix Algebra **25 Marks**

Numerical Methods:
Iterative Methods: Roots of transcendental equations using Bisection, Newton-Raphson and other methods; convergence of solutions *(3L)*
Simultaneous solutions of system of linear equations: Gauss elimination method and pivoting, ill-conditioned equations and refinement of solutions, Gauss-Seidal Iterative method *(3L)*
Interpolation with equal and unequal intervals: Newton-Gregory interpolation formula with equal intervals, Newton's and Lagrange's formula for unequal intervals, spline interpolation *(4L)*
Numerical Differentiation and integration: classical formula for equally spaced

abscissa,Simpson's1/3and3/8rules,Trapezoidal'srule,Rombergintegration, Gauss'squadratureformula,MonteCarlomethodofmultidimensionalintegrals*(5L)*

Matrix Algebra:
Notation and definition of a matrix, types of matrices, transpose of a matrix, determinants of a matrix, inverse of a matrix, elementary transformations of matrices, solution of system of linear equations by matrix method, rank of a matrix, eigenvalues and eigen vectors *(10L)*

Statistical Computing **25 Marks**

Descriptive Statistics- Types of statistical data, Classification, Tabulation and Diagrammatic representation of data, Frequency Distribution, Cumulative Distribution and their graphical representation, Histogram, Frequency Polygon, Frequency Curve and Ogive, concepts of central tendency and dispersion: relative dispersion,skewnessandkurtosisandtheirmeasuresbasedonquantilesand moments; Bivariate frequency distribution: scatter diagram, product moments, correlation coefficients and its properties (statements only), limitations of the correlation coefficient, Spearman's and Kendall's rank correlation coefficients regression lines, Multivariate frequency distributions: Multiple correlations, partial correlations, multiple correlation coefficients in terms of total and partial correlation coefficients, Multiple linear regressions. *(15L)*

Basic Principles of Statistical Inference- Random Variables and their expectations and variances, Univariate theoretical distributions: Binomial, Poisson and Normal distributions; Point and interval estimation of the parameters, maximum likelihood method of point estimation; testing of hypothesis: null and alternative hypothesis, critical region, two types of errors. *(5L)*

Random Sampling and Sampling Distributions: Simple random sampling (with and without replacement), expectations and standard errors of sample mean and sample proportion, random sampling from probability distributions. *(5L)*

References:
S. C. Gupta and V. K. Kapoor : Fundamental of Mathematical Statistics
A. M. Goon, M. K. Gupta and B. Dasgupta: Fundamentals of Statistics; Vol. II
V. K. Rohatgi and A. K. Md. Ehsanes Saleh: An introduction to Probability and Statistics

MSST304-4

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST304-4	GE	T	Business Statistics	10	40	50	4

Business Statistics **50 Marks**

Types of statistical data: primary and secondary data, Classification, Tabulation

and Diagrammatic representation of data, Frequency Distribution, Cumulative Distribution and their graphical representation, Histogram, Frequency Polygon, Frequency Curve and Ogive *(7L)*

Measures of central tendency: Arithmetic geometric and harmonic mean, median and mode *(4L)*

Measures of dispersion: Mean Deviation, Variance, moments, skewness and kurtosis and their measures based on quantiles and moments *(6L)*

Correlation Coefficient and its Properties, Spearman's Rank Correlation Coefficient, Correlation and Regression Analysis- Bivariate and Multivariate, Fitting of Linear and Polynomial equations by the principle of Least Squares. *(8L)*

Random Experiments and Random Events, Classical definition of Probability, Conditional Probability, Independence of Events and Bayes Theorem *(4L)*

Random Variable and its Probability Distribution, Cumulative Distribution Function, Probability Mass Function and Probability Density Function, Mathematical Expectation, Variance and Moments, Simple Theorems including theorems on expectation and variance of a sum of random variables and expectation of product of Random Variables *(5L)*

Binomial, Poisson and Normal distributions, Testing of Hypotheses: Null and Alternative hypotheses, Types of Errors, Critical Region, Level of Significance and Power of a test, p-values, Tests of hypotheses for a single mean, a single variance of a Normal Distribution, testing equality of two means and the equality of two variances of two Normal distributions *(8L)*

Chi square test of goodness of fit, Chi square analysis of contingency table *(5L)*

Introduction to time series data, Determination of trend and seasonal components, Stationary time series, Correlogram analysis (3L)

References:

M. Ravishankar and D. K. Dey :A First Course in Linear Model Theory
S. C. Gupta and V. K. Kapoor : Fundamental of Mathematical Statistics
A. M. Goon, M. K. Gupta, B. Dasgupta : Fundamentals of Statistics; Vol.II
C. Chatfield : The Analysis of Time Series – An Introduction
G. E. P. Box & G.M. Jenkins: Time Series Analysis – Forecasting and Control
M. W. Trosset :An Introduction to Statistical Inference and Its Applications
V.K. Rohatgi and A. K. Md. Ehsanes Saleh: An introduction to Probability and Statistics

MSST305-1

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST305-1	DE	T	Advanced Statistical Methods	10	40	50	4

Advance Statistical Methods **50 Marks**

Overview and comparison of the three paradigms–frequentist approach, data analytic approach and Bayesian approach *(3L)*
Choice of priors *(3L)*
Bayesian Inference–estimation, testing, interval estimation and prediction for some common models and common priors. *(7L)*
Hierarchical and Empirical Bayes. Bayesian Computation *(5L)*
Generalised linear models, analysis of binary and group data by using logistic models, loglinear models; discrete data analysis using Poisson regression; An introduction of mixed linear models and joint generalized linear models. *(7L)*
Nonparametric regression, interpolating and smoothing splines for simple regression, use of cross validation, application to logistic and Poisson regression *(7L)*
Analysis of longitudinal data *(5L)*
Introduction to Jack knife and Bootstrap–methods for estimating bias and standard error based i.i.d. random variables. Standard examples *(6L)*
Relationship of jackknife with bootstrap *(3L)*
Applications of boot strap to some special problems *(4L)*

References:

J. O. Berger :Statistical Decision Theory and Bayesian Analysis
C. P. Robert : The Bayesian Choice
B. Efron :The Jackknife, the Boot strap and other Sampling Plans
B. Efron : Bootstrap methods – another look at jackknife
B. Efron & R. J. Tibshirani: An Introduction to the Bootstrap
J. Shao & D. Tu : The Jackknife and Bootstrap
A. Agresti : Categorical Data Analysis (2nd edition)
G. M. Fitzmaurice, N. M. Laird and J. H. Ware: Applied Longitudinal Analysis

MSST305-2

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST305-2	DE	T	Advanced Probability Theory	10	40	50	4

Advanced Probability Theory **50 Marks**

Uniform integrability, applications *(8L)*
Conditional expectations and their properties (with proofs), Regular conditional probabilities and distributions *(10L)*
Discrete parameter martingales: filtrations, martingales, sub-, super-, reversed-martingales, examples, maximal inequality, up crossings inequality, convergence theorems, stopping times, optional sampling. Applications *(20L)*
Stationary processes, second-order processes, spectral distribution *(12L)*

References:

S. Resnick : A Probability Path, Birkhäuser;5th ed.
D. Williams : Probability with martingales
K. L .Chung : A Course in ProbabilityTheory,3rd ed.
K. B. Athreya & S. N. Lahiri : Probability Theory
Y. S. Chow & H. Teicher : Probability Theory: Independence, Interchangeability, Martingales,3rd edition

MSST306-1

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST306-1	DE	P	Practical Based on MSST305-1	10	40	50	4

Practical based on MSSTAT305-1 **50 Marks**

Practical based on MSSTAT305-1

MSST306-2

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST306-2	DE	P	Practical Based on MSST305-2	10	40	50	4

Practical based on MSSTAT305-2 **50 Marks**

Practical based on MSSTAT305-2

MSST307

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST307			Social outreach				

MSST401

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST401	Core	T	Stochastic Process & Time Series Analysis	10	40	50	4

Stochastic Process **25 Marks**

Introduction, Stationary process, Markov process *(2L)*
Markov chain with finite state space and countable state space, Classification of states, Chapman-Kolmogorov equation, Calculation of n-step transition probability matrix and its limit, Stationary distribution of Markov chain, Random walk and Gambler's ruin problem *(10L)*
Continuous time Markov chains, Poisson process, Pure birth process, pure death process, Birth and death processes, Renewal theory, Elementary Renewal theorem, Statement and uses of Key Renewal theorem *(10L)*
Branching process, Probability of ultimate extinction and distribution of population size *(3L)*

References:

J. L. Doob : Stochastic Processes
S. Karlin & H. M. Taylor : A First Course in Stochastic Process , Vol.I
J. Medhi : Stochastic Processes
D. R. Cox : Renewal Theory
S. Ross : Stochastic Processes

Time Series Analysis **25 Marks**

Introduction to time series data, Determination of trend and seasonal components, Stationary time series, Variate difference method *(7L)*
Autocorrelation and partial autocorrelation functions, Correlogram analysis *(5L)*
Moving Average and Autoregressive processes, Forecasting techniques: Box-Jenkins model *(7L)*
ARCH and GARCH models *(6L)*

References:

C. Chatfield : The Analysis of Time Series – An Introduction
G. E. P. Box & G. M. Jenkins :Time Series Analysis– Forecasting and

Control

A. Pankratz : Forecasting with Univariate Box-Jenkins Model
N. H. Chen : Time series, applications to finance

MSST402

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST402	Core	T	Demography & Sample Survey	10	40	50	4

Demography **25 Marks**

Sources of demographic data: census and registration *(3L)*

Measurement of mortality and morbidity, graduation of mortality rates *(5L)*
Life table; Model life tables, complete and Abridged life tables and their methods of construction *(5L)*
Measurement of fertility and reproduction and their uses, Stable and stationary population *(4L)*
Internal and international migration, inter censal and post censal estimates *(3L)*
Population growth, population estimation and projection, Logistic curve and related methods of testing *(5L)*

References:

A. K. Chattopadhyay & A. K. Saha : Demography: techniques and analysis
C .L. Chiang : Introduction to Stochastic Processes in Biostatistics
P. R. Cox :Demography
H. S. Shryocket.al. : The Methods and Materials of Demography
N. Keyfitz : Applied Mathematical Demography
S. Biswas : Introduction to Stochastic Processes in Biostatistics and Demography

Sample Survey **25 Marks**

Probability sampling from a finite population---notions of sampling design, sampling scheme, inclusion probabilities; some problems of sampling design construction based on inclusion probabilities *(3L)*

Basic sampling schemes—Simple random sampling with and without replacement, Unequal probability sampling with and without replacement, Systematic sampling. Related estimators of population total/mean, their variances and variance estimators– Mean per distinct unit in simple random with replacement sampling, Des Raj and Murthy's estimator (for sample of size two) in unequal probability sampling without replacement. *(8L)*

Stratified sampling – Allocation problem and construction of strata (optimal, proportional and equal allocation) *(3L)*
Ratio, Product, Difference and Regression estimators, Unbiased Ratio estimators –

Probability proportional to aggregate size sampling *(3L)*
Sampling and sub-sampling of clusters, Two-stage sampling with equal/unequal number of second stage units and simple random sampling without replacement / unequal probability sampling with replacement at first stage, Ratio estimation in two-stage sampling. *(5L)*
Double sampling for stratification, Double sampling ratio and regression estimators, Sampling on successive occasions *(3L)*

References:

W. G. Cochran : Sampling Techniques, 3rd ed.
Des Raj & Chandak : Sampling Theory
A.S. Hedayat ,& B. K. Sinha : Design and inference in finite population sampling
P. Mukhopadhyay : Theory and Methods of Survey Sampling
M. N. Murthy : Sampling Theory and methods

MSST403-1

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST403-1	Floating	T	Industrial Statistics (Special-I)	10	40	50	4

Industrial Statistics (Special I) **50 *Marks***

Advanced Statistical Quality Management and Industrial Experimentation

Advanced Statistical Quality Management:

Quality systems; ISO9000 standards; concept of six–sigma and define–measure–analyse–control–improve approach *(3L)*

Precision and accuracy of measurement systems, estimation of measurement uncertainty *(3L)*
Multivariate Quality control, use of control ellipsoid and utility functions *(5L)*
Qualityatdesignstage,qualityfunctiondeployment,failuremodeandeffectanalysis, Conjoint analysis *(4L)*
Service Quality assessment, SERVQUAL model *(5L)*
Warranty data analysis and customer satisfaction *(5L)*

Industrial Experimentation: Quality engineering: Quality, System, parameter and tolerance designs, Signal-to-noise ratio, Taguchi's approach to quality engineering and off-line control, Stages of new product development, Quality management vis a vis quality engineering, Procedure for quality problem-solving, A strategy for quality improvement by team effort. *(4L)*
Framework of experimental design, One-factor-at-a-time experiment, Two-factor factorial design, Classification of experimental designs, Planning and analysis of fractional factorial experiments, Advancement of robust design. *(5L)*
Orthogonal array experiments: Structure and use of two-level and three-level orthogonal

arrays, Linear graphs, Column-merging method, Classification of orthogonal arrays, Dummy-level techniques, Combination designs, Branching design, Numerical examples. *(9L)*

Response surface experiments, First order and Second order design, orthogonal design, analysis, response surface designs for fitting second order models, desirable properties of response surface designs, and itsrolein quality improvement; Study of correlated response surface designs. *(7L)*

References:

D. C. Montgomery: Introduction to Statistical Quality Control
G. B. Wetherill: Sampling Inspection and Quality Control
W. Blischke and D. N. P. Murthy: Product Warranty Handbook
W. Blischke and D. N. P. Murthy: Warranty Cost Analysis
V. A. Zeithaml, A. Parasuraman and L. L. Berry: Delivering Quality Service (Balancing Customer Perceptions and Expectations)
S. H. Park: Robust Design and Analysis for Quality Engineering.
A. Dey: Theory of Block Designs
D. C. Montogomery: Design and Analysis of Experiments
Box, G.E.P. and Draper, R.N.(1987): Empirical model building and Response Surface
Box,G.E.P.andDraper,R.N.(2007):ResponseSurfaces,MixturesandRidgeAnalyses
Khuri, A. I. and Cornell, J. A.(1996): Response Surface
G.C.Tiao,S.Bisgaard,W.J.Hill,andD.Peña(2000):BoxonQualityandDiscovery: with Design, Control, and Robustness

MSST403-2

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST403-2	Floating	T	Biostatistics (Special-I)	10	40	50	4

Biostatistics (Special I) **50 Marks**

Survival Analysis, Risk Analysis and Clinical Trials

Concepts of time, various censoring mechanism and likelihood in those cases *(6L)*
Parametric inference: Point estimation, confidence intervals, scores, likelihood ratio tests for selected parametric models *(10L)*
Estimation of survival function from censored data: Acturial estimator, Kaplan-Meier and Nelson – Aalen estimators *(8L)*
Regression model for survival data, Cox's proportional hazard model with one and multiple covariates, Accelerated failure time model *(10L)*

Competing risk theory, Multivariate survival models; Random effects models for survival data analysis. *(8L)*

Clinical trials: General concepts, some useful designs and analysis of clinical trials, use of prognostic factors *(8L).*

References:

R. E. Elandt– Johnson and N. L. Johnson: Survival models and data analysis
D. R. Cox and D. Oakes : Analysis of survival data
A. J. Gross and V. A. Clark : Survival distribution: Reliability application in the Bio – medical Sciences
R. G. Miller : Survival Analysis
E. T. Spurgeon : Life contingencies
J. L. Fleiss : Design and Analysis of Clinical Experiments
E. T. Lee : Statistical Methods for Survival data Analysis

MSST403-3

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST403-3	Floating	T	Advanced Mathematical Statistics (Special-I)	10	40	50	4

Advanced Mathematical Statistics (Special-I) ***50 Marks***

Advanced Design of Experiments

Finite Group and finite field, Finite Geometry – projective and Euclidean, Construction of complete set of MOLS, Construction of BIBD using MOLS, finite geometry and Bose's difference method. *(8L)*
PBIB Design, Concepts of association schemes, two associated PBIB design, Group divisible designs, Intra Block Analysis. *(8L)*
Fractional factorial design for 2^k experiment, Resolution III, IV and V fractions 2^k experiments, Orthogonal arrays, Construction of orthogonal arrays involving Three level factors. *(9L)*
Optimality of BIBD in simple set ups *(5L)*
Response Surface Methodology, First and second order response surface designs, Conditions of rotatability, Construction and analysis of rotatable designs within dependent errors; Second order Slope rotatable designs within dependent errors; Blocking of response surface designs, Optimal designs among first order regression designs. *(15L)*
Weighing designs, Optimum chemical balance and spring balance weighing design, H_N matrices: its construction and uses; Advanced Design of Experiments some problems of correlated block and response surface designs**.** *(5L)*

References:

D. Raghavarao : Constructions and Combinatorial Problems in Design of Experiments
R. C. Bose : Mathematical Theory of Symmetrical Factorial Design (Sankhya - Volume 8)
R. C. Bose : On the construction of Balance incomplete Blocks (Annals Eugenics- Volume9)
R. C. Bose and Shimomoto : Classification and analysis of PBIB designs with two associate class (JASA-m Volume 47)
M. C. Chakrabarty : Mathematics of design of experiments

R. H. Myers : Response Surface Methodologies
Box and Draper : Response Surface Methodologies
K. S. Banerjee : Weighing Design
Alok Dey : Block Designs
K. R. Shah and B. K. Sinha: Lecture Notes on Optimal Designs; Springer and Verlag

MSST404-1

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST404-1	DE	T	Industrial Statistics (Special-II)	10	40	50	4

Industrial Statistics (Special II) **50 Marks**

Advanced Reliability Theory and Advanced Operations Research

Advanced Reliability Theory:

Reliability of coherent systems; cut and path sets; modular decomposition; bounds on system reliability; structural and reliability importance of components. *(5L)*
Ageing properties and order relations of life distributions and their consequence; Closure of the ageing properties and order relations under reliability operations (formation of coherent system, convolution and mixture). *(6L)*
Progressive censoring, Kaplan Meier and Nelson - Aalen estimators of reliability function *(5L)*
Regression model in reliability analysis, Cox proportional hazards Model and accelerated failure time model; associated graphical techniques *(6L)*
Maintenance and replacement policies; availability of repairable systems *(3L)*

Advanced Operations Research

Queuing Theory: Steady state solutions of $E_k/M/1$andM/E_k1 queues; Imbedded Markov chain approach and steady state solution of M/G/1 and GI/M/1 queues; P-K formula Machine Interference problem; Optimization in Queuing Model. *(6L)*
Multi-item inventory subject to constraints, Dynamic risk model, P and Q system of analysis *(3L)*
Network Analysis: Drawing of network; various kinds of float and critical path determination; PERT and associated problems; role of crashing; other areas of network applications; flows in network; LP formulation of selected problems *(5L)*
Advanced mathematical programming techniques: Post optimality analysis: Sensitivity analysis; parametric programming. Integer programming: Gomory's algorithm; Branch and bound algorithm and Traveling salesman problem. Multi criterion and goal programming Stochastic Programming: two stage and chance constrained programming, typical examples *(5L)*

Sequencing: 2×n, 3×n and m×n problems; Jonson's algorithm, different routing m×2 problem *(3L)*

Simulation as a solution procedure of OR problem, random, quasi random and pseudo random numbers, tests for randomness, random number generators, static and dynamic simulation, application of simulation in various types of queuing and inventory problems, Metropolis-Hasting's algorithm and metaheuristics; Location-scale models for exponential, Weibull, Gamma and Extreme value distributions to be extended with correlated errors *(3L)*

References:

R.E. Barlow and F. Proschan: Statistical Theory of Reliability and Life
Testing J.F. Lawless : Statistical Models and Methods for Lifetime
Data Nelson : Statistical models for failure time data
P.J. Smith : Analysis of Failure and Survival data
C. Ebeling : Reliability and Maintainability Engineering
J. D. Kalbfleisch and R. L. Prentice: The Statistical analysis of failure time data (2^{nd}edition)
H.A. Taha : Operational Research
D.T .Phillips, A. Ravindranand J. Solberg : Operations Research: Principle and Practice
D. Grossand C.M. Harris : Fundamentals of Queuing Theory
Hartley : Operations Research for managerial Decisions

MSST404-2

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST404-2	DE	T	Biostatistics (Special-II)	10	40	50	4

Biostatistics (Special II) **50 Marks**

Statistical Genetics and Epidemiology

Statistical Genetics:

Mendel's laws, Estimation of allele frequencies, Hardy-Weinberg law, Mating tables, Genotype frequencies with imbreeding, Disequillibrum constant, Imbreeding coefficient, Models of natural selection and mutation, Detection and estimation of linkage (recombination), Linkage analysis: Elston-Stewart algorithm, QTL mapping. *(15L)*

Description of a DNA sequence. Pair-wise alignment-Needleman-Wunsch algorithm, Discrimination using Markov Chain, Hidden Markov Models and estimation of parameters *(10L)*

Epidemiology:

Introduction to Epidemiology, Principles of Epidemiologic investigations, Different Epidemiologic measures (risk, relative risk, odds, odds ratio, incidence, prevalence), Confoundingandinteraction(Mantel–Haenszelmethods,estimationandtests), DesignandAnalysisofEpidemiologicstudies,Epidemiologicalstudiesforcertain particular diseases; Some modeling approaches for identifying the risk factors *(25L)*

References:

D.C. Thomas : Statistical Methods in Genetic Epidemiology
D.L. Hartl : A Primer of Population Genetics
J. Ott : Analysis of Human genetic Linkage
P. Sham : Statistics in Human Genetics
R. Durbin, S. Eddyetal : Biological sequence analysis
Ben Hui Liu : Statistical Genomics
K.J. Rothman & S. Geenland : Modern Epidemiology
S.Selvin : Statistical Analysis of Epidemiologic Data
D. McNeil : Epidemiological Research Methods
J.F. Jekel, J.G. Elmore & D.L. Katz : Epidemiology, Biostatistics and Preventive Medicine

MSST404-3

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST404-3	DE	T	Advanced Mathematical Statistics (Special-II)	10	40	50	4

Advanced Mathematical Statistics (Special II) 50 Marks

Advanced Statistical Inference

Invariance procedure, symmetry and invariance, maximal invariance, most powerful invariant test, Unbiasedness and invariance, invariant and confidence sets*(15L)*
Overview and comparison of the three paradigms – classical, data analysis and Bayesian analysis, Relative advantages and disadvantages, Detailed study of Bayesian Analysis – Choice of subjective priors, conjugate and other non subjective priors, Hierarchical and Emperical Bayes methods. *(15L)*
Linear rank statistics and its asymptotic distribution under null and contiguous alternatives, statement and use of Wald–Wolfowitz–Noether theorem, Goodness of fit test and its asymptotic distribution, U – statistics and their asymptotic properties, Consistencyoftestsandasymptoticnormalityoftheststatistics,ARE–Pitmanformula. An introduction of testing of hypothesis with random effects. *(20L)*

References:

E.L. Lehman : Testing Statistical Hypothesis
T.S. Ferguson : Mathematical Statistics
J. Hajek and Z. Sidak : Theory of rank test

D. A.S. Fraser : Non Parametric methods in Statistics
J.O. Berger :Statistical Decision Theory and Bayesian Analysis
D.R. Cox and V. Oakes : Analysis of survival Data
Mc Cullagh and Nelder :Generalized Linear Model

MSST405-1

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST405-1	DE	P	Practical Based on MSST401, 402, 403-1 & 404-1	10	40	50	4

Practical Based on MSST401, 402. 403-1 & 404-1 50 Marks

Practical Based on MSST401, 402. 403-1 & 404-1

MSST405-2

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST405-2	DE	P	Practical Based on MSST401, 402, 403-2 & 404-2	10	40	50	4

Practical Based on MSST401, 402, 403-2& 404-2 50 Marks

Practical Based on MSST401, 402, 403-2& 404-2

MSST405-3

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST405-3	DE	P	Practical Based on MSST401, 402, 403-3 & 404-3	10	40	50	4

Practical Based on MSST401, 402, 403-3 & 404-3 50 Marks

Practical Based on MSST401, 402, 403-3& 404-3

MSST406

Course				Marks			Credit
Course code	**Type**	**T/P**	**Name**	**I.A.**	**E.T**	**Total**	
MSST406	Project/ Term paper	N.A.	N.A.	10	40	50	4

Project / Term paper **50 Marks**

Project:- Topic selection in consultation with the teacher; literature search from different reference books and using internet search; typed write-up with proper tables, structures, figures and literature to be submitted (approximately 25-30 pages with 12 font size);seminar lecture on this topic to be delivered in presence of all the teachers and an external subject expert