Course Specifications for the academic year 2018/2019
Special Degree

Special Degree in Mathematics - Level I
MSP3144: Mathematical Methods in Physics and Engineering-II(60 Lecture hrs)

Course Unit Code	MSP3144	**Course Unit Title**	Mathematical Methods in Physics and Engineering		
Credits	4	**Lectures / Tutorials (Hrs)**	**60**	**Pre-requisites**	
Objectives		Objectives of this course unit are to provide students with the knowledge and experience of • Laplace transformations of functions and their applications in Dynamical Systems • Fourier series (FS) approximations of periodic functions.			
Learning Outcomes		At the end of this course unit the students will be able to • Explain conditions for the existence of Laplace Transformation (LT) of a function • Find Laplace Transformations of common functions and prove properties of Laplace Transformation operator. • Find LT of different types of functions. • Find inverse LT (ILT) and study the techniques in finding ILTs of different forms of function. • Apply LTs to solve ODEs and PDEs. • Find Fourier series approximations of periodic functions.			
Course Content		Laplace Transformations, Inverse Laplace transformations, Gamma, Beta and Bessel functions and their Laplace transformations, Applications in solving ODEs and PDEs, Heat and wave functions, Fourier Series, Legendre Polynomials, Hermite function, Ricaati equation, Bessel functions of second kind.			
Method of teaching and learning: Lectures, class discussion, tutorial discussion.					
Method of Asses: Mid semester Tests: 20%, Semester End Examination - 80**%**					
References: • Laplace Transforms. Murray R. Spiegel, • Integral Transforms, M. D. Raisinghania, • An introduction to Laplace Transforms and Fourier series, Dyke, P.P.G. • Advanced Engineering Mathematics, H. K. Dass					

MSP3174: Topology (60 hrs)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP 3174</td><td>Course Unit Title</td><td colspan="3">Topology</td></tr>
<tr><td>Lectures (hrs.)</td><td>60</td><td rowspan="2">Pre-requisites</td><td rowspan="2"></td></tr>
<tr><td>Credits</td><td>4</td><td>Practical (hrs.)</td><td></td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">The objectives of this course unit is to
introduce the various topological concepts that are topology, topological spaces, open sets, closed sets, dense sets, sub-spaces, basis, sub-basis, product topology, metric spaces, hausdorff space, continuity, homeomorphism, connectedness, compactness,etc. and some of their properties.
providing her or him with an adequate language for advanced studies of mathematics, and developing skills in working with abstract concepts whose meaning are defined by various sets of axioms.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, students should be able to
work with the various topological concepts that are introduces in the course.
construct abstract arguments about topological spaces.
solve problems of a topological nature in mathematics and other fields where topological issues arise.</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Topological spaces, Basis for a Topology, The Subspace Topology, Closed Sets, Limit Points, Continuous functions, The Product Topology, The Metric Topology, Connected Spaces, Compact Spaces</td></tr>
<tr><td colspan="2">Methods of teaching and learning</td><td colspan="4">Reading material, Lectures, Tutorial Classes, Discussion</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Continuous assessment -20%
End Semester Examination -80%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">Topology by James, J.R. Munkres
General Topology, Seymour Lipschutz
General Topology, M.G. Murdeshwar
Introduction to General Topology, K.D. Joshi</td></tr>
</table>

MSP3184: Numerical Methods with Applications (60 hrs) (Credit Value 4)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP 3184</td><td>Course Unit Title</td><td colspan="3">Measure Theory with Applications</td></tr>
<tr><td>Lectures +Tutorial Discussions (hrs.)</td><td>60</td><td>Pre-requisites</td><td rowspan="2">None</td></tr>
<tr><td>Credits</td><td>4</td><td>Practical (hrs.)</td><td></td><td></td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">Measure theory and theory of the integral developed by Lebesgue at the beginning of this century found numerous applications. This course provides the essential foundations of this important aspect of mathematical analysis.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">By the end of this course you should be able to:
• Explain the term “measure” and demonstrate their basic properties.
• demonstrate the meaning of outer and inner measures with their basic properties.
• illustrate with examples the concept of algebras, sigma-algebras, measurable sets, measurable space and measure space.
• demonstrate the concept of measurable functions, with examples and some basic theorems on measurable functions.
• demonstrate the concept of Lebesgue integration both on the general measure space and the real line.
• demonstrate and apply the basic theory of integration and convergence, with the application in evaluating integrals.
• demonsatrete the product measures and product spaces and how integrals are evaluated on them with Fubini’s theorem.</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Borel – algebra, Borel subsets, Lebesgue outer measure, Lebesgue measurable subsets, Lebasque measure, Lebesgue measurable functions. Properties that hold almost everywhere, Lebesgue integral, Lebesgueintegrable functions, Monotone Convergence theorem, dominated convergence theorem, Fatou’s Lemma, Relation of Riemann and Lebesgue Integrals, Modes of convergence (topics are discussed with applications and example of probability theory) Introduction to martingales.</td></tr>
<tr><td colspan="2">Methods of teaching and learning</td><td colspan="4">Lectures, class discussion, tutorial discussion.</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Continuous assessment -20%
End Semester Examination -80%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">• Introduction to Measure Theory, by G.De Barra (1974)
• Real Analysis, by H.L. Royden (1988)
• LebesgueMeasuere and Integration, by P.K. Jain and V.P. Gupta</td></tr>
</table>

MSP321α: Advanced Group Theory (23 hrs) (Credit Value 1.5)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP321α</td><td>Course Unit Title</td><td colspan="3">Advanced Group Theory</td></tr>
<tr><td colspan="2">Lectures (Hrs)</td><td>23</td><td rowspan="2">Pre-requisites</td><td rowspan="2">MAT311β</td></tr>
<tr><td>Credits</td><td>1.5</td><td colspan="2">Practical (Hrs)</td><td>-</td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">The objective of this course unit is to provide the students the advanced concepts of Group Theory</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, the student should be able to:
Prove and apply Lagrange’s Theorem
understand and apply Isomorphism Theorems
Understand and use the concept of conjugacy
Apply Sylow’s Theorems to determine the structure of certain groups</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Advanced Theory on Groups and Subgroups:
Larange’s Theorem and Applications
Isomorphism Theorems and Applications
Concept of Conjugacy
Sylow’s Theorems and Applications</td></tr>
<tr><td colspan="2">Method of teaching and learning</td><td colspan="4">Lectures, Reading Materials, Presentations.</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Assessment Test :20% , Semester End Written Examination: 80%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">A course in Abstract Algebra – Vijay K. Kanna& S. K. Bhambri
Contemporary Abstract Algebra – Joseph A. Gallian
Abstract Algebra – Thomas W. Hungerford
Any Algebra, Abstract Algebra book</td></tr>
</table>

MSP322α: Real Analysis-IV (23 hrs) (Credit Value 1.5)

Course Unit number	MSP322α	**Course Unit Title**	Real Analysis IV		
		Lectures (hrs.)	23	**Pre-requisites**	None
Credits	1.5	**Practical (hrs.)**	-		
Course Unit Objectives		The objectives of this course unit are • to introduce techniques of performing double integrals, triple integrals and surface integrals. • Introduce applications of above integrals. • to introduce implicit functions, implicit function theorem and applications • to introduce calculus of variations and applications.			
Learning Outcomes		On completion of the course unit, students should be able to • performdouble integrals, triple integrals and surface integrals. • solve applications of above integrals • identify the difference between explicit functions and implicit functions. • prove the implicit function theorem and apply it in relevant problems. • apply calculus of variation techniques to solve relevant problems			
Course Content		More on integration on R^2, Greens theorem, Change of variables in double integrals. **Implicit function theorem:**definition, derivative of implicit functions, implicit function theorem. Stationary values under subsidiary condition. Calculus of variation			
Methods of teaching and learning		Lectures, Reading materials, Class discussions.			
Method of Assessment		Mid semester Examination20% End of Semester Examination 80%			
References		Mathematical Analysis- S.C. Malik, Savita Arora, Calculus, Elliott Mendelson, Elementary Multivariable Calculus, Bernard Kolman, William, F.Trench			

MSP324α: Complex Analysis (23 hrs) (Credit Value 1.5)

Course Unit Code	MSP324α	**Course Unit Title**		Complex Analysis	
		Lecturers/Tutorials (Hours)	23	**Prerequisites**	MAT322β
Credits	1.5	**Practical (Hours)**			
Objectives		The objectives of this course unit are to provide students with knowledge of the theory of advanced topics on complex analysis to equip with skills for problem-solving using complex analysis techniques applied to diverse situations in physics, engineering and other mathematical contexts.			
Learning Outcomes		Upon successful completion of this course unit, the students will be able to: • represent functions as Taylor and Laurent series; classify singularities and poles; find residues and evaluate complex integrals using the residue theorem. • use the residue theorem to compute several kinds of real integrals. • explain mean value property and maximum principle with examples and major theorems: Cauchy's, Liouville's and Morera's. • Construct conformal mappings between many kinds of domain and to use conformal mapping to solve the Dirichlet problem in a region. • apply the theory learnt in the course to solve a variety of problems at an appropriate level of difficulty			
Course Content		Review of elementary complex analysis topics from vector analysis: Morera's Theorem, Liouville's Theorem, Rouche's Theorem, Winding numbers, the generalized version of Cauchy's theorem, Morera's theorem, the fundamental theorem of algebra, the identity theorem, the Riemann sphere and Weierstrass-Casorati theorem, meromorphic functions, Rouche's theorem, integration by residues, Conformal mappings and its Physical applications.			
Teaching and Learning process		Through lectures and problem discussions			
Methods of Assessment		Continuous assessment -20% End Semester Examination -80%			
References		• Introduction to complex analysis by William Chen • Complex variables and applications by Churchill, Ruel V; Brown, James Word • Theory and problems of complex variables with an introduction to conformal mapping and its applications by Spiegel, Murray R. • A guide to complex variables by Krantz, Steven G. • Complex Variables: Introduction and Applications Mark Ablowitz and Athanassios Fokas. • Complex Variables: Theory and Applications, Kasana H.S., Prentice-Hall of India Pvt. Ltd, 2ndedition, 2005.			

MSP3254 Measure Theory with Applications (60 hrs) (Credit Value 4)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP 3254</td><td>Course Unit Title</td><td colspan="3">Numerical Analysis with Applications</td></tr>
<tr><td colspan="2">Lectures / Tutorials (Hr)</td><td>60</td><td>Pre-requisites</td><td></td></tr>
<tr><td>Credits</td><td>4</td><td colspan="2">Lab (Hr)</td><td></td><td></td></tr>
<tr><td>Objectives</td><td colspan="5">To provide students with the
• skills in problem solving of systems of linear equations with direct methods and numerical methods.
• knowledge of convergence criterion of iterative sequences.
• knowledge of finding solutions for differential equations (ODE and PDE) numerically.
• knowledge in errors, consistence, convergence accuracy requirements and available computational resources.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="5">On completion of the course unit, the students should be able to
• apply the numerical techniques for other Sciences and Engineering in real world problem solving.
• determine the most suitable numerical technique with appropriate initial and boundary conditions in problem solving .
• compare the solutions obtained using numerical methods.
• analyze various numerical methods relevant to errors, consistence and convergence.</td></tr>
<tr><td>Course Content</td><td colspan="5">Solving Linear systems: Matrix notation, Direct methods, Norms and the theorems related to norms, Banach lemma, Pivotal and scaling techniques, Gauss and Jordan eliminations, LU decomposition techniques. Iterative Methods - Theorems related to convergence of iterative sequences and convergence criteria, Jacobi, Gauss Seidel, SOR Methods.

Numerical solutions of ordinary differential equations (ODE):Stability of a solution, Lipschitz conditions and constants, Picard Iteration technique with applications. One step methods - Euler (explicit and implicit) and Modified Euler methods, RungeKutta method. Errors and error propagation, Order of consistence, Evolution functions. Higher order Taylor expansion for solving ordinary differential equations and Higher order Differential equations. Multi step methods- Adams Bash forth formula. Predictor corrector methods.

Numerical solutions of partial differential equations:Parabolic type, Elliptic type, Hyperbolic type using explicit and implicit finite difference methods, Upwind schemes with applications.</td></tr>
<tr><td>Method of teaching and learning</td><td colspan="5">Lectures, Reading materials, Tutorial discussions.</td></tr>
<tr><td>Method of Assessment</td><td colspan="5">Semester End Written Examination : 80%
Mid Semester Examination : 20 %</td></tr>
<tr><td>References</td><td colspan="5">• Elementary Numerical Analysis, 3rd edition, 2004, Atkinson, Kendall,Han,Weimin.
• Numerical Methods for Engineers and Scientists, 2nd edition 2007, J N. Sharma.
• Numerical Methods for Mathematics, Science and Engineering, 2000, John H Mathews.
• Numerical Analysis, 10th Edition, 2014, Richard L. Burden, J. Douglas Faires, and Annette M. Burde.</td></tr>
</table>

MSP3263: Regression Analysis (45 hrs) (Credit Value 3)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP 3263</td><td>Course Unit Title</td><td colspan="4">Regression Analysis</td></tr>
<tr><td colspan="2">Lectures (Hr)</td><td>45</td><td rowspan="2">Pre-requisites</td><td rowspan="2"></td></tr>
<tr><td>Credits</td><td>3</td><td colspan="2">Lab (Hr)</td><td></td></tr>
<tr><td colspan="2">Objectives</td><td colspan="5">The objectives of this course unit are
• to provide students with the knowledge of simple linear regression and multiple linear regression.
• to make skills in estimating and testing methods for the parameters in the models.
• to make skills in checking the inadequacy of models.
• to provide skills in using a statistical package in applying regression models and interpreting the results.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="5">On successful completion of the course unit, the students will be able to
• determine when regression analysis is the appropriate statistical tool in analysing a problem.
• understand how regression helps us to make predictions using the least squares concept.
• assess the assumptions in regression analysis.
• interpret the results of regression.</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="5">Introduction: Correlation analysis, regression and model building, use of regression, role of the computer.

Correlation Analysis: Population Correlation coefficient and sample correlation coefficient. Hypothesis testing for population correlation coefficient.

Simple Linear Regression: Simple linear regression model, least-squares estimation of the parameters, hypothesis testing on the slop and intercept, interval estimation in simple linear regression, prediction of new observations, coefficient of determination, estimation by maximum likelihood.

Multiple Linear Regression: Multiple linear regression models, Estimation of the parameters, Hypothesis testing in multiple linear regression, Confidence interval in multiple regression, prediction of new observations, multi correlation.

Model Adequacy Checking: Residual analysis, Lack of fit of the regression model.

Indicator Variables, Variable Selection and Model Building, Introduction to Nonlinear Regression, Introduction to Generalized Linear Models.</td></tr>
<tr><td colspan="2">Method of teaching and learning</td><td colspan="5">Lectures, Practical sessions, Assignments based learning as laboratory works.</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="5">Semester End Written Examination : 80%
Mid Semester Examination : 20 %</td></tr>
<tr><td colspan="2">References</td><td colspan="5">• Applied Regression Analysis, 3rd edition, 2005, Draper, Norman R. andSmith, Harry.
• Introduction to linear regression analysis, 2003, Douglas C. Montgometry, Elizabeth A Peck and G. Geoffrey Vining.</td></tr>
</table>

MSP3274 Differential Geometry and Tensor Analysis (60 hrs) (Credit Value 4)

<table>
<tr><td>Course Unit</td><td>MSP 3274</td><td>Course Unit Title</td><td colspan="3">Tensor Analysis, Differential Geometry and Theory of Manifolds</td></tr>
<tr><td>Credits</td><td>4</td><td>Lectures/Tutorials (Hrs)</td><td>Lab (Hrs)</td><td>Independent learning (hrs)</td><td>Pre-requisites</td></tr>
<tr><td>Notional hours</td><td>200</td><td>60</td><td>-</td><td>140</td><td>NONE</td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">The objective of this course unit is to give a thorough knowledge in the theories of Tensor Analysis, Differential Geometry and theory of Manifolds and their applications.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">After successfully completing this course students should be able to
• obtain the Riemann and Ricci Tensors, Gaussian and Mean curvatures, Einstein Tensor etc. for a given metric using the concepts in Tensor Analysis and Differential Geometry and
• discuss the various properties of the relevant space given by the metric.</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Tensor Analysis:
Tensor Algebra: Basic Definitions, Addition and subtraction of tensors, Multiplication of Tensors, Tensor Contraction, Symmetric and Anti-symmetric Tensors, Line Element and Metric Tensor, Associated Metric Tensor, Lowering and Raising of Indices.
Tensor Analysis: Christoffel Symbols, Covariant and Contravariant Derivatives, Riemann-Christoffel Tensor, Gaussian and mean Curvature of a Surface, Ricci-Einstein Tensor
Differential Geometry: Curves in Space, Ferret-Serret Formula, Surfaces, Tangent Plane and Normal line, First and Second Fundamental Forms, Arc length and surface area, Transformation Metric, Directional Ratios and Directional Coefficients, Orthogonal Trajectories, Dual Family of curves, Gauss and Mean curvature, Geodesics
Theory of Manifolds: Definitions, Manifolds, Differentiable manifolds, Vector fields on Manifolds, Differential forms, Multiplication of forms, The wedge product, Exterior differentiation, the Lie derivatives, the first and second Carton equations, Torsion and the curvature,the Tetrad formalism.</td></tr>
<tr><td colspan="2">Method of teaching and learning</td><td colspan="4">Teaching:Lectures, class discussion, tutorial discussion.
Independent learning: preparation for lectures/tutorials (30hrs), group discussions (15hrs), homework (50hrs), referring library books/Internet sources (45hrs).</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Mid semester tests: 20%
End Semester Examination: 80%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">• Theory and Problems of Vector and Tensor Analysis – Schaum’s outline Series
• Tensor Calculus- U.C. De, A.A. Shaikh, J. Sengupta
• Applications of Tensor Analysis-A.J. McConnel
• Theory and Problems of Differential Geometry - Schaum’s outline Series
• Elementary Differential Geometry-Barret O’Neill
• Differential Geometry – D. Somasundaram
• The Mathematical Theory of Black Holes – S. Chandrasekar</td></tr>
</table>

MSP3283 Special Topics in Statistics (eg. Multivariate Data Analysis) (45 hrs) (Credit Value 3)

<table>
<tr><td>Course Unit number</td><td>MSP3283</td><td>Course Unit Title</td><td colspan="3">Multivariate Data Analysis</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">3</td><td>Lectures (hrs.)</td><td>45</td><td rowspan="2">Pre-requisites</td><td rowspan="2">MSP313β Mathematical Statistics II
MSP316β Applied StatisticsII</td></tr>
<tr><td>Practical (hrs.)</td><td></td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">The objectives of this course unit are to
• introduce the language of multivariate data analysis
• understand the characteristics of multivariate quantitative research, including strengths and weaknesses
• understand the principles and characteristics of the multivariate data analysis techniques</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, students should be able to
• distinguish between dependence and interdependence methods in multivariate data analysis
• identify the most appropriate statistical techniques for a multivariate dataset
• carry out and apply commonly used multivariate dataanalysis techniques, and interpret results
• use statistical software packages for the analysis of multivariate data</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Multivariate data and multivariate statistics: Introduction, Types of data, Basic multivariate statistics, The aims of multivariate analysis.
Exploring multivariate data graphically: scatter plot, scatter plot matrix, checking distributional assumptions using probability plots.
Multivariate Normal Distribution, Tests on one or Two Mean vectors, Multivariate Analysis of Variance, Tests on Covariance Matrices, Discriminant Analysis, Classification Analysis, Cluster analysis, Principle component analysis and factor analysis.</td></tr>
<tr><td colspan="2">Methods of teaching and learning</td><td colspan="4">Lectures, Tutorials and Practical sessions</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Continuous assessments, Mid Semester Examination-20%
End Semester Examination -80%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">• Methods of Multivariate Analysis, ALVIN C. RENCHER
• Applied Multivariate Statistical Analysis, Richard A Johnson, Dean W. Wichern.
• Applied Multivariate Data Analysis Everitt B.S. and Dunn G. (2001), Arnold, London</td></tr>
</table>

MSP3293:Applied Statistics III (30 hrs) (Credit Value 2)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP 3293</td><td>Course Unit Title</td><td colspan="3">Applied Statistics III</td></tr>
<tr><td>Lectures (hrs.)</td><td>30</td><td rowspan="2">Pre-requisites</td><td rowspan="2">IMT313β, AMT 314β</td></tr>
<tr><td>Credits</td><td>2</td><td>Lab (Hr)</td><td></td></tr>
<tr><td colspan="2">Objectives</td><td colspan="4">To provide students with the knowledge
• of two basic designs and analysis of experiments.
• in chi square distributed test statistics and hypothesis testing.
• of handling non parametric tests
• of using the techniques of nonparametric regression</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, the students should be able to
• identify the hypotheses relevant to parameters.
• formulate null and alternative hypotheses
• determine the appropriate test statistics for a testing procedure.
• select the level of significance and the test criterion for rejection of null hypothesis.
• identify the nature of nonparametric regression as kernel smoothing technique with advantages and disadvantages
• define different type of kernels used in nonparametric regression
• formulate nonparametric kernel smoothing rules as nonparametric regression formula for both equidistance design and stochastic design.
• identify the convergence and the effect of bandwidth to smoothness and mean squared error.</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">ANOVA of Completely randomized design, Randomized Block design.Chi Square tests: Goodness of fit test, Contingency tables for testing independence, Bartlett test, Chi square test of homogeneity, Testing correlation coefficients for bivariate distributions.
Non parametric tests :Kolmogorov Smirnov tests, One sample sign test, One sample runs test, Two sample runs test, Mann Whitney U test, Two sample sign test, Wilcoxon Match pairs sign rank test, Kruskal Wallis H Test, Friedman rank sum test.
The normal approximations for all the above tests.
Nonparametric Regression (Kernel smoothing)An overview of nonparametric regression. Weighted average as smoothing and use of kernels for smoothing Prietsly-Chao Kernel estimates and Nadaraja-Watson Kernel estimates. Numerical tests of methods via implementations. Convergence of Mean Squared error of estimates. Effect of bandwidth selection. Cross validation and Nearest Naighbour estimates.</td></tr>
<tr><td colspan="2">Method of teaching and learning</td><td colspan="4">Lectures and assignments.</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Semester End Written Examination : 80%
Mid Semester Examination : 20 %</td></tr>
</table>

References	• Introduction to Mathematical Statistics, 6th edition, 2005, Robert V. Hogg, Joseph McKean and Allen T.Craig. • Design and Analysis of Experiments, 5th edition, 2007, Montgomery, Douglas C. • Probability & Statistics for Engineers and Scientists, 8th edition, 2007, Ronald E. Walole, Raymond H. Myers, Sharon L. Myers and Keying Ye. • Comprehensive Statistical Methods, 2007, P.N. Arora, Sumeet Arora and S. Arora. • Non parametric Statistics for the behavioural Sciences, Sidney Siegel. • Applied Nonparametric Regression, W. Haerdel, Econometric Society Monographs (Book 19), Cambridge University Press; Revised edition (January 31, 1992)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP
3193</td><td>Course Unit Title</td><td colspan="3">Bayesian Inference and Decision Theory</td></tr>
<tr><td>Lectures (hrs.)</td><td>45</td><td>Pre-requisites</td><td>None</td></tr>
<tr><td colspan="2">Course Unit
Objectives</td><td colspan="4">The objectives of this course unit are
To introduce fundamentals of the Bayesian theory of inference.
To convince the students how use Bayesian inference to model real world phenomena
To introduce hypothesis testing according to the Bayesian viewpoint.
To introduce concepts in decision theory.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, students should be able to
use relative frequencies to estimate probabilities and calculate conditional probabilities
calculate posterior probabilities using Bayes’ theorem
calculate simple likelihood functions
describe the role of the posterior distribution, the likelihood function and the posterior distribution in Bayesian inference about a parameter.
do hypothesis testing according to the Bayesian viewpoint</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Fundamentals of the Bayesian theory of inference, probability as a representation for degrees of belief, the likelihood principle, the use of Bayes Rule to revise beliefs based on evidence, conjugate prior distributions for common statistical models, methods for approximating the posterior distribution. Graphical models for representing complex probability and decision models by specifying modular components. Concepts in decision analysis, including inuence diagrams, decision trees, and utility theory or/and special topics in advanced Bayesian inference and decision theory</td></tr>
<tr><td colspan="2">Methods of teaching and learning</td><td colspan="4">Lectures (3 hours per week), self study.</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Continuous Assessments: 20%
End Semester Examination: 80%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">William M. Bolstad, 2004, Introduction to Bayesian Statistics, Jhon Wiley and Sons, Inc, Hoboken, New Jersey.
Bayesian statistics, The Open University, Walton Hall, Milton Keynes MK7 6AA, 2007
Jayanta K. Ghosh, Mohan Delampady, Tapas Samanta, 2006, An Introduction to Bayesian Analysis Theory and Methods, Springer Science+ Business Media, LLC</td></tr>
</table>

B.Sc. Special Degree in Mathematics - Level II

MSP4114 Ring & Field Theory (60 hrs) (Credit Value 4)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP4114</td><td>Course Unit Title</td><td colspan="3">Ring and Field Theory</td></tr>
<tr><td colspan="2">Lectures (Hrs)</td><td>60</td><td rowspan="2">Pre-requisites</td><td rowspan="2">None</td></tr>
<tr><td>Credits</td><td>4</td><td colspan="2">Practical (Hrs)</td><td>-</td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">The objective of this course unit is to provide students the concepts of Ring and Field Theory</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">Upon successful completion of this course unit , the student will be able to
• explain the concepts of Rings
• demonstrate knowledge of the content of the major theorems
• use appropriate ideas for the proof of the theorems
• apply concepts of Rings and Fields to real problems</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Rings:Definition and Examples of Rings, Properties of Rings, Integral Domains, Characteristic of a Ring, Ideals, Quotient Rings
Ring Homomorphisms and Isomorphisms: Definitions and Examples, Properties of Ring Homomorphisms, Isomorphism Theorems
Polynomial Rings: Notations, The Division Algorithm and Consequences, Reducibility, irreducibility, Unique Factorization Domain,
Fields:Extension Fields, Splitting Fields, Algebraic Extensions, Finite Fields</td></tr>
<tr><td colspan="2">Method of teaching and learning</td><td colspan="4">Lectures, Reading Materials, Presentations</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Assessment Test: 20% , Semester End Written Examination: 80%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">• A course in Abstract Algebra – Vijay K. Kanna&S. K. Bhambri
• Abstract Algebra Thomas W. Hungerford
• Contemporary Abstract Algebra – Joseph A. Gallian</td></tr>
</table>

MSP4b26 Seminars and Research/Study Project-Mathematics/Statistics (Credit Value 6)

MSP4134 Functional Analysis (60 hrs) (Credit Value 4)

Course Unit number	**MSP4134**	**Course Unit Title**	**Functional Analysis**		
		Lectures (Hr)	60	**Pre-requisites**	
Credits	4	**Tutorials (Hr)**			
Objectives		The objectives of this course unit are to provide the students with the understanding of different type of functional spaces, their properties and applications			
Learning Outcomes		On completion of the course unit the students will be able to: • define a metric space, complete metric spaces, normed and Banach spaces and Inner product space and Hilbert Spaces with examples • discuss the linear operators on Banach spaces and their properties • apply the properties of inner product spaces to explain orthonormal systems in inner product spaces and Hilbert spaces. • use the best approximation theorem and related properties on Hilbert spaces as applications			
Course Content		**Metric Spaces :**Definition, examples and related theorems, Hoelder and Minkowsky inequalities, Sets in Metric Spaces, Sequences in Metric Spaces, Completeness, Complete Metric Spaces, Examples for complete and incomplete metric spaces, Continuity, uniform continuity and uniform convergence, Contraction Mapping Theorem. **Normed Spaces and Banach Spaces :**Definition of norms and normed spaces, examples and related theorems. Finite and infinite dimensional spaces, equivalent norms, Sequence of functions in normed spaces, pointwise and uniform convergence, Banach spaces and related theorems, Linear operators on normed spaces, operator norms, bounded linear functionals, dual spaces. **Inner Product Spaces and Hilbert Spaces:**Definitions and examples, related theorems, Cauchy Schwartz inequality, Parallelogram identity, theorems and applications, Hilbert spaces, Linear operators on Hilbert spaces, Orthonormal systems in Hilbert spaces, Best approximation theorem, Fourier representations, Bessel's inequality, Rietz Representation Theorem and related results, examples.			
Method of teaching and learning:		Lectures, Reading materials, Class discussions for solving problems			

Method of Assessment:	Class Test 20% Semester End Written Examination: 80%
References:	• A.H. Siddique Khali Ahmad & P. Ramachandra*Introduction to Functional Analysis with Applications*, ANAMAYA Publications New Delhi 2006 • M. Thamban Nair, *Functional Analysis Functional Analysis First Course*, Prentice Hall of India, New Delhi, 2002 • E Kreyzig*Introductory Functional Analysis with Applications*, Wielly 1989 • W. Rudin*Real and Complex Analysis* 3rd Edition McGraw Hill 1987 • John B Conway, *A course in Functional Analysis*, 2nd Edition, Springer Verlag, 1990 • Lecture Notes of Prof. W.W. Chen *Linear Functional Analysis*http://rutherglen.ics.mq.edu.au/wchen/

MSP4144 Time Series Analysis (60 hrs) (Credit Value 4)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP4144</td><td>Course Unit Title</td><td colspan="3">Time Series Analysis</td></tr>
<tr><td>Lectures (hrs.)</td><td>60</td><td>Pre-requisites</td><td>None</td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">This course introduces the theory and practice of time series analysis, with an emphasis on practical skills. The objective of this course unit is to equip students with various forecasting techniques and knowledge on statistical methods for analyzing time series data. The students should get acquainted with the main concepts of Time Series theory and methods of analysis.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, students should be able to
• Summarize and carry out exploratory and descriptive analysis of time series data.
• Describe and conduct appropriate statistical modelling techniques for time series data.
• Choose an appropriate ARIMA model for a given set of data and fit the model using an appropriate package
• Compute forecasts for a variety of linear methods and models.</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Introduction to basic concepts of time series analysis such as auto-regression, moving averages, integration, ARIMA, autocorrelation, and trends and volatility. Stationary, testing for unit roots, and structural change different formulations of lags, and causality.Time series forecasting. Time series modelling, such as multi-equation models, cointegration and error-correction models or/and special topics in advanced time series analysis.</td></tr>
<tr><td colspan="2">Methods of teaching and learning</td><td colspan="4">Lectures, Practices in computer class, self study in computer class, self study with literature.</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Continuous Assessments: 20%
End Semester Examination: 80%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">• Shumway, R.H., Stoffer, D.S. (2006), Time Series Analysis and Its Applications (with R examples), Springer-Verlag, New York.
• Brockwell P. And Davis R. (2009), Time series: Theory and methods, Springer publications.
• Chatfield C. (2003), The Analysis of time series, An introduction, Chapman & Hall.</td></tr>
</table>

MSP4153: Statistical Laboratory (60 hrs)

<table>
<tr><td>Course Unit number</td><td>MSP4153</td><td>Course Unit Title</td><td colspan="3">Statistical Laboratory</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">3</td><td>Lectures (hrs.)</td><td>15</td><td rowspan="2">Pre-requisites</td><td rowspan="2">MSP313β Mathematical StatisticsII
MSP316β Applied StatisticsII</td></tr>
<tr><td>Practical (hrs.)</td><td>45</td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">The objectives of this course unit are
• to introduce and explain the important ideas in practical statistics,
• to understand various statistical methods and applications,
• to understand the practical problems in data analysis and pitfalls</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, students should be able to
• Summarizing univariate, bivariate and multivariate data using graphically and numerically
• Identify the pattern of the given data and apply the suitable statistical techniques according to that pattern.</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">The following statistical problems will be solved with computers using ‘R’:
• Summarizing data (univariate, bivariate and multivariate)
• Analysing one sample, two samples and more than two samples data sets.
• Linear Regression and correlation.
• Analysis of Categorical Data: Goodness-of-fit test, Test of independence, Test of homogeneity.</td></tr>
<tr><td colspan="2">Methods of teaching and learning</td><td colspan="4">Lectures and Practical sessions</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Mid-Semester Examination-20%
End Semester Examination -80%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">• Kitchens, Larry J. Basic Statistics and Data Analysis. Thomson/Brooks/Cole, 2002.</td></tr>
</table>

MSP4164: Analytical and Numerical Methods for PDEs (60 hrs) (Credit Value 4)

<table>
<tr><td>Course Unit number</td><td>MSP4164</td><td>Course Unit Title</td><td colspan="3">Analytical and Numerical Methods for PDEs</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">4.00</td><td>Lectures (hrs.)</td><td>60</td><td rowspan="2">Pre-requisites</td><td rowspan="2">None</td></tr>
<tr><td>Practical (hrs.)</td><td></td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">The objectives of this course unit isto provide an understanding of analytical and numerical methods of solution for the most important types of partial differential equations that arise in Physics, Engineering and other sciences paying special attention to real world problems.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, students should be able to
use analytical and numerical methods for solving linear homogeneous and nonhomogeneous PDEs
apply those methods to model and solve real world problems that arise in various fields
analyse computer implementation of related algorithms</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Analytical methods for Partial Differential Equations: Introduction to Elliptic, Parabolic and Hyperbolic PDEs, Initial and boundary value problems, Superposition Principle of solutions, Fourier series, Separation of variables, Homogeneous and non-homogeneous problems, Time dependent and independent non-homogeneous problems, Sturm-Liouville Systems, Eigen values and Eigen functions, Finite Fourier Transforms and non-homogeneous problems, Problems in Infinite Spatial Domains, Fourier Transforms, Fourier Transforms method for PDEs, Laplace Transforms methods for PDEs.

Numerical Methods for Partial Differential Equations: Approximation of partial derivatives using finite differences, Finite-difference methods for parabolic, hyperbolic and elliptic equations, Heat equation, Wave

equation and Poisson equation as examples, Convergence and Stability, Finite-element methods for PDEs in one dimensional space</td></tr>
<tr><td colspan="2">Methods of teaching and learning</td><td colspan="4">Through lectures and tutorial discussions.</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Continuous assessment 30%

End Semester Examination 70%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">Mark A Pinsky, “ Partial Differential Equations and Boundary-Valu Problems with Applications “, McGraw-Hill, 1998
J David Logan, “Partial Differential Equations”, Springer, 2005
M K Jain, S R K Iyengar and R K Jain, “Computational Methods for Partial Differential Equations”, Willey, 1993</td></tr>
</table>

MSP4224: Introduction to Stochastic Analysis (60 hrs) (Credit Value 4) Prerequisites- MSP3254: Measure Theory with Applications

<table>
<tr><td>Course Unit number</td><td>MSP4224</td><td>Course Unit Title</td><td colspan="3">Introduction to Stochastic Analysis</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">4</td><td>Lectures (hrs.)</td><td>60</td><td rowspan="2">Pre-requisites</td><td rowspan="2">MSP3184 – Measure Theory</td></tr>
<tr><td>Tutorials (hrs.)</td><td></td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">The objectives of this course unit are
to introduce Advanced Probability Theory and Stochastic Calculus.
to convince the students how stochastic processes and stochastic calculus are used t model real world phenomena.
to discuss applications in Finance and other relevant fields.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, students should be able to
understand the basic concepts in stochastic calculus
apply that knowledge to solve real world problems</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Introduction to Measure Theoretic Probability Theory(sigma algebras, probability measure, probability space etc), Conditional expectation and its properties, Stochastic Processes, Brownian motion and its derived processes (Brownian bridge, Brownian motion with drift, Geometric Brownian motion), Discrete and Continuous Martingales, Riemann and Riemann-Stieltjes Integration, Ito stochastic calculus, Ito lemma, Stochastic differential equations, Applications in Finance, Black-Scholes Model etc</td></tr>
<tr><td colspan="2">Methods of teaching and learning</td><td colspan="4">Lectures: 60 hrs (4 hrs per week)</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Continuous assessment: 20%
End Semester Examination:80%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">Elementary Stochastic Calculus with Finance in View, T.Mikosch, World Scientific Publishers, 1998.
Martingales and Stochastic Analysis, J.Yeh, World Scientific Publishers, 1995.</td></tr>
</table>

MSP4234: Topics in Applied Mathematics I (60 hrs) (Credit Value 4)

(Eg. Dynamical Systems/Control Theory)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP 4234</td><td>Course Unit Title</td><td colspan="3">Special Topics in Applied Mathematics- Dynamical Systems and Control Theory</td></tr>
<tr><td>Lectures (hrs.)</td><td>60</td><td rowspan="2">Pre-requisites</td><td rowspan="2">None</td></tr>
<tr><td>Credits</td><td>4</td><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">The objectives of this course unit are to give
• the knowledge to perform aqualitative study of differential equations(for solutions) using phase plane technique
• the knowledge of handling nonlinear systems
• identify and describe the stability of the solutions using different stability criteria
• the ability to design and analysis the control systems</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, students should be able to
• deduce important characteristics of the solutions of differential equations using phase plane technique
• perform the linearization technique for nonlinear systems
• decide the stability property of the solutions of a given system of ordinary differential equations
• model and analysis a given dynamic input-state-output (i/s/o) system
• describe the controllability and observability of a given i/s/o system
• perform a stability analysis of a given i/s/o system</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Phase plane methods for second order differential equations.First order systems in two variables and linearization. Stability of the regular systems in the sense of Poincare and Liapunov.Liapunov methods for determining stability two dimensional autonomous systems.

Linear systems and control theory. Stability analysis. Controllability and controller forms. Observability and observer forms.</td></tr>
<tr><td colspan="2">Methods of teaching and learning</td><td colspan="4">Lectures, discussions during the lectures, class tests.</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Continuous assessment
End Semester Examination</td></tr>
<tr><td colspan="2">References</td><td colspan="4">Non-linear Ordinary differential equations, D. W. Jordan and P. Smith.
Systems and Control Theory, E.D. Sontag</td></tr>
</table>

MSP4254: Special Topics in Applied Mathematics (60 hrs) (Credit Value 4)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP 4254</td><td>Course Unit Title</td><td colspan="3">Operations Research</td></tr>
<tr><td>Lectures +Tutorial Discussions (hrs.)</td><td>60</td><td rowspan="2">Pre-requisites</td><td rowspan="2">None</td></tr>
<tr><td>Credits</td><td>4</td><td>Practical (hrs.)</td><td></td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">The overall goal of this course is to acquaint students with the basic concepts and principles of operations research mainly in the areas of Linear Programming (LP), Integer Linear Programming (ILP), Goal Programming (GP) and Non-Linear Programming (NP) to improve the analytical thinking and modelling abilities on quantitative decisions making problems.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">Upon successful completion of this course, students will be able to:
• identify and outline solution procedures for practical decision-making problems,
• design and formulate relevant practical problems as linear programming, integer programming, goal programming and nonlinear programming models,
• solve such problems by means of basic solution methods and specialized software tools like LINGO or MS Excel,
• analyse and interpret given solutions of such problems,
evaluate and appreciate the existence solution techniques.</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Introduction History of Operations Research, Objectives of Operations Research, Characteristics of Operations Research, Scope of Operations Research Concepts of Modelling, Meaning and Necessity of Operations Research Models, Important Topics of Operations Research. BREIF INTRODUCTION TO CONVEX ANALYSIS; Convex Sets, Convex Functions, Convex Optimization. MODELING WITH LINEAR PROGRAMMING; Introduction to Linear Programming, Applications and Modelling with Linear Programming, Linear Programming problem with Two variables, Geometry of Linear Programming and Simplex Algorithm, Duality in Linear Programming. INTEGER LINEAR PROGRAMMING; Introduction, Illustrative Applications, Integer Programming Algorithms. GOAL PROGRAMMING; Introduction and Examples, A Goal Programming Formulation, Goal Programming Algorithms. NONLINEAR PROGRAMMING; Introduction and examples, Basics of Unconstrained and Set – Constrained Optimization, Karush – Kuhn – Tucker (KKT) Optimality Conditions, Multivariable Unconstrained Algorithms.</td></tr>
<tr><td colspan="2">Methods of teaching and learning</td><td colspan="4">Lectures, class discussion, tutorial discussion.</td></tr>
</table>

Method of Assessment	Continuous assessment -20% End Semester Examination - 80%
References	• Hamdy A. Taha (2007), *Operations Research: An Introduction*, 8th edition, Pearson Education, INC. • B. Kolman, R. E. Beck (1995), *Elementary Linear Programming with Applications*, Second Edition, Academic Press. • Hamdy A. Taha (1975), *Integer Programming: Theory, Applications, and Computations*, Academic Press.

MSP4263: Design and Analysis of Experiments/Operations Research (45 hrs) (Credit Value 3)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP4263</td><td>Course Unit Title</td><td colspan="3">Design and Analysis of Experiments</td></tr>
<tr><td colspan="2">Lectures and Tutorials (Hr)</td><td>45</td><td rowspan="2">Pre-requisites</td><td rowspan="2"></td></tr>
<tr><td>Credits</td><td>3</td><td colspan="2">Lab (Hr)</td><td></td></tr>
<tr><td colspan="2">Objectives</td><td colspan="4">The objectives of this course unit are
• to provide students with the knowledge of various experimental designs with the ability of constructing the ANOVA tables, estimating parameters, and making conclusions.
• to make skills in applying the most appropriate designs in real world problems.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On successful completion of the course unit, the students will be able to
• carry out analysis of variance and make relevant conclusions.
• estimate the model parameters.
• analyze experimental designs of more factors with less number of observations.
• study the various main effects and interaction effects of experiments.</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Principles of design, Experimental errors, Replication and randomization. Estimating effects, testing hypotheses, finding confidence intervals for effects, estimating missing values and carrying out the analysis of variance for completely randomized design, Randomized Block design, Latin square design and Greco Latin square design.
Analysis of variance of Factorial experiments with main effects and interactions, 2k designs, Confounding effects and fractional factorial design, Higher fractions and screening designs.
Random effect models. Control and Noise variables.</td></tr>
<tr><td colspan="2">Method of teaching and learning</td><td colspan="4">Lectures, Discussions and Reading materials</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Semester End Written Examination : 80%
Mid Semester Examination : 20 %</td></tr>
<tr><td colspan="2">References</td><td colspan="4">• Design and Analysis of Experiments, 5th edition, 2007, Montgomery, Douglas C.
• Design and Analysis of Experiments with R, 2015, Lawson, John.</td></tr>
</table>

MSP4273: Special Topics in Statistics (45 hrs) (Categorical Data Analysis (22.5 hrs) + Sampling Theory (22.5 hrs)) (Credit Value 3)

<table>
<tr><td rowspan="2">Course Unit number</td><td rowspan="2">MSP 4273</td><td>Course Unit Title</td><td colspan="3">Sampling Theory and Categorical Data Analysis</td></tr>
<tr><td colspan="2">Lectures / Tutorials (Hr)</td><td>45</td><td rowspan="2">Pre-requisites</td><td rowspan="2">MSP313β
MSP316βI</td></tr>
<tr><td>Credits</td><td>3</td><td colspan="2">Lab (Hr)</td><td>-</td></tr>
<tr><td colspan="2">Objectives</td><td colspan="4">The objectives of this course unit are to
• provide knowledge of implementing sampling surveys.
• Provide knowledge of applying suitable sampling techniques in real world problems for collecting data and estimating population parameters using sample data.
• improve understanding of qualitative data
• improve technical competence to model and test categorical data.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, the students should be able to
• construct questionnaires for collecting information.
• apply the appropriate sampling method with suitable sample size for real life situations.
• make the estimations of population parameters with the confidence intervals.
• compare various sampling techniques.
• understand and model categorical data
• visualize and interpret categorical data
• extract and structure your data
• make inference on your data
• use statistical software to analyse categorical data</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Planning of a survey, Designing Questionnaires, Problems arising in execution of a survey, Census and samples, The principal steps in a sample survey, The role of sampling theory, The probability and non probability sampling.

The simple random sample, Estimating population means, variance, total and proportion, Variances of estimates, The finite population correction, Confidence limits, Estimation of a ratio, Sample size determination, Stratified random sampling, Properties of estimates, Proportional allocation, Neymann allocation, Optimum allocation of cost. Relative precision of stratified random and simple random sampling. Systematic sampling, Linear systematic sampling and circular systematic sampling, Quota sampling, Cluster sampling, multistage sampling,

Introduction to Distributions and Inference for Categorical Data: Categorical response data, distributions for categorical data, statistical inference for categorical data.

Describing Contingency Tables: Probability structure for contingency tables, comparing two proportions, partial association in stratified 2 x 2 tables, Extensions for I x J tables.</td></tr>
</table>

	Inference for Contingency Tables: Confidence intervals for association parameters, Testing independence in two-way contingency tables, two-way tables with ordered classification, small-sample tests of independence. Logistic Regression: Interpreting parameters in logistic regression, Inference for logistic regression, Multiple Logistic Regression, Fitting logistic regression models. Building and Applying Logistic Regression Models
Method of teaching and learning	Lectures, discussions, assignments and Practical sessions
Method of Assessment	Semester End Written Examination : 80% Mid Semester Examination : 20 %
References	• Sampling Techniques, 3rd edition, (1999) 2007, William G Cochran. • Elementary Survey Sampling, 5th edition, 1996, Richard L. Scheaffer and William Mendenhall III . • Categorical Data Analysis, Second Edition, Alan Agresti • Categorical Data Analysis for the behavioural and Social Sciences.

MSP4283: Introduction to Stochastic Processes (45 hrs) (Credit Value 3)

<table>
<tr><td>Course Unit number</td><td rowspan="2">MSP4224</td><td>Course Unit Title</td><td colspan="3">Introduction to Stochastic Analysis</td></tr>
<tr><td rowspan="2">Credits</td><td>Lectures (hrs.)</td><td>60</td><td rowspan="2">Pre-requisites</td><td rowspan="2">MSP3184 – Measure Theory</td></tr>
<tr><td rowspan="2">4</td><td>Tutorials (hrs.)</td><td></td></tr>
<tr><td colspan="2">Course Unit Objectives</td><td colspan="4">The objectives of this course unit are
• to introduce Advanced Probability Theory and Stochastic Calculus.
• to convince the students how stochastic processes and stochastic calculus are used t model real world phenomena.
• to discuss applications in Finance and other relevant fields.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On completion of the course unit, students should be able to
• understand the basic concepts in stochastic calculus
• apply that knowledge to solve real world problems</td></tr>
<tr><td colspan="2">Course Content</td><td colspan="4">Introduction to Measure Theoretic Probability Theory(sigma algebras, probability measure, probability space etc), Conditional expectation and its properties, Stochastic Processes, Brownian motion and its derived processes (Brownian bridge, Brownian motion with drift, Geometric Brownian motion), Discrete and Continuous Martingales, Riemann and Riemann-Stieltjes Integration, Ito stochastic calculus, Ito lemma, Stochastic differential equations, Applications in Finance, Black-Scholes Model etc</td></tr>
<tr><td colspan="2">Methods of teaching and learning</td><td colspan="4">Lectures: 60 hrs (4 hrs per week)</td></tr>
<tr><td colspan="2">Method of Assessment</td><td colspan="4">Continuous assessment: 20%
End Semester Examination:80%</td></tr>
<tr><td colspan="2">References</td><td colspan="4">• Elementary Stochastic Calculus with Finance in View, T.Mikosch, World Scientific Publishers, 1998.
• Martingales and Stochastic Analysis, J.Yeh, World Scientific Publishers, 1995.</td></tr>
</table>