FYUP Course Outline for Semester III

S. No.	Course Code	Course Title	Credits	Category
1	MTHS200MJ	Vector Calculus	4	Major
2	MTHS201MJ	Linear Algebra	4	Major
3	MTHS200MN	Probability Theory	4	Minor
4	DOMS200MD	Principles of Economics	3	Multidisciplinary
5	DOELL200AE	Communication Skills	3	Ability Enhancement
6	DOMS200SE	R-Software	2	Skill Enhancement

B.Sc. Mathematical Sciences- FYUGP

Course Title : **Vector Calculus** **Semester: 3rd**

Course Code : MTHS200MJ **Category: Major**

Credit hrs. : 4

Course Objective: The objectives of vector calculus are to understand Vector Operations, Multivariable Functions, Gradient, Divergence, and Curl and Vector Fields

Course Outcomes:

1. Develop a deep understanding of vectors and their geometric interpretations, as well as vector operations and their algebraic and geometric properties.
2. Acquire problem-solving skills by solving problems involving vector calculus concepts and techniques.
3. Enhance visualization skills by understanding and visualizing surfaces, curves, and vector fields in three-dimensional space.
4. Master integration techniques for computing line integrals, surface integrals, and volume integrals over vector fields.
5. Understand and apply fundamental theorems of vector calculus, such as Green's Theorem, Stokes' Theorem, and the Divergence Theorem, in various contexts and applications.

Unit I: Three dimensional coordinate system, vectors, dot product, cross product, equations of lines and planes, cylinders and quadric surfaces, cylindrical and spherical coordinates

Unit II: Vector functions and space curves, derivatives and integrals of vector functions, arc length and curvature, motion in space- velocity and acceleration.

Unit III: Double integrals over rectangles, iterated integrals, double integrals over general regions, change of order of integration; double integrals in polar coordinates, applications, surface area, triple integrals, triple integrals in cylindrical and spherical coordinates, change of variables.

Unit IV: Vector fields, line integrals, fundamental theorem for line integrals, Green’s theorem, curl and divergence, parametric surfaces and their areas, surface integrals, Stoke’s theorem, Divergence theorem

Textbooks: Calculus – Early Transcendentals by James Stewart (2006 Edition)

Supplementary texts:

- A First Course in Calculus - by Serge Lang,
- Calculus – by Howard Anton,
- Textbook of Calculus - by Larson and Edwards,
- Schaum’s Outline of Vector Analysis,
- Calculus I & II by Tom Apostol

B.Sc. Mathematical Sciences- FYUGP

Course Title : Linear Algebra **Semester: 3rd**

Course Code : MTHS201MJ **Category: Major**

Credit hrs. : 4

Course Objective: Introduces students, the use of computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, vector spaces, eigenvalues and eigenvectors, vectors and basic vector operations and solving computational problems of linear algebra.

Course Outcome:

1. Students will develop a thorough understanding of fundamental linear algebra topics such as vector spaces, matrices, determinants, eigenvalues, and eigenvectors, which are required for further studies in mathematics and related subjects.
2. Students will master key operations such as matrix multiplication, row reduction and discovering inverses as well as how to solve systems of linear equations which will help them improve their problem-solving and analytical skills.
3. Students will be able to apply linear algebra concepts to real-world issues in physics, engineering, computer science, economics, and other subjects, illustrating the subject's widespread relevance and usefulness.

Unit I: Introduction to systems of linear equations, Gauss-Jordan elimination, matrices and matrix operations, matrix arithmetic, transpose and adjoint of a matrix, inverses, diagonal, triangular and symmetric matrices, determinants, cofactor expansion, row reduction.

Unit II: Euclidean n-space, linear transformations on n-spaces, vector spaces, subspaces, linear independence, basis and dimension, row space, column space, null space, rank and nullity. Inner products, orthogonality, orthonormal bases, Gram-Schmidt process, change of basis

Unit III: Complex numbers, arithmetic of complex numbers, polar form, brief introduction to complex functions, complex vector spaces.

Unit IV: Eigenvalues and eigenvectors, diagonalization, orthogonal diagonalization, general linear transformations, kernel and range, inverses, similarity and isomorphism

Textbooks:

- Elementary Linear Algebra by Howard Anton and Chris Rorres
- Linear Functions and Matrix Theory by Bill Jacob
- A Textbook on Matrices by Hari Krishen
- Linear Algebra – Schaum's Outline Series
- Linear Algebra and its Applications by David C. Lay, Springer
- Linear Algebra and its Applications by Gilbert Strang Thomson Learning

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Course Title : **Probability Theory** **Semester: 3rd**

Course Code : MTHS200MN **Category: Minor**

Credit hrs. : 4

Course Objective: The main objective of this course is to introduce the notion of probability, random variable, expectation, Law of Large Numbers and the Central Limit Theorem with their applications based on which statistical theory and tools have been developed.

Course Outcomes: After successful completion of this course, student will be able to:
1. Recall concept of probability and related terminology.
2. Differentiate discrete and continuous random variables and their distributions.
3. Understand probability mass function, density function and distribution function.
4. Compute expectations of random variables and their generating functions
5. Learn the concepts of weak and strong laws of large numbers and central limit theorem.

Unit I: Probability: Introduction**,** random experiments, sample space and algebra of events. Counting principle: permutations and combinations etc. Definitions of Probability-classical, statistical and axiomatic. Conditional probability, laws of addition and multiplication, independence of events, Theorem of total probability, Bayes theorem and its applications.

Unit II: Random Variables: discrete and continuous random variables. Cumulative distribution function (c.d.f.), Probability mass function (p.m.f.) & Probability density function (p.d.f.) - definition and properties. Expectation of a random variable, expectation of a function of a random variable, simple properties, moments and cumulants. Some Special Distributions and their applications: Uniform (discrete and continuous), Bernoulli, Binomial, Poisson, Exponential, Normal.

Unit III: Two-dimensional random variables, Joint distribution for two random variables (continuous and discrete case); independence, marginal and conditional distributions. Expectation of sums of random variable, covariance, variance of sums, correlations. Conditional expectation and conditional variance.

Unit IV: Moment generating function, probability generating function and characteristics function; cumulant generating function, derivation for various distributions; sums of independent random variables. Markov and Chebyshev's inequalities, normal approximation to binomial; strong and weak law of large numbers; central limit theorem with proof (using Levy's Continuity Theorem).

Text Book:

- Mood A. M. , Grabyll R. A. and Boes D. C., *Introduction to the theory of Statistics*, Tata McGraw Hill
- Miller, I. and Miller, M., *John E. Freund's Mathematical Statistics with applications*, Pearson Education, Asia.

- Ross Sheldon M., *A first Course in Probability*, Pearson.
- Ross Sheldon M., *Introduction to Probability Models*, Academic Press
- Goon A.M., Gupta M.K. and DasGupta B., *Fundamentals of Statistics*, Volume-I, The World Press, Kolkata.
- Rohtagi, V.K. and Md. Ehsanes Saleh A. K., *An Introduction to Probability and Statistics*, John Wiley & Sons.

B.Sc. Mathematical Sciences- FYUGP

Course Title : **Principles of Economics** **Semester: 3rd**

Course Code : DOMS200MD **Category: Multidisciplinary**

Credit hrs. : 3

Course Objective: Introduce the student's concepts of cost, nature of production and its relationship to business operations, to understand marginal analysis to the "firm" under different market conditions and to integrate the concept of price and output decisions of firms under various market structure.

Course Outcomes: After the completion of paper student will able to:

1. Understand fundamentals of decision making of consumers and producers.
2. Understand the basics of demand and supply.
3. Understand and measure the degree to which demand responds to changes in income and prices of related commodities
4. Understand how consumers make consumption decision

Unit I: Nature and scope of economics: Positive and Normative economics; Micro and Macroeconomics; Major economic problems; Demand and supply concept: Law of demand, elasticity of demand and its measurement. Law of diminishing marginal utility, law of equi-marginal utility. Law of Supply, Indifference curve analysis; meaning of indifference curve; properties of indifference curve. Consumer's equilibrium; consumer's surplus; effects of price change; income effect and substitution effect; breaking up of price effect into income and substitution effect.

Unit III: Theory of Production: Fixed and Variable Inputs, Production function (Short run and long run), Production with one variable input (Labor); Concept of Total product, average product and marginal product; Law of variable proportion, three stages of Production; Production with two variable input; Isoquants; MRTS, Returns to scale (constant, increasing and decreasing returns to scale);

Unit III: Concept of cost: Accounting cost and Economic Cost; Short run costs- Total fixed and variable cost; Short run Average cost curve; Marginal cost; Relationship between AC and MC; Long run average cost curve; Economies of scale; Concept of total revenue average revenue and marginal revenue; Relationship between AR and MR.

Prescribed Text Books:

1. Microeconomics by Robert Pindyck and Daniel Rubinfeld, 9th Edition (2017)-Latest Edition
2. Principles of Microeconomics, N.Gregory Mankiw, 8th Edition (2016)
3. Economics, Paul A. Samuelson, William D. Nordhaus, 20th Edition (2019)
4. Roger Sherman: Market regulation, Pearson, 1st Edition (2008)

B.Sc. Mathematical Sciences- FYUGP

Course Title : **R Software** **Semester: 3rd**

Course Code : DOMS200SE **Category: Skill**

Credit hrs. : 3

Course Objectives: The learning objectives include:

- To understand R Programming and its roles in problem solving.
- To understand data handling and its analysis.
- Learning the basic statistical software will help students to easily switch over to any other statistical software in future.

Course Learning Outcomes: After completing this course, students should have developed a basic understanding of R programming language.

Unit I: Overview of R and its applications, Installation of R and R-Studio, R as a calculator, Basic data types and objects in R, help functions in R, assignment operator, vectors, operations on vectors. Setting working directory, importing different data formats (.csv, .xlsx, .txt) into R, sub-setting and writing output. Handling matrices, data frames and lists in R.

Unit II: Introduction to creating functions, calling functions, Conditional statements (if-else), Plots and graphics in R. Descriptive statistics in R, Basic correlation and regression analysis using R. Apply family of functions in R- apply() and tapply(). Random data generation in R. Creating frequency tables, proportion tables and crosstabs for categorical variables.

Text Books and Reference Books:

a) Chang, W. (2013). R graphics cookbook. O'Reilly Media.

b) Jones, O., Maillardet, R., & Robinson, A. (2014). Introduction to scientific programming and simulation using R. CRC Press.

c) Matloff, N. (2011). The art of R programming: A tour of statistical software design. No Starch Press.

d) Wickham, H., Çetinkaya-Rundel, M., & Grolemund, G. (2023). R for data science. O'Reilly Media.

e) Wickham, H. (2015). Advanced R. CRC Press.