Minor Courses offered by the Department of Mathematics

These courses are designed for students from Physics, Chemistry, Biology, Computer Science, B.Com. (General), B.Com. (CS), etc. These courses will be floated depending on the number of students registering and the availability on the faculty. The number of students may be restricted depending on the available classroom facility and first-cum-first serve basis.

LIST OF MINOR COURSES (ELECTIVES/ALLIED/SPECIALISATION):

UG courses having different streams of specialisations may consider the minor stream Eg. B.Com.(General), B.Com.(Computer Science), B.Com.(Foreign Trade), B.Com.(Cooperative management), etc.

a) Minor Stream I (Within the Department)

Offered in Semester	Course Code	Type of Course	Credits	Hours	Title of the Course
I		MID - 1	4	5	**Statistics-I**
II		MID - 2	4	5	**Statistics-II**
III		MID - 3	4	5	**Statistics-III**
IV		MID - 4	4	5	**Statistics-IV**
V		MID - 5	4	5	**Operations Research-I**
VI		MID - 6	4	5	**Operations Research-II**
VII		MID - 7	4	5	**Calculus of Variations**
		MID - 8	4	5	**Integral Equations**

b) Minor Stream II (12 credits from the disciplines + 12 credits from discipline)

- **Stream II is designated for students from Arts, Commerce and Humanities.**

Offered in Semester	Course Code	Type of Course	Credits	Hours	Title of the Minor Course
I		MID - 1	4	5	**Mathematics of Finance**
II		MID - 2	4	5	**Business Statistics**
III		MID - 3	4	5	**Numerical Analysis**
IV		MID - 4	4	5	**Optimization Techniques-I**
V		MID - 5	4	5	**Optimization Techniques-II**
VI		MID - 6	4	5	**Applied Statistics**

c) Minor Stream III

- **Minor Stream III is tailored for Students Pursuing B.Sc. in Physics, Chemistry, Other Science Students (Other than Mathematics).**

Offered in Semester	Course Code	Type of Course	Credits	Hours	Title of the Minor Course
I		MID - 1	4	5	**Matrices and Trigonometry**
II		MID - 2	4	5	**Calculus**
III		MID - 3	4	5	**Vector Calculus**
IV		MID - 4	4	5	**Introduction to Differential Equations**
V		MID - 5	4	5	**Fourier Series and Laplace Transform**
VI		MID - 6	4	5	**Numerical Analysis**

MINOR STREAM - I
MINOR – 1 : STATISTICS-I – 4 CREDITS (60 HOURS)

Course Objectives

* To introduce the basic concepts of probability and statistics, including sample spaces, events, probability rules, random variables, and probability distributions.
* To develop an understanding of the mathematical foundations of probability and statistics, such as expectation, variance, and covariance.
* To apply probability and statistics to solve problems in a variety of contexts, such as business, engineering, and science.

Unit I: (Chapter 3 – 3.1, 3.2, 3.3, 3.4, 3.5, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13)
Theory of Probability - I – Mathematical and Statistical Probability, Axiomatic approach to Probability – Some theorems on probability– Simple problems
Unit II: (Chapter 4 – 4.1, 4.2, 4.3)
Theory of Probability – II : Extended axiom of addition and axiom of continuity – Bayes' theorem – Geometric probability - Simple problems.
Unit III: (Chapter 5 – 5.1, 5.2, 5.3, 5.4, 5.5)
Distribution function – Discrete random variable – Continuous random variable – Two dimensional random variable – Simple problems.
Unit IV: (Chapter 6 - 6.1, 6.2, 6.3, 6.4, 6.5, 6.6)
Mathematical Expectation : Mathematical expectation or expected value of a random variable – expected value of function of a random variable – Properties of expectation – Properties of variance – Covariance – Simple problems.
Unit V: (Chapter 8 – 8.1, 8.2, 8.3, 8.4, 8.5, 8.7)
Special Discrete Probability Distributions : Discrete uniform distribution – Bernoulli distribution – Binomial distribution – Poisson distribution – Geometric distribution -

Text Book: S.C. Gupta & V.K. Kapoor , Fundamentals of Mathematical Statistics- Sultan Chand and Sons,12th Edition ,2022

Reference Books:
1. S.P. Gupta, Statistical methods- Sultan Chand and Sons, 45th Edition 2017
2. R.S.N.Pillai & V. Bagavathi, Statistics –S.Chand & company LTD, Reprint 2014

MINOR -2 : STATISTICS-II – 4 CREDITS (60 HOURS)

Course Objectives

- To introduce the normal distribution and its properties.
- To develop an understanding of the special continuous probability distributions.
- To introduce the concept of correlation and its measurement.
- To develop an understanding of the linear and curvilinear regression models.
- To introduce the concepts of theory of attributes and its applications.

Unit I: (Chapter 9 – 9.1, 9.2, 9.2.1, 9.2.2, 9.2.3, 9.2.5, 9.2.6, 9.2.7)
Normal Distribution: Limiting form of binomial distribution – Characteristics – Mode – Median – Moment Generating function – Cumulant Generating Function – Moments of Normal distribution

Unit – II: (Chapter 9 – 9.3, 9.3.1, 9.3.2, 9.3.3, 9.3.4, 9.4, 9.5, 9.5.1, 9.5.2, 9.5.3)
Special Continuous Probability Distributions: Rectangular Distribution - Triangular distribution – Gamma Distribution – simple problems.

Unit III: (Chapter 10 – 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7)
Correlation: Meaning of correlation – scatter diagram – Karl pearson's coefficient of correlation – Calculation of the correlation coefficient for a bivariate frequency distribution – Probable error of correlation coefficient – Rank correlation – Simple problems.

Unit IV: (Chapter 11 – 11.4)
Linear and Curvilinear Regression : Linear regression – Curvilinear regression - Regression curves – simple problems

Unit V: (Chapter 13 – 13.13.7)
Theory of Attributes: Notations – Dichotomy – Classes and Class frequencies – Consistency of data – Independence of attributes – Association of attributes - Simple problems.

Text Book: S.C. Gupta & V.K. Kapoor , Fundamentals of Mathematical Statistics- Sultan Chand and Sons,11th Edition ,2014

Reference Books:

1. S.P. Gupta, Statistical methods- Sultan Chand and Sons, 45th Edition 2017
2. R.S.N.Pillai & V. Bagavathi, Statistics –S.Chand & company LTD, Reprint 2014

MINOR -3 : STATISTICS-III – 4 CREDITS (60 HOURS)

Course Objectives

- To introduce the concepts of sampling distribution and estimation.
- To develop an understanding of the different types of sampling methods and their errors.
- To learn how to construct and interpret confidence intervals for population means and proportions.
- To learn how to test hypotheses about population means and proportions using large and small sample theory.
- To introduce the concepts of experimental design and its applications.

Unit I: (Chapter 2 – 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8)

Sampling Distribution and Estimation: Introduction – types of sampling methods – sampling and non sampling errors – sampling distribution of mean , difference between two means, proportion, difference between two proportions – Central limit theorem – simple problems

Unit II: (Chapter 2 – 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.16)

Sampling Distribution and Estimation: Estimation – confidence interval for the population mean for large samples (when σ is known) , for small samples (when σ is unknown) – for the difference between two population means for large samples (when σ is known) , for the difference between two population means for small samples (when σ is unknown) – confidence interval for the difference between two population proportions for large samples – determining the sample size(using confidence interval)

Unit III: (Chapter 3 – 3.1, 3.2, 3.3, 3.4, 3.5, 3.6)

Tests of Hypothesis: test of significance for large sampling theory – Testing of hypothesis about a population proportion – about the difference between two proportions – about population mean – about difference between two means – difference between two standard deviations

Unit IV: (Chapter 3 – 3.7, 3.8, 3.9, 3.10, 3.11)

Tests of Hypothesis: Test of significance for small sampling theory – about the mean population – about the difference between two means(Using t – test) – Paired t – test for difference of means – testing of hypothesis for equality of two variances

Unit V: (Chapter 3 – 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, 3.18, 3.19)

Tests of Hypothesis: Chi- square distribution - χ^2 Test of Goodness of Fit - χ^2 test of independence of attributes - χ^2 test for population variance – designs of experiments – Completely Randomized (CRD) or One-way Classification – Randomised block design (RBD) or Two way classification – Latin square design (LSD)

Text Book: K. Subramani & A. Santha, Statistics for Management, Second Edition 2011

Reference Books:

1. S.C. Gupta & V.K. Kapoor , Fundamentals of Mathematical Statistics- Sultan Chand and Sons,11th Edition ,2014

2. R.S.N.Pillai & V. Bagavathi, Statistics –S.Chand & company LTD, Reprint 201

MINOR -4 : STATISTICS-IV – 4 CREDITS (60 HOURS)

Course Objectives

- To introduce the F-test and its applications.
- To develop an understanding of the Analysis of Variance (ANOVA) technique and its applications.
- To introduce the concepts of statistical quality control and total quality management.
- To develop an understanding of the methods of measuring fertility and mortality, and to learn how to construct life tables.
- To introduce the concepts of time series analysis and index numbers, and to learn how to construct and interpret these measures.

Unit I: (Chapter 5)
F – Test and Analysis of variance: The F- test or the Variance ratio test – Applications of F-test – Analysis of Variance(ANOVA) – Assumptions in ANOVA – Technique of ANOVA – ANOVA in Two – way classification model

Unit II: (Chapter 7)
Statistical Quality Control: Control charts - $\bar{X}$ chart – R chart – Control chart for C – Control chart for P – Advantages and limitations of Statistical quality control – Total quality management – Acceptance sampling

Unit III: (Chapter 16)
Vital Statistics: Introduction – Uses – Methods – Measurement of Fertility – Reproduction rates – Measurement of Mortality – Life tables

Unit IV: (Chapter 5 – 5.2, 5.3, 5.4, 5.5, 5.6)
Time Series Analysis: Time Series analysis – Secular Trend – Measurement of Seasonal variations – Cyclical variations – irregular variations

Unit V: (Chapter 5 – 5.7, 5.8, 5.9, 5.10)
Index Numbers: Characteristics – Uses – Methods of Constructing index numbers – Tests of consistency and adequacy – Cost of living index

Text book:
1. Dr. S.P. Gupta, Statistical methods, Sultan Chand & Sons, 46th Edition, 2021 (Unit I, II, III)
2. K. Subramani & A. Santha, Statistics for Management, Second Edition 2011. (Unit IV, V)

Reference Books:
1. S.C. Gupta & V.K. Kapoor , Fundamentals of Mathematical Statistics- Sultan Chand and Sons,11th Edition ,2014
2. R.S.N.Pillai & V. Bagavathi, Statistics –S.Chand & company LTD, Reprint 2014

MINOR – 5 : OPERATIONS RESEARCH – I – 4 CREDITS (60 HOURS)

Objectives:

1. To introduce the field of operations research which has many applications in management techniques.
2. To help students to find optimum solution in business and management problems.

Unit I:

Operations Research –An overview: Introduction – Origin and development of O.R. – Nature and features of O.R. – Applications of Operations Research - Linear programming problem: Mathematical formulation - production allocation problem, product mix problem, product allocation problem only- Graphical solution method - General LPP - Canonical and Standard forms only.

Unit II:

Linear programming problem- Simplex Method : Introduction – The computational procedure –The Simplex Algorithm – Use of Artificial variables -Two Phase method – Big- M method.

Unit III:

Transportation problem: Definition- Formulation and solution of transportation problem - Initial Basic Feasible solution - Test for optimality - degeneracy in transportation problem - Modi method.

Unit IV:

Assignment problem: Introduction - Mathematical formulation of the problem – solution methods of Assignment problems - Special cases in Assignment problems: Maximization case only.

Unit V:

Network Scheduling by PERT/ CPM:- Introduction - Network and basic components - logical sequences - Rules of Network constructions - Concurrent Activities - Critical path Analysis.

Text Book:"Operations Research" by Kanti Swarup, P.K.Gupta and Man Mohan, Sultan Chand & Sons Educational Publishers, New Delhi, 16th Edition 2014.

Reference Book: 1. Hamdy A., Taha, Operations Research, Pearson publisher, 9 th Edition,2012

MINOR -6 : OPERATIONS RESEARCH – II – 4 CREDITS (60 HOURS)

Objectives:

1. To introduce the various techniques of Operations Research. 2. To make students solve real time problems in Business and management.

UNIT – I :

Sequencing Problem: Introduction –Problem of sequencing – Basic terms used in sequencing –Processing n jobs through two machines –Processing n jobs through k machines.

UNIT – II :

Games and Strategies : Two person zero sum games - Some basic terms - the maximin - minimax principle - Games without saddle points - Mixed strategies - graphic solution of 2 x n and m x 2 games – Dominance property .

UNIT- III :

Replacement Problems : Introduction – Replacement policy when value of money does not change with time – Replacement policy when value of money changes with time – Replacement of equipment that fails suddenly - Group replacement policy .

UNIT IV :

Inventory Control : Costs associated with inventories – Factors affecting inventory control - An inventory control problem – The concept of EOQ – Deterministic inventory with no shortages – Deterministic inventory problem with shortages – problems of EOQ with price breaks.

UNIT V :

Queueing Theory – Elements of a queueing system – Classification of queueing models – Definition of transient and steady states – Poisson Queueing Systems – Model I { (M/M/1):(∞/FIFO)} – Model III {(M/M/1) : (N/FIFO)} – Model V {(M/M/C):(∞/$FIFO$)}.

Text Books:

1. Kanti Swarup, P.K. Gupta and Man Mohan, Operations Research, 16th edition, Sultan Chand and Sons, Reprint 2014.

Unit I : Chapter 12- sec 12.1 to 12.5 pp.327 – 338
Unit II : Chapter 17- sec 17.1 to 17.7 pp.443 – 464
Unit III : Chapter 18 – sec 18:1, 18:2.1,18:2.2,18:3 pp.478 – 492
Unit IV : Chapter 19 – sec 19.6 to 19.12 pp. 510 – 538
Unit V : Chapter 21 – sec 21:3, 21:7, 21:8, 21:9, pp.589,590,596 to 604, 608 to 610, 613to 618

Reference Books

1. Resource Management Techniques(Operations Research) by V. Sundaresan, K. S. Ganapathy Subramanian, K. Ganesan – A. R. Publications
2. Operations Research: An Introduction, 9th edition, Hamdy A.Taha, Pearson, 2010

MINOR-7 CALCULUS OF VARIATIONS -(4 CREDITS-60 HOURS)

Course Objectives

1. To learn about functionals and solving related variational problems by Euler's equation
2. To understand and solve the variational problems functionals depending on higher order derivatives

	Course Outcome
CO 1	To study about the general variational of a functional and the Weierstrass Erdmann conditions
CO 2	To study and understand about canonical form of Euler equations and other transformations, Noether's Theorem and conservation laws
CO 3	To learn about second variation and Legendre conditions of a functional

Unit I:

Functionals- some simple variational problems-The variation of a functional- A necessary condition for an extremum-

The simplest variational problem-Euler's equation-The case of several variables-A simple variable end point problem- The variational derivative-Invariance of Euler's equation.*[Chapter-1]*

Unit II:

The fixed end point problem for n-unknown functions - Variational problem in parametric form-Functionals depending on higher order derivatives-Variational problems with subsidiary conditions. *[Chapter-2]*

Unit III:

The general variational of a functional- derivation of the basic formula- End points lying on two given curves or surfaces- Broken extremals- The Weierstrass Erdmann conditions. *[Chapter-3]*

Unit IV:

The canonical form of Euler equations- First integrals of the Euler equations- The Legendre transformation- Canonical transformations- Noether's Theorem- The principle of least action-Conservation laws- The Hamilton Jacobi equation-

Jacobi theorem.*[Chapter-4]*

Unit V:

The second variation of a functional- The formula for the second variation, Legendre conditions-Sufficient conditions for a weak extremum. *[Chapter-5]*

Text Book:

I.M. Gelfand and S.V.Fomin, *Calculus of Variations*, Dover Publications, 2000.

Reference Books:

1. A.S. Gupta, *Calculus of Variations with Applications*, Prentice-Hall of India, 2008.
2. M.L. Krasnov, G.I. Makarenko and A.I. Kiselev, *Problems and Exercises in the Calculus of Variations*, Mir Publishers, Moscow 1975.

MINOR-8 INTEGRAL EQUATIONS (4 Credits -60 HOURS)

Course Objectives	Description
1	Learn about the classification of integral equations and IVP for ODEs.
2	Explore BVPs for ODEs, elliptic PDEs, and Abel's problem.
3	Investigate the relationship between second-order ODEs and integral equations.
4	Examine integral equations of the second kind, including degenerate kernels.
5	Learn about operators and the Neumann series for solving integral equations.

Course Outcomes	Description
CO1	Apply the classification of integral equations to solve initial value problems for ODEs.
CO2	Solve boundary value problems for ODEs and elliptic PDEs and understand Abel's problem.
CO3	Transform second-order ODEs into integral equations and address singular boundary value problems.
CO4	Solve integral equations of the second kind, especially those with degenerate kernels.
CO5	Apply operators and Neumann series approaches to solve integral equations.

Unit-I

Introduction - Classification of integral equation - examples - IVP for ODE.

Unit-II

BVP for ODE - BVP for elliptic PDE - Abel's problem.

Unit-III

Second order ODE and integral equations -Differential equation theory - initial value problems - Boundary value problems - Singular boundary value problems.

Unit-IV

Integral equations of the second kind - Introduction - Degenerate kernels - a different approach.

Unit-V

Operators - Newmann series.

Text Book

Porter and Stirling, Integral equations, pp 1-94. A practical treatment from spectral theory to applications. - Cambridge: Cambridge University Press, 1996.

MINOR STREAM II

MINOR -1: MATHEMATICS OF FINANCE – 4 CREDITS (60 HOURS)

UNIT I :

Ratio, Proportion and Percentage: Ratio: Definition – Continued Ratio – inverse Ratio. Proportion – Continued Proportion – Direct Proportion – Inverse Proportion – Variation – Inverse Variation – Joint Variation – Percentage: Meaning and computation of percentage. Interest: Simple interest – compound interest (reducing balance and flat interest rate) – equated monthly installments (EMI) – Problems.

UNIT II :

Matrices and Determinates (up-to order 3 only): Multivariable data - Definition of a Matrix; Types of matrices; Algebra of matrices; Determinates – Ad-joint of a matrix – Inverse of a matrix via ad-joint matrix – homogeneous system – Solution of non- homogeneous system of linear equations (not more than three variables) – Conditions for existence and uniqueness of solution – Solution using inverse of the coefficient matrix – Problems.

UNIT III :

Functions: (To identify and define the relationships that exist among the business variables) Definition of function, constants, variables, continuous real variable, domain or interval – Types of functions – one valued function – Explicit function – Algebraic functions – Polynomial functions – Absolute value function – Inverse function – Rational and irrational function – Monotone function – Even and odd function – Supply/demand function – Cost function – Total revenue function – Profit function – Production function – Utility function – Consumption function.

(Problems: 80%, Theory: 20%)

Text Books

1. **Kappor, V.K., Business Mathematics, Sultan Chand & Sons, New Delhi**

Books for References:

1. Agarwal, B.M., Basic Mathematics & Statistics, Sultan Chand & Sons, New Delhi
2. Rajagopalan, S. & Sattanathan., R., Business mathematics, McGraw-Hill, New Delhi
3. Bari, Business Mathematics, New Literature Publishing Company, Mumbai.
4. Bhardwaj, R. S. (2019). Business Mathematics and Statistics. New Delhi: Scholar Tech Press.
5. Richard, I. L., Masood, H. S., David, S. R., & Rastogi, S. (2017). Statistics for Management. New Jersey: Pearson Education.
6. Thukral, J. K. (2017). Business Mathematics and Statistics. New Delhi: Maximax Publications.
7. Vohra, N. D. (2014). Business Mathematics and Statistics. New Delhi: Tata McGraw Hill Education India.

MINOR – 2 : BUSINESS STATISTICS– 4 CREDITS (60 HOURS)

UNIT I:

Statistics-Definition-Functions, Scope and Limitations of statistics - Statistical Enquiry Stages in conducting a statistical survey-Primary data Vs secondary data-Sources of secondary data - Classification, Tabulation and Presentation of data- Diagrams.

UNIT II: Univariate Analysis

(a) Measures of Central Tendency – Average – Meaning - Characteristics of a typical average - Computation of Mean, Median, Mode, Geometric Mean, Harmonic Mean and Weighted Arithmetic Mean- Merits and Limitations of each.

(b) Measures of Dispersion: Dispersion - Meaning - Properties of a good measure of dispersion - Absolute versus relative measure of dispersion - Computation of Range, Quartile Deviation, Mean Deviation, Standard Deviation and Co-efficient of Variation- Merits and Limitations of each.

(c) Skewness – Meaning - Variation versus Skewness - Measures of Skewness- Karl and Co-efficient of Skewness.

UNIT III: Bi-variate Analysis

(a) Simple and Liner Correlation Analysis: Meaning – Definition - Types of Correlation Methods of Studying Correlation - Correlation) and Properties.

(b) Simple and Liner Regression Analysis: Definition - CorrelationVs Regression Regression lines and Regression Equations Regression co-efficient- Computation of correlation co-efficient from regression co-efficient.

UNIT IV:

Index Numbers: Definition - Characteristics of Index numbers – Uses - Types of index numbers - Construction of Price Index numbers - Unweighted Index numbers -Weighted Index numbers - Tests of adequacy of Index number - formulae. Chain - basis index number base shifting, splicing, and deflating problems in constructing indexnumbers; Consumer price index.

UNIT V:

Analysis of Time Series: Introduction Uses - Components of time series - Measurement of trend- graphical method, semi-average method, moving average and method of least square (including linear, second degree, Parabolic and exponential trend) - Computational of seasonal, indices by simple average, Ratio - trend, ratio - to - moving average and link relative methods.

Text Books

1. J. K. Sharma, Business Statistics, Vikas Publishing House (P), Ltd., New Delhi.
2. R.S.N. Pillai and Bagavathi, Business Statistics, S. Chand & Co., New Delhi.

Books for References

1. S.P. Gupta & M.P Gupta, Statistical Methods, Sultan Chand & Co, New Delhi
2. K. Alagar, Business Statistics, Tata McGraw Hill Publications, New Delhi
3. Arora & Arora., Statistics for Management, S.Chand & Co, New Delhi

MINOR -3 : NUMERICAL ANALYSIS – 4 CREDITS (60 HOURS)

UNIT I:

Numerical solution of algebraic and transcendental equations – Bolzano's bisection method - Successive approximation method – Regula falsi method – Newton-Raphson method.

UNIT II:

Numerical solution of simultaneous linear algebraic equations – Gauss elimination method - Gauss Jordan elimination method – Gauss Seidel iteration method.

UNIT III:

Finite difference operator - Interpolation – Newton-Gregory forward and backward interpolation – Newton's divided difference formula – Lagrange's interpolation formula for uneven intervals – Gauss interpolation formula – Numerical differentiation – Numerical Integration – Trapezoidal rule – Simpson's 1/3rd rule.

UNIT IV:

Numerical solutions of Ordinary differential equations of first and second order – Simultaneous equations – Taylor series method – Picard's method.

UNIT V:

Euler's method – Improved Euler's Method - Modified Euler's Method – Runge-Kutta method of second and fourth order – Milne's predictor corrector method.

Text book

Numerical Method in Science and Engineering,
M.K.Venkataraman,NationalPublicationCo,Chennai(2001)
Unit1: Chapter 3 and 4
Unit2: Chapter 5
Unit3: Chapter 6 and 9
Unit4:Chapter11(Relevantportions)Unit5:Chapter11(Relevantportions)

ReferenceBooks

ComputerorientedNumerical MethodsbyV.Rajaram–PHI(P)Ltd.

e-LearningSource

http://ndl.iitkgp.ac.in
http://ocw.mit.edu
http://mathforum.org

MINOR -4: OPTIMIZATION TECHNIQUES – I – 4 CREDITS (60 HOURS)

Objectives:

1. To introduce the field of operations research which has many applications in management techniques.
2. To help students to find optimum solution in business and management problems.

Unit I:

Operations Research –An overview: Introduction – Origin and development of O.R. – Nature and features of O.R. – Applications of Operations Research - Linear programming problem: Mathematical formulation - production allocation problem, product mix problem, product allocation problem only- Graphical solution method - General LPP - Canonical and Standard forms only.

Unit II:

Linear programming problem- Simplex Method : Introduction – The computational procedure –The Simplex Algorithm – Use of Artificial variables -Two Phase method – Big- M method.

Unit III: Transportation problem: Definition- Formulation and solution of transportation problem - Initial Basic Feasible solution - Test for optimality - degeneracy in transportation problem - Modi method.

Unit IV: Assignment problem: Introduction - Mathematical formulation of the problem – solution methods of Assignment problems - Special cases in Assignment problems: Maximization case only.

Unit V:

Network Scheduling by PERT/ CPM:- Introduction - Network and basic components - logical sequences - Rules of Network constructions - Concurrent Activities - Critical path Analysis.

Text Book: "Operations Research" by Kanti Swarup, P.K.Gupta and Man Mohan, Sultan Chand & Sons Educational Publishers, New Delhi, 16th Edition 2014.

1. Unit I : Chapter 1, 2 & 3 Sections 1.1 to 1.3, 1.10, 2.1 to 2.4, 3.2 to 3.5
2. Unit II : Chapter 4 Sections 4.1, 4.3, 4.4
3. Unit III : Chapter 10 Sections 10.1, 10.2, 10.5, 10.8, 10.9, 10.10, 10.12, 10.13
4. Unit IV : Chapter 11 Sections 11.1 to 11.4
5. Unit V : Chapter 25 Sections 25.1 to 25.6

Reference Book:

1. Hamdy A., Taha, Operations Research, Pearson publisher, 9 th Edition,2012

MINOR -5 : OPTIMIZATION TECHNIQUES – II – 4 CREDITS (60 HOURS)

Objectives:

1. To introduce the various techniques of Operations Research.

2. To make students solve real time problems in Business and management.

UNIT – I :

Sequencing Problem: Introduction –Problem of sequencing – Basic terms used in sequencing –Processing n jobs through two machines –Processing n jobs through k machines.

UNIT – II :

Games and Strategies : Two person zero sum games - Some basic terms - the maximin - minimax principle - Games without saddle points - Mixed strategies - graphic solution of 2 x n and m x 2 games – Dominance property .

UNIT- III :

Replacement Problems : Introduction – Replacement policy when value of money does not change with time – Replacement policy when value of money changes with time – Replacement of equipment that fails suddenly - Group replacement policy .

UNIT IV :

Inventory Control : Costs associated with inventories – Factors affecting inventory control - An inventory control problem – The concept of EOQ – Deterministic inventory with no shortages – Deterministic inventory problem with shortages – problems of EOQ with price breaks.

UNIT V :

Queueing Theory – Elements of a queueing system – Classification of queueing models – Definition of transient and steady states – Poisson Queueing Systems – Model I { (M/M/1):(∞/FIFO)} – Model III {(M/M/1) : (N/FIFO)} – Model V {(M/M/C):(∞/$FIFO$)}.

Text Books:

1. Kanti Swarup, P.K. Gupta and Man Mohan, Operations Research, 16th edition, Sultan Chand and Sons, Reprint 2014.

Unit I : Chapter 12- sec 12.1 to 12.5 pp.327 – 338

Unit II : Chapter 17- sec 17.1 to 17.7 pp.443 – 464

Unit III : Chapter 18 – sec 18:1, 18:2.1,18:2.2,18:3 pp.478 – 492

Unit IV : Chapter 19 – sec 19.6 to 19.12 pp. 510 – 538

Unit V : Chapter 21 – sec 21:3, 21:7, 21:8, 21:9, pp.589,590,596 to 604, 608 to 610, 613to 618

Reference Books

1. Resource Management Techniques(Operations Research) by V. Sundaresan, K. S. Ganapathy Subramanian, K. Ganesan – A. R. Publications

2. Operations Research: An Introduction, 9th edition, Hamdy A.Taha, Pearson, 2010

MINOR – 6 : APPLIED STATISTICS– 4 CREDITS (60 HOURS)

Objectives:

1. To learn the basics of statistics concepts
2. To learn solving correlation and regression problems

Outcomes:

1. Ability to understand and represent data
2. Ability to analyze and interpret data.

UNIT I:

Diagrammatic and Graphic Presentation: General Rules for Constructing Diagrams, Types of Diagrams, One Dimensional or Bar Diagrams, Types of Bar Diagrams, Two-Dimensional Diagrams Limitations of Pie Diagrams.

UNIT II:

Measures of Central Value: Arithmetic Mean : Calculation of Simple Arithmetic Mean-IndividualObservations,CalculationofArithmeticMean-DiscreteSeries,CalculationofArithmeticMean-ContinuousSeries,MeritsandLimitationsofArithmeticMean.
Median: Calculation of Median-Individual Observations, Computation of Median-Discrete Series, Calculation of Median-Continuous Series, Merits and Limitations of Median
Mode :Calculation of Mode-Individual Observations, Calculation of Mode-Discrete Series,CalculationofMode-ContinuousSeries,MeritsandLimitationsofMode.

UNIT III :

Measures of Dispersion: Significance of Measuring Variation, Properties of a Good Measure of Variation, The Interquartile Range or the Quartile Deviation, Merits and Limitations, The Mean Deviation, Calculation of Mean Deviation, Calculation of Mean Deviation – Continuous Series, Merits and Limitations, The Standard Deviation, Difference Between Mean Deviation and Standard Deviation, Calculation of Standard Deviation, Merits and Limitations.

UNIT IV :

Correlation Analysis: Types of Correlation, Scatter Diagram Method, Merits and Limitations of the Method, Karl Pearson's Coefficient of Correlation, Direct Method of Finding Out Correlation Coefficient, Origin is made and Problems, Rank Correlation Coefficient, Merits and Limitations of the Rank Method.

UNIT V :

Regression Analysis: Uses of Regression Analysis ,Difference Between Correlation and Regression Analysis, Regression Lines, Regression Equations, Regression Equation of Y on X, Regression Equation of X on Y and Problems

TEXTBOOK

S.P.GUPTA, "Statistical Methods", Sultan Chand &Sons, Educational Publishers ,New Delhi,2016

REFERENCEBOOK:

P.R.Vittal, "Mathematical Statistics",Margham Publications, 2016

MINOR STREAM – III

MINOR -1 : MATRICES AND TRIGONOMETRY – 4 CREDITS (60 HOURS)

Unit 1:
Martrices – rank of Matrices – Consistency of a system of linear non –homogeneous equations (statement only) – simple problems

Unit 2:
Characteristic roots of a square matrix – Evaluation of Eigen values and Eigen vectors of a vectors of a square matrix – Cayley Hamilton theorem (statement only) – simple problems – Orthogonal transformation of a symmetric matrix to diagonal form

Unit 3:
De Moivre's theorem and its applications – Direct and Inverse circular and hyperbolic functions.

Unit 4:
Logarithm of a complex quantity- Expansion of Trigonometrical functions

Unit 5:
Gregory's series- Summation of series.

Text book:

1. ***Dr. P.R. Vittal, Allied Mathematics, Margham Publications, 2018***
2. ***Trigonometry, S. Narayanan and T.K. Manicavachagom Pillai, S. Viswanathan (Printers & Publishers) Pvt. Ltd, (1997)***

MINOR -2 : CALCULUS – 4 CREDITS (60 HOURS)

UNIT I :
nth derivative – Standard results – Trigonometrical transformation – Formation of equations involving derivatives – Leibnitz formula

UNIT II :
Total differential coefficients – Euler's theorem – Partial derivatives of a function of two functions - Maxima and Minima of two variables – Lagrange's method of undetermined multipliers

UNIT- III :
Circle, radius and centre of curvature – Cartesian formula for radius of curvature – envelope

UNIT- IV:
Integration of rational algebraic functions – Integration of irrational algebraic functions - Properties of definite integrals

UNIT- V:
Integration by parts – reduction formula, Bernoulli's formula - Evaluation of double integral (Cartesian form only) – Triple integral (Cartesian form only)

Textbook

Calculus Volume — I, T. K. Manickavachagom Pillai, Printers and Publishers (May1992 Edition)
Unit 1: Chapter 3 – 1.1, 1.2, 1.3, 1.4,1.5, 1.6, 2.1,
Unit 2: Chapter 8-1.3, 1.4, 1.5, 1.6, 1.7, 4, 4.1, 5,
Unit 3: Chapter 10 – 1.1, 1.2, 2.1, 2.2, 2.3, 2.4, 2.5
Calculus Volume II , S.Narayanan and T.K. Manickavasagam Pillai (2008)
Unit 4 : Chapter 1 : 7.3, 7.4, 7.5, 8, 11
Unit 5 : Chapter 1: 12,13,14, 15.1, and Chapter 5: 2, 4,

Reference books

1. Integral Calculus, N. P. Bali, Laxmi Publications, Delhi, (1991)
2. 2. Calculus(2nd Edition), Lipman Bers and Frank Karal, Holt McDougal, 1976.
3. Thomas' Calculus 12th Edition, George B.Thomas, Maurice D.Weir and Joel Hass, Pearson Education, 2015.

MINOR -3 : VECTOR CALCULUS – 4 CREDITS (60 HOURS)

Objective:
To attain the basic knowledge on vector calculus.

UNIT I :
Vector differentiation – Differentiation of vectors – Meaning of the derivative of position vector - Physical applications -– Vector differential operator - Gradient - Direction and magnitude of gradient – Simple problems.

UNIT II :
Divergence and curl - Formula involving operator, operators involving twice – Simple problems.

UNIT III:
Vector integration - Line integral – Surface integral – Volume integral – Simple problems.

UNIT IV :
Gauss divergence theorem – Green's theorem (in space) (Statement only) – Simple problems using theorems.

UNIT V :
Stoke's theorem - Green's theorem (in plane) (Statement only) – Simple problems using theorems. #

Text Book:

S. Narayanan and T.K. Manicavachagom Pillai, Vector Algebra and Analysis, S.Viswanathan Pvt. Ltd. (1995).
UNIT I Chapter 4 Sections 1 - 8
UNIT II Chapter 4 Sections 9 - 12
UNIT III Chapter 6 Sections 1 - 5
UNIT IV Chapter 6 Sections 6 - 8
UNIT V Chapter 6 Sections 9, 10

Books for Reference:

1. M.L. Khanna, Vector Calculus, Jai Prakash Nath and Co., Eighth Edition (1986).
2. P.R. Vittal, Vector analysis, Analytical Geometry & sequences and series, Margham Publications, Chennai (2004).

MINOR -4 : INTRODUCTION TO DIFFERENTIAL EQUATIONS – 4 CREDITS (60 HOURS)

Ordinary differential equations

Unit 1:

Ordinary differential equations – linear equations and equations reducible to the linear form - Exact differential equations – Equations of the First, but of higher degree – Equations solvable for dy/dx, solvable for y, solvable for x, Clairaut's form and singular solutions – geometrical meaning of a differential equations – orthogonal trajectories.

Unit 2:

Linear Differential equations with constant coefficients – Homogenous linear ordinary differential equation – linear differential simultaneous differential equations.

Partial differential equations

Unit 3:

Formation of Partial differential equations – by elimination of arbitrary constants – by elimination of arbitrary functions – Defines of general, particular and complete solutions - Singular integral – Lagranges method of solving the linear equation Pp+Qq=R

Unit 4 :

Charpits method - Linear Partial Differential equation of second and higher order with constant coefficients.

Unit 5 :

Boundary value problems method of separation of variable transverse vibrations of string – the one dimensional heat flow equations a Cartesian form.

Text books

1. **T.K. Manicavachagom Pillay , Calculus , Volume – I, S. Viswanathan (Printers and Publishers) Pvt Ltd. (2004)**
2. **Dr. M.B.K. Moorthy & K. Senthilvadivu, Transforms and partial differential equations VRB Publishers, (2009).**
3. **Transforms and Partial differential equations by Dr. A. Singaravelu**

Reference Books

1. Introductory course in Differential equations , D.A.Murray, Orient Longman (1967)
2. Engineering Mathematics , M.K.Venkataraman, National Publications , Chennai (2009)

e-Learning Source

http://ndl.iitkgp.ac.in/
http://ocw.mit.edu/
http://mathforum.org/

MINOR -5 : FOURIER SERIES AND LAPLACE TRANSFORMS – 4 CREDITS (60 HOURS)

UNIT 1:

Dirichlet's condition general Fourier series Odd and Even Functions half range Sine series and Half range cosine series.

UNIT 2:

Complex form of Fourier series Parseval's Identity.

UNIT 3:

Transform of the equation by changing the dependent variables / the independent variables – Method of variations of parameters – ordinary simultaneous differential equations.

UNIT 4:

Definition transform of 1 – transform of the function $e^{-at}, \cos at, \sin bt, t^n$, where n is a positive integer, $\sinh at, \cosh at$ - first shifting theorem – if the Laplace transform of a function f(t) is $\emptyset(s)$, then the Laplace transform of $e^{-a} f(t)$ is $\emptyset(s+a)$ - Laplace transform of $e^{-at}\cos bt, e^{-at}\sin bt, e^{-at}t^n$ - Second shifting theorem – Transform of $f'(t)$ and $f''(t)$ – inverse transform relating to the above standard forms.

UNIT 5:

Application to solution of ordinary differential equation with constant coefficients – involving the above transforms.

Text books

1. **Dr. M.B.K. Moorthy & K. Senthilvadivu, Transforms and partial differential equations VRB Publishers, (2009).**
2. **T.K. Manicavachagom Pillay , Calculus , Volume – I, S. Viswanathan (Printers and Publishers) Pvt Ltd. (2004)**

Reference Books

1. Introductory course in Differential equations , D.A.Murray, Orient Longman (1967)
2. Engineering Mathematics , M.K.Venkataraman, National Publications , Chennai (2009)

MINOR -6 : NUMERICAL ANALYSIS – 4 CREDITS (60 HOURS)

UNIT I:

Numerical solution of algebraic and transcendental equations – Bolzano's bisection method - Successive approximation method – Regula falsi method – Newton-Raphson method.

UNIT II:

Numerical solution of simultaneous linear algebraic equations – Gauss elimination method - Gauss Jordan elimination method – Gauss Seidel iteration method.

UNIT III:

Finite difference operator - Interpolation – Newton-Gregory forward and backward interpolation – Newton's divided difference formula – Lagrange's interpolation formula for uneven intervals – Gauss interpolation formula – Numerical differentiation – Numerical Integration – Trapezoidal rule – Simpson's 1/3rd rule.

UNIT IV:

Numerical solutions of Ordinary differential equations of first and second order – Simultaneous equations – Taylor series method – Picard's method.

UNIT V:

Euler's method – Improved Euler's Method - Modified Euler's Method – Runge-Kutta method of second and fourth order – Milne's predictor corrector method.

Text book

Numerical Method in Science and Engineering, M.K. Venkataraman, National Publication Co, Chennai(2001)
Unit1: Chapter 3 and 4
Unit2: Chapter 5
Unit3: Chapter 6 and 9
Unit4:Chapter11(Relevantportions)Unit5:Chapter11(Relevantportions)

Reference Books
Computer oriented Numerical Methods by V.Rajaram–PHI(P)Ltd.
e-Learning Source

http://ndl.iitkgp.ac.in
http://ocw.mit.edu

http://mathforum.org