**HSNC UNIVERSITY, MUMBAI**

**HSNCU Syllabus**

**School of Applied Sciences**

**Syllabus of MSc Data Science and Business Analytics**

**Board of Faculty of Science & Technology**

Board of Studies in the Subject of Data Science & Business Analytics

1. Name of the Chair Person: Dr. Maqsood Khan, Ex Registrar, University of Mumbai, Ex Director, Sydenham Management Institute, Ex Professor and Director, NL Dalmia Institute of Management studies, Ex CEO, HCOI Ministry of Minority Affairs, GOI.
2. Name of the Co – Chairperson: Dr. Nidhi Singh, Academic Head of Data Science and Business Analytics.

Teachers from the college:

3. Beenarani Karutharan, Assistant Professor, Department of Computer science
4. Mrs.Mrunal M Hardikar , Assistant Professor, Department of Mathematics

External Professor:

5. Rosemary Gosling, Director of External Studies(Retd) for the London School of Economics and Political Science (LSE)
6. Dr. Santosh Bothe, Founder and Director AiSense( Start up funded by BIRAC, Govt. of India), Principal, Saraswati College, Shegaon, Affliated to SGBU Amravati University.

External experts:

7. Prof. Parag Mahulikar is Ex- Dean and Senior Professor of Marketing at IES Management College and Research Centre, Bandra, India and Management Consultant.
8. Dr. Alok Deepak Dabade, Assistant Professor, Department of Statistics, University of Mumbai.
9. Dr. Sujata Suvarnapathki, Assitant Professor, Department of Statistics, Ramnarayan Ruia Autonomous College, Matunga, Mumbai.
10. Subhash kumar, Assistant Professor, MCA, MPHIL IT department, St.Xavier's college, Mumbai.
11. Industry Expert: Vinayak Deshpande, Managing Director, Sankhya Analytical Research Pvt. Ltd.
12. Industry Expert: Nishad Kapadia, MCA, Technical trainer,Data and Solution Architect Project Manager, TeraData, Mumbai.
13. Industry Expert: Gaurav Tiwari MSc, Working in Kotak Mahindra bank Ltd.,
14. Industry Expert: Praveena Premanand Menon, MSc in Big Data Analytics.
15. Alumni: Rushabh Maru, Harsh Mahapadi

## Program Outcomes (POs)

After successful completion of course, students will be able to:

1. Apply advanced statistical, mathematical, and computational methods to analyse complex datasets.
2. Design, implement, and evaluate machine learning and AI models for predictive analytics.
3. Handle, pre-process, and manage structured and unstructured data using modern tools.
4. Visualize data effectively and communicate insights for decision-making.
5. Write efficient programs in Python, R, SQL, and use high-performance computing frameworks.
6. Conduct research, solve analytical problems, and derive actionable insights.
7. Practice ethical, legal, and responsible data management and analysis.
8. Apply data science techniques across interdisciplinary domains.
9. Develop critical thinking and innovative problem-solving skills.
10. Engage in lifelong learning to adapt to emerging data science technologies.

## Part –I

**Outline of Choice Based Credit System as outlined by University Grants Commission:**

**R. ****: The Definitions of The Key Terms Used In The Choice Based Credit System And Grading System Introduced From The Academic Year 2026-2027 are as Under:**

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a core course.

2. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

2.1 **Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

2.2 **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

2.3 **Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. **Choice Base Credit System:** CBCS allows students to choose inter- disciplinary, intra-disciplinary courses, skill-oriented papers (even from other disciplines according to their learning needs, interests and aptitude) and more flexibility for students.

4. **Honours Program:** To enhance employability and entrepreneurship abilities among the learners, through aligning Inter Disciplinary / Intra Disciplinary courses with Degree Program. Honours Program will have 40 additional credits to be undertaken by the learner across three years essentially in Inter / Intra Disciplinary course.

A learner who joins Regular Undergraduate Program will have to opt for Honours Program in the first year of the Program. However, the credits for honours, though divided across three years can be completed within three years to become eligible for award of honours Degree.

5. **Program:** A Program is a set of course that are linked together in an academically meaningful way and generally ends with the award of a Degree Certificate depending on the level of knowledge attained and the total duration of study, B.Sc. Programs.

6. **Course:** A 'course' is essentially a constituent of a 'program' and may be conceived of as a composite of several learning topics taken from a certain knowledge domain, at a certain level. All the learning topics included in a course must necessarily have academic coherence, i.e. there must be a common thread linking the various components of a course. A number of linked courses considered together are in practice, a 'program'.

7. **Bridge Course:** Bridge course is visualized as Pre-semester preparation by the learner before commencement of regular lectures. For each semester the topics, whose knowledge is considered as essential for effective and seamless learning of topics of the Semester, will be specified. The Bridge Course can be conducted in online mode. The Online content can be created for the Bridge Course Topics.

8. **Module and Unit:** A course which is generally an independent entity having its own separate identity, is also often referred to as a 'Module' in today's parlance, especially when we refer to a 'modular curricular structure'. A module may be studied in conjunction with other learning modules or studied independently. A topic within a course is treated as a Unit. Each course should have exactly 3 Units.

9. **Self-Learning: 20% of the topics will be marked for Self-Learning.** Topics for Self-Learning are to be learned independently by the student, in a time- bound manner, using online and offline resources including online lectures, videos, library, discussion forums, fieldwork, internships etc.

Evaluative sessions (physical/online), equivalent to the credit allocation of the Self Learning topics, shall be conducted, preferably, every week for each course.

Learners are to be evaluated real time during evaluative sessions. The purpose of evaluative sessions is to assess the level of the students' learning achieved in the topics earmarked for Self-Learning.

The teacher's role in these evaluative sessions will be that of a Moderator and Mentor, who will guide and navigate the discussions in the sessions, and offer concluding remarks, with proper reasoning on the aspects which may have been missed by the students, in the course of the Self-

Learning process.

The modes to evaluate self-learning can be a combination of the various methods such as written reports, handouts with gaps and MCQs, objective tests, case studies and Peer learning. Groups can be formed to present self- learning topics to peer groups, followed by Question and Answer sessions and open discussion. The marking scheme for Self-Learning will be defined under Examination and Teaching.

The topics stipulated for self-learning can be increased or reduced as per the recommendations of the Board of Studies and Academic Council from time to time. All decisions regarding evaluation need to be taken and communicated to the stakeholders preferably before the commencement of a semester. Some exceptions may be made in exigencies, like the current situation arising from the lockdown, but such ad hoc decisions are to be kept to the minimum possible.

10. **Credit Point:** Credit Point refers to the 'Workload' of a learner and is an index of the number of learning hours deemed for a certain segment of learning. These learning hours may include a variety of learning activities like reading, reflecting, discussing, attending lectures / counselling sessions, watching especially prepared videos, writing assignments, preparing for examinations, etc. Credits assigned for a single course always pay attention to how many hours it would take for a learner to complete a single course successfully. A single course should have, by and large a course may be assigned anywhere between 2 to 8 credit points wherein 1 credit is construed as corresponding to approximately 30 to 40 learning hours.

11. **Credit Completion and Credit Accumulation:** Credit completion or Credit acquisition shall be considered to take place after the learner has successfully cleared all the evaluation criteria with respect to a single course. Thus, a learner who successfully completes a 4 CP (Credit Point) course may be considered to have collected or acquired 4 credits. Learner level of performance above the minimum prescribed level (viz. grades / marks obtained) has no bearing on the number of credits collected or acquired. A learner keeps on adding more and more credits as he completes successfully more and more courses. Thus, the learner 'accumulates' course wise credits.

12. **Credit Bank:** A Credit Bank in simple terms refers to stored and dynamically updated information regarding the number of Credits obtained by any given learner along with details regarding the course/s for which Credit has been given, the course-level, nature, etc. In addition, all the information regarding the number of Credits transferred to different programs or credit exemptions given may also be stored with the individual's history.

13. **Credit Transfer:** (performance transfer) When a learner successfully completes a program, he/she is allowed to transfer his/her past performance to another academic program having

some common courses and Performance transfer is said to have taken place.

14. **Course Exemption:** Occasionally, when two academic programs offered by a single university or by more than one university, may have some common or equivalent course-content, the learner who has already completed one of these academic programs is allowed to skip these 'equivalent' courses while registering for the new program. The Learner is 'exempted' from 'relearning' the common or equivalent content area and from re-appearing for the concerned examinations. It is thus taken for granted that the learner has already collected in the past the credits corresponding to the exempted courses.

Part-II

**O***** The fees for transfer of credits or performance will be based on the number of credits that a learner has to complete for award of the degree.**

**The Scheme of Teaching and Examination:**
The performance of the learners shall be evaluated in two components: Internal Assessment with 25% marks by way of continuous evaluation and by Semester End Examination with 50% marks by conducting the theory examination.

**INTERNAL ASSESSMENT: - It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the credit-based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.**

## 1. For Theory Courses

| Sr. No. | Particulars | Marks |
|---|---|---|
| 1 | Self-Learning Evaluation | 15 Marks |

## For Courses with Practical

Each practical course can be conducted out of 25 marks

**The semester end examination (external component) of 60% for each course will be as follows:**

i) **Duration** – **2 Hours**

ii) **Theory Question**

**Paper Pattern**: -

1. There shall be three questions each of 20 marks. On each unit there will be one question.
2. All questions shall be compulsory with internal choice within the questions. (Each question will be of 30 marks with options.)
3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depend on the weightage of the topic.

The marks will be given for all examinations and they will be converted into grade (quality) points. The semester-end, final grade sheets and transcripts will have only credits, grades, grade points, SGPA and CGPA.

## 3. Project:

• Project which can in the following forms

− Case Studies

− Videos

− Blogs

− Research paper (Presented in Seminar/Conference)

− Field Visit Report

− Presentations related to the subject (Moot Court, Youth Parliament, etc.)

− Internships (Exposition of theory into practice)

− Open Book Test

− any other innovative methods adopted with the prior approval of Director Board of Examination and Evaluation.

## 4. Self-Learning Evaluation:

**− 20% OF THE TOPICS OF CURRICULUM ARE LEARNED BY THE STUDENT THROUGH SELF LEARNING USING ONLINE / OFFLINE ACADEMIC RESOURSE SPECIFIED IN THE CURRICULUM.**

**− HENCE 20% OF THE LECTURES SHALL BE ALLOCATED FOR EVALUATION OF STUDENTS ON SELF LEARNING TOPICS**

**− The identified topics in the syllabus shall be learnt independently by the students in a time bound manner preferably from online resources. Evaluative sessions shall be conducted by the teachers and will carry 10 Marks.**

**CLUB the self-learning topics into 3-4 GROUPS OF TOPICS ONLY FOR EVALUATION.**

**- PRESCRIBE TIME DURATION (IN DAYS) FOR COMPLETION OF EACH GROUP OF TOPIC AND EARMARK SELF LEARNING EVALUATION LECTURES IN THE IMETABLE. HENCE EACH GROUP OF TOPIC CAN BE ASSIGNED 3 REGULAR LECTURES FOR THIS EVALUATION FOR THE ENTIRE CLASS**

**3 Sub Topics**

Each evaluative session shall carry 5 Marks.

**4 Sub Topics**

Each evaluative session shall carry 5 Marks

**EVALUATION OF SELF LEARNING TOPICS CAN COMMENCE IN REGULAR LECTURES ASSIGNED FOR SELF LEARNING EVALUATION IN THE TIMETABLE**

**3 Evaluative sessions**

Each evaluative session shall carry 5 Marks

**4 Evaluative sessions**

Each evaluative session shall carry 5 Marks

## Methods for Evaluation of Self-learning topics:

− Seminars/presentation (PPT or poster), followed by Q&A − Objective questions /Quiz / Framing of MCQ questions.

− Debates

− Group discussion

− You-Tube videos (Marks shall be based on the quality and viewership)

− Improvisation of videos

− Role Play followed by question-answers

**TEACHERS CAN FRAME OTHER METHODS OF EVALUATION ALSO PROVIDED THAT THE METHOD, DULY APPROVED BY THE COLLEGE EXAMINATION COMMITTEE, IS NOTIFIED TO THE STUDENTS AT LEAST 7 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION AND IS FORWARDED FOR INFORMATION AND NECESSARY ACTION AT LEAT 3 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION.**

− Viva Voce

− Any other innovative method

## SEMESTER END EXAMINATION: -

**It is defined as the examination of the learners on the basis of performance in the semester end theory / written examinations.**

**B. Semester End Examination- 60 Marks**

1) Duration – These examinations shall be of 2.5 Hours duration.

2) Question Paper Pattern: -

i. There shall be four questions each of 15 marks.

ii. All questions shall be compulsory with internal choice within the questions.

iii. Question may be sub-divided into sub-questions a, b, c, d, e & f only and the allocation of marks depends on the weightage of the topic.

THE MARKS OF THE INTERNAL ASSESSMENT SHOULD NOT BE DISCLOSED TO THE STUDENTS TILL THE RESULTS OF THE CORRESPONDING SEMESTER IS DECLARED.

# HSNC University, Mumbai

**(2026-2027)**

Ordinances and Regulations

With Respect to

Choice Based Credit System (CBCS)

For the Programmes Under

**The Faculty of Science and Technology**

For the Course

**Data Science & Business Analytics**

## Curriculum – First Year Postgraduate Programmes (NEP)

## Semester-I and Semester -II

**(2026-2027)**

# Curriculum Structure

(Under NEP Guidelines)

| Course Category | Course Name | Credits |
|---|---|---|
| Major | Statistical Methods | 3 |
| Major | Mathematical Foundation for Data Science | 3 |
| Major | Programming in Python | 3 |
| Discipline Specific Elective | R Programming for Data Analysis | 3 |
| | Cyber Security | 3 |
| Minor | Research Methodology | 4 |
| Practical | Practical of Core Courses | 4 |
| **Total Credits** | | **20** |
| **SEM II** | | |
| **Course Category** | **Course Name** | **Credits** |
| Major | Database Management System | 3 |
| Major | Foundations of Machine Learning | 3 |
| Major | Advanced Statistical methods | 3 |
| Discipline Specific Elective | Cloud Computing | 3 |
| | Financial technology | 3 |
| Practical | Practical of Core Courses | 4 |
| | Internship | 4 |
| **Total Credits** | | **20** |
| | | |

# Statistical Methods

| | | | |
|---|---|---|---|
| **Course Name: Statistical Methods** | | **Course Code:** | |
| **Session Per Week (1 session is 60 minutes)** | | **3** | |
| **Credits** | | **3** | |
| | | **Hours** | **Marks** |
| **Evaluation System** | **Theory Examination** | **2** | **60** |

**Course outcome:**

CO1: Understand and apply measures of dispersion to analyze variability in datasets.
CO2: Compute and interpret skewness and kurtosis to describe the shape of data distributions.
CO3: Apply concepts of conditional probability, independence, and Bayes' theorem in solving real-world problems.
CO4: Define and analyze discrete and continuous random variables along with their probability distributions.
CO5: Compute expectation, variance, and standard deviation of random variables and interpret their significance.
CO6: Apply Binomial, Poisson, Normal, and Exponential distributions to model real-life data.
CO7: Understand the concept of sampling distributions and apply it to large sample analysis.
CO8: Explain estimation techniques and compute point and interval estimates for population parameters.
CO9: Construct and interpret confidence intervals for means and proportions using appropriate distributions.
CO10: Apply statistical distributions such as t, chi-square, and F for inference and data analysis.

| Unit | Content | No. of Lectures |
|---|---|---|
| 1 | **Measures of Dispersion, Skewness & Kurtosis:**<br>1.1 Concept of dispersion. Requirements of good measure.<br>1.2 Absolute and Relative measures of dispersion: Range, Quartile Deviation, Mean absolute deviation, Standard deviation, Variance and Combined variance.<br>Raw moments and central moments and relations between them.<br>1.3 Concept of Skewness and Kurtosis: Measures of Skewness: Karl Pearson's, Bowley's and Coefficient of skewness based on moments, Box Plot.<br>1.4 Conditional probability - Multiplication rule, Independence, Law of total probability, Bayes' theorem | 15 |
| 2 | 2.1 Random Variables - Random variable, Discrete random variable, Probability mass function, Cumulative density function<br>2.2 Expectation and Variance - Expectation of a discrete random variable, Variance, and standard deviation of a discrete random variable. Properties of Expectation and variance. Correlation coefficient. | 15 |

| | | |
|---|---|---|
| | 2.3 Binomial and Poisson random variables - Bernoulli trials, Binomial distribution, Expectation and variance of a binomial random variable, Poisson distribution.<br>2.4 Continuous random variable, Expectation and variance.<br>2.5 Continuous Probability distributions: Normal Distribution and Exponential distribution.<br>2.6 Central Limit theorem (statement only). | |
| 3 | 3.1 Sampling distribution of sample means and sample proportion (For large sample only).<br>Estimation:<br>3.2 Concept of Parameter, statistic, estimator, and estimate.<br>3.3 Properties of good estimator (Only names), unbiasedness and standard error of an estimator. (Development of critical region is not expected.)<br>3.4 Point and Interval estimate of single proportion, difference of two proportions.<br>3.5 Confidence intervals for (i) Mean of Normal population, (ii) difference between means of two independent Normal populations having the same variance.<br>3.6 Introduction of t distribution, Chi square distribution, F distribution<br>3.7 Confidence intervals using t distribution, Chi square distribution, F distribution. | 15 |

**Self – Learning Topics (Unit wise)**

| **Sub Unit** | **Topics** |
|---|---|
| 1 | Absolute and Relative measures of dispersion: Range, Quartile Deviation, Mean absolute deviation, Standard deviation, Variance and Combined variance. |
| **2** | Variance - Expectation of a discrete random variable, Variance, and standard deviation of a discrete random variable.<br>Bernoulli trials, Binomial distribution, Expectation and variance of a binomial random variable, Poisson distribution. |
| **3** | Sampling distribution of sample means<br>Concept of Parameter, statistic, estimator, and estimate.<br>difference of two proportions. |

| | | |
|---|---|---|
| **Course Name: Statistical Methods Practical** | **Course Code** | |
| **Session Per Week (1 session is 60 minutes)** | **2** | |
| **Credits** | **1** | |
| | | |

| **Suggestive list of Practical: Statistical Methods** | |
|---|---|
| **1** | Computation of Measures of Dispersion and Variability |
| **2** | Analysis of Skewness and Kurtosis using Statistical Measures and Box Plot |
| **3** | Application of Conditional Probability and Bayes' Theorem |
| **4** | Study of Random Variables, Expectation and Probability Distributions |
| **5** | Sampling Distribution and Estimation of Population Parameters |
| **6** | Construction of Confidence Intervals using Z, t, Chi-square and F Distributions |

**Reference books:**

1.Excel Statistics-A Quick Guide, Nel J. Salkind, Sage Publications.
2.Zeynep Tufekci, How social media took us from Tahrir Square to Donald Trump.
3.Timnit Gebru et al, Datasheets for Datasets.
4. Rachelle Hampton, The Black Feminists Who Saw the Alt-Right Threat Coming.

**Statistical Methods:**

1. Medhi J.: Statistical Methods, An Introductory Text, Second Edition, New Age InternationalLtd.
2. Agarwal B.L.: Basic Statistics, New Age InternationalLtd.
3. Spiegel M.R.: Theory and Problems of Statistics, Schaum's Publications series. TataMcGraw Hill.
4. Kothari C.R.: Research Methodology, Wiley EasternLimited.
5. David S.: Elementary Probability, Cambridge UniversityPress.
6. Hoel P.G.: Introduction to Mathematical Statistics, Asia PublishingHouse.
7. Hogg R.V. and Tannis E.P.: Probability and Statistical Inference. McMillanPublishing Co. Inc.
8. Pitan Jim: Probability, Narosa PublishingHouse.
9. Goon A.M., Gupta M.K., Dasgupta B.: Fundamentals of Statistics, Volume II: The World Press Private Limited,Calcutta.
10. Gupta and Kapoor: Fundamentals of Applied Statistics, S. Chand
11. Gupta and Kapoor: Fundamentals of Mathematical Statistics, S. Chand
12. Sharma S. D.: Operations Research, Kedar Nath Ram Nath
13. Taha Hamdy A.: Operations Research-An Introduction, Tenth Edition, Pearson

# Mathematical foundation for Data science

| Course Name: Mathematical foundation for Data science | | Course Code: | |
|---|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | | **3** | |
| **Credits** | | **3** | |
| | | **Hours** | **Marks** |
| **Evaluation System** | **Theory Examination** | **2** | **60** |

**Course outcome:**

CO1: Apply matrix operations, determinants, inverses, and factorization techniques (Gaussian elimination, LU, QR) to solve systems of linear equations.
CO2: Analyse linear transformations, eigenvalues, eigenvectors, and matrix diagonalization, and apply advanced concepts such as singular value decomposition (SVD) .
CO3: Compute derivatives of univariate functions and apply them to determine maxima, minima, and Taylor series expansions
CO4: Evaluate partial derivatives, gradients, Jacobians, and Hessians to analyse multivariate functions, including optimization of local and global extrema.
CO5: Evaluate partial derivatives, gradients, Jacobians, and Hessians to analyse multivariate functions, including optimization of local and global extrema.
CO6: Implement numerical techniques such as Bisection method, Newton-Raphson method, and fixed-point iteration to obtain approximate solutions of nonlinear equations.

| Unit | Content | No. of Lectures |
|---|---|---|
| 1 | **Linear Algebra**<br>System of linear equations, Matrix operations, Computation of determinant and inverse of a matrix, Generalized inverse, matrix equations, Solution of system of linear equations by Gaussian elimination, inverse of matrix, LU factorization<br>Linear transformation, eigenvalues and eigenvectors, matrices diagonalization, orthogonality, orthogonal complements, orthogonal Diagonalization, Positive semi definite and position definite, QR-Factorization, Singular value decomposition, Real life applications | 15 |
| 2 | **Differentiation**<br>Differentiation of Univariate Functions, maxima and minima, Taylor series, Differentiation Rules.<br>Partial Differentiation and Gradients, Basic Rules of Partial Differentiation, Chain rule, Jacobian matrix, Gradient of a vector-valued functions, Gradients of Matrices, Higher-Order Derivatives, Hessian Matrix, multivariate Taylor series, multivariate Taylor polynomial, local and global maxima & minima | 15 |

| | | |
|---|---|---|
| 3 | **Optimization Fundamentals and Numerical Methods:** Optimization Fundamentals and Numerical Methods: Local and global extrema, Necessary and sufficient conditions, convex functions, Unconstrained Optimization: Gradient descent, Newton's method, Constrained Optimization: Lagrange multipliers, Numerical Methods for Nonlinear equations: Bisection method, Newton-Raphson, Fixed-point iteration. | 15 |

**Self – Learning Topics (Unit wise)**

| Sub Unit | Topics |
|---|---|
| 1 | System of linear equations, Matrix operations, Computation of determinant and inverse of a matrix, |
| **2** | Differentiation of Univariate Functions, maxima and minima, Differentiation Rules. |
| **3** | Bisection and Newton-Raphson method |

| Course Name**: Mathematical foundation for Data science Practical** | **Course Code** | |
|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | **2** | |
| **Credits** | **1** | |
| Practical: Using MATLAB / Python | | |
| **1** | Matrix Operations, Determinant and Inverse of a Matrix | |
| **2** | Solution of System of Linear Equations using Gaussian Elimination | |
| **3** | LU and QR Factorization of Matrices and Eigenvalues Computation | |
| **4** | Computation of Derivatives and Maxima-Minima of Functions | |
| **5** | Partial Derivatives, Gradient, Jacobian and Hessian Matrix | |
| **6** | T**aylor Series Expansion of Single and Multivariable Functions** | |
| **7** | Root Finding using Bisection and Newton-Raphson Methods | |
| **8** | Optimization using Gradient Descent and Lagrange Multipliers | |

**Reference books:**


1. GGG_Nicholson, _W_Keith_Linear_algebra_with_applications_McGraw_Hill.
2. Mathematics for Machine Learning Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong, Cambridge University Press .
3. Higher Engineering Mathematics- H.K. Dass, Er. Rajnish Verm-S.chand

# Programming in Python

| Course Name: Programming in Python | | Course Code: | |
|---|---|---|---|
| Session Per Week (1 session is 60 minutes) | | 3 | |
| Credits | | 3 | |
| | | Hours | Marks |
| Evaluation System | Theory Examination | 2 | 60 |
| | Internal | - | 15 |
| | Practical Examination | 2 | 25 |

**Course Outcomes**

1. After completion of this course, students will be able to:
2. Apply Python programming concepts to solve basic computational problems.
3. Use NumPy for performing numerical operations and manipulating arrays efficiently.
4. Analyze datasets using Pandas, including cleaning, transforming, and summarizing data.
5. Create meaningful visualizations using Matplotlib and other visualization tools.
6. Integrate programming, analysis, and visualization techniques for basic data science tasks

| Unit | Content | No. of Lectures |
|---|---|---|
| **Unit I: Python Programming Fundamentals & NumPy** | **Basics of Python:** variables, data types, operators, input/output<br>**Introduction to NumPy and array creation**<br>**NumPy operations:** indexing, slicing, reshaping, concatenation, splitting<br>**Computation on arrays:** ufuncs, aggregations, broadcasting, sorting<br>**Advanced topics:** structured arrays, conditional operations, random number generation<br>**Control structures:** conditional statements and loops<br>Functions and basic data structures (list, tuple, set, dictionary) | 15 |
| **Unit 2: Data Analysis using Pandas** | **Introduction to Pandas:** Pandas Objects- Series, Data Frame, Index, Data indexing and selection and filtering, dropping entries from an axis, arithmetic and data alignment, function application and mapping, Summarizing and computing descriptive statistics<br>**Data Cleaning and transformation:** Reshaping, handling missing values, replacing values, removing duplicates, transforming data using a function or mapping, Discretization and Binning, Filtering outliers, permutation and random sampling, computing indicators/Dummy variables, group-wise operations and transformations. | 15 |
| **Unit 3: Data Manipulation & Visualization** | **Matplotlib:** Line plots, Scatter plots, visualizing errors, density and contour plots, Histograms, Bindings and density, customizing plot legend and colorbars, Multiple subplots, Text and Annotations, Customizing ticks, customizing matplotlib configurations and stylesheets, Three-Dimensional plotting in Matplotlib<br>**Alternatives to Matplotlib:** Exploring seaborn plots, Plotly plots, ggplot, PyViz, Bokeh and Panel, Yellow brick, etc. | |

Self-Learning topics (Unit wise)

| Sub Unit | Topics |
|---|---|
| 1 | **Basics of Python:** variables, data types, operators, input/output |
| 2 | Reshaping, handling missing values, replacing values, removing duplicates |
| 3 | Line plots, Scatter plots, Histograms, **Alternatives to Matplotlib:** Exploring seaborn plots, Plotly plots, ggplot, PyViz, Bokeh and Panel, Yellow brick, etc. |

| Course Name: **Programming in Python Practical** | **Course Code** | |
|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | **2** | |
| **Credits** | **1** | |

**Suggestive List of Practical:**

Practical should be based on:

1. Python Programming Fundamentals
2. NumPy Array Operations
3. Data Handling using Pandas
4. Data Cleaning and Transformation
5. Data Manipulation and Analysis
6. Data Visualization

**Reference Books:**


1. **Lutz, Mark.** *Learning Python* (5th Edition). O'Reilly Media, 2013.
2. **Downey, Allen B.** *Think Python: How to Think Like a Computer Scientist* (2nd Edition). O'Reilly Media, 2015.
3. **VanderPlas, Jake.** *Python Data Science Handbook: Essential Tools for Working with Data*. O'Reilly Media, 2016.
4. **McKinney, Wes.** *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython* (2nd Edition). O'Reilly Media, 2017.
5. **Grus, Joel.** *Data Science from Scratch: First Principles with Python* (2nd Edition). O'Reilly Media, 2019.
6. **Geron, Aurélien.** *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow* (2nd Edition). O'Reilly Media, 2019.
7. **Hunter, John D. et al.** *Matplotlib for Python Developers*. Packt Publishing, 2013.
8. **VanderPlas, Jake.** *Introduction to Machine Learning with Python: A Guide for Data Scientists*. O'Reilly Media, 2016.

**R Programming for Data Analysis**

**R Programming for Data Analysis** **(Total Hours : 45 Lectures)**

| Unit | Content | No. of Lectures |
|---|---|---|
| 1 | Fundamentals of R<br>Introduction to R features of R, installation of R, Starting and ending R session, getting help in R ,<br>Value assigning to variables.<br>Basic Operations: +, -, *, ÷, ^, sqrt.<br>Numerical functions: log 10, log , sort, max, unique, range, length, var, prod, sum, summary, dim, sort, five num etc.<br>Reading and writing data: From and to CSV files and HTML.<br>Data Type: Vector, list, matrices, array and data frame 1.7 Variable Type: logical, numeric, integer, complex, character and factor.<br>Operations on matrices.<br>Control statements: if, if-else, if-else-if, while loop, for loop. 1.10 Defining functions and Printing outputs. | 15 |
| 2 | Data Handling<br>Data Manipulation: Selecting random N rows, removing duplicate row(s), dropping a variable(s), Renaming variable(s), sub setting data, creating a new variable(s), selecting of random fraction of row(s), appending of row(s) and column(s), simulation of variables.<br>Data Processing: Data import and export, setting working directory, checking structure of Data :Str(), Class(),, Changing type of variable (for eg as.factor, as.numeric)<br>Introduction to dplyr and data.table packages<br>Data Visualisation using simple functions and ggplot: Simple bar diagram, subdivided bar diagram, multiple bar diagram, pie diagram, Box plot for one and more variables, histogram, frequency polygon, scatter plot eg plot(), correlation plot. | 15 |
| 3 | Statistical Computing:<br>Descriptive Statistics: Averages, Positional Averages, Dispersion, Skewness , Kurtosis, Correlation Curve Fitting and Regression<br>Some Probability Distributions: Plotting of pmf/pdf, cdf, computation of probabilities of Binomial, Poisson, Normal, Exponential.<br>Statistical Tests for t, Chi-square, F and ANOVA<br>Operations Research Techniques:<br>A Concept and Mathematical Formulation of Linear Programming Problem, Transportation Problems and Assignment Problems.<br>Numerical problems of all above using lpSolve. | 15 |

**Self-Learning topics (Unit wise)**

| Sub Unit | Topics |
|---|---|
| 1 | Introduction to R features of R, installation of R, Starting and ending R session, getting help in R, Operations on matrices. |
| 2 | Data Visualisation using simple functions and ggplot: Simple bar diagram, subdivided bar diagram, multiple bar diagram, pie diagram, Box plot for one and more variables, histogram, frequency polygon, scatter plot eg plot(), correlation plot. |
| 3 | Descriptive Statistics: Averages, Positional Averages, Dispersion, Skewness , Kurtosis, Correlation Curve Fitting and Regression |

| **Course Name: R Programming for Data Analysis Practical** | **Course Code** | |
|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | **2** | |
| **Credits** | **1** | |
| | | |

| Suggested list of Practical: **R Programming for Data Analysis** | |
|---|---|
| 1 | Introduction to R and Basic Operations |
| 2 | Data Import, Export and Data Structures in R |
| 3 | Control Structures and User-Defined Functions in R |
| 4 | Data Manipulation and Processing using R |
| 5 | Data Visualization using Base R and ggplot2 |
| 6 | Statistical Analysis and Operations Research using R |

**Reference Books:**


1. Crawley, M. J. (2006). Statistics - An Introduction Using R. John Wiley, London.
2. Purohit, S. G.; Gore, S. D. and Deshmukh, S. R. (2015). Statistics Using R (Second Edition). Narosa Publishing House, New Delhi.
3. Shahababa, B. (2011). Biostatistics with R. Springer, New York.
4. Verzani, J. (2005). Using R for Introductory Statistics. Chapman and Hall/CRC Press, New York.
5. Matloff, N. (2011). The Art of R Programming. No Starch Press, San Francisco.
6. Wickham, H. and Grolemund, G. (2017). R for Data Science. O'Reilly Media, New York.
7. Dalgaard, P. (2008). Introductory Statistics with R (Second Edition). Springer, New York.
8. Grolemund, G. (2014). Hands-On Programming with R. O'Reilly Media, New York.
9. Taha, H. A. (2017). Operations Research: An Introduction (Tenth Edition). Pearson, New Delhi.
10. Venables, W. N. and Ripley, B. D. (2002). Modern Applied Statistics with S (Fourth Edition). Springer, New York.

# Cyber Security

**Cyber Security** **(Total Hours : 45 Lectures)**

| Unit | Content | No. of Lectures |
|---|---|---|
| 1 | **Social Media Security**<br>1.1 Introduction to Cyber Space: History of Internet, Cyber Crime, Information Security, Computer Ethics and Security Policies 1.2 Choosing the Best Browser according to the requirement and email security: Guidelines to choose web browsers, Securing web browser, Antivirus, Email security<br>1.3 Guidelines for secure password and wi-fi security<br>1.4 Guidelines for setting up a Secure password<br>1.5 Two-steps authentication<br>1.6 Password Manager<br>1.7 Wi-Fi Security<br>1.8 Guidelines for social media and basic Windows security 1.9 Guidelines for social media security<br>1.10Tips and best practices for safer Social Networking<br>1.11Basic Security for Windows<br>1.12User Account Password | 15 |
| 2 | **Security Guidelines**<br>Smartphone security guidelines: Introduction to mobile phones, Smartphone Security, Android Security, IOS Security<br>Cyber Security Initiatives in India: Counter Cyber Security Initiatives in India, Cyber Security Exercise, Cyber Security Incident Handling, Cyber Security Assurance<br>Online Banking, Credit Card and UPI Security: Online Banking Security, Mobile Banking Security, Security of Debit and Credit Card, UPI Security, Micro ATM, e-wallet and POS Security, Security of Micro ATMs.<br>2.4 e-wallet Security Guidelines<br>2.5 Security Guidelines for Point of Sales(POS) | 15 |
| 3 | **Social Engineering and IT Security**<br>Social Engineering: Social Engineering, Types of Social Engineering, How Cyber Criminal Works, How to prevent for being a victim of Cyber Crime.<br>Cyber Security Threat Landscape and Techniques: Cyber Security Threat Landscape, Emerging Cyber Security Threats, Cyber Security Techniques.<br>IT Security Act and Misc. Topics: IT Act, Hackers-Attacker Countermeasures, Web Application Security, Digital Infrastructure Security, Defensive Programming<br>3.4 Information Destroying and Recovery Tools<br>3.5 Recovering from Information Loss | 15 |

| | | |
|---|---|---|
| | 3.6 Destroying Sensitive Information<br>3.7 CCleaner for Windows | |

Self-Learning topics (Unit wise)

| Sub Unit | Topics |
|---|---|
| 2 | Online Banking, Credit Card and UPI Security: Online Banking Security, Mobile Banking Security, Security of Debit and Credit Card, UPI Security, Micro ATM, e-wallet and POS Security, Security of Micro ATMs. e-wallet Security Guidelines, Security Guidelines for Point of Sales(POS) |
| 3 | Engineering: Social Engineering, Types of Social Engineering, How Cyber Criminal Works, How to prevent for being a victim of Cyber Crime. |

| **Course Name: Cyber Security Practical** | **Course Code** | |
|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | **2** | |
| **Credits** | **1** | |
| | | |

**Any 8 practical on topics studied**

# SEMESTER II

# Database Management System

| Course Name: Database Management System | | Course Code: | |
|---|---|---|---|
| Session Per Week (1 session is 60 minutes) | | 3 | |
| Credits | | 3 | |
| | | Hours | Marks |
| Evaluation System | Theory Examination | 2 | 60 |
| | Internal | - | 15 |

**Course outcome:**

1. To define program-data independence, data models for database systems, database schema and database instances.
2. To recall Relational Algebra concepts, and use it to translate queries to Relational Algebra.
3. To classify the methodology of conceptual modeling through Entity Relationship model.
4. To identify the methodology of logical model and also identify the methodology of physical model.
5. To distinguish Structure Query Language statements used in creation and manipulation of database.

| Unit | Content | No. of lectures |
|---|---|---|
| **1 Introduction to DBMS** | **1.1 Introduction to DBMS:** Database, DBMS – Definition, Overview of DBMS, Advantages of DBMS, Levels of abstraction, Data independence, DBMS Architecture<br>**1.2 Data models:** Architecture (1-tier, 2-tier, 3-tier and N-tier), Relational, Hierarchical, Network Data Model<br>**1.3 Entity Relationship Model:** Entities, attributes, entity sets, relations, relationship sets, weak entities, aggregation / generalization, Conceptual Design using ER (entities VS attributes, Entity Vs relationship, binary Vs ternary, constraints beyond ER)<br>**1.4 ER to Table**: Entity to Table, Relationship to tables with and without key constraints.<br>**1.5 Transaction management:** Transaction, Concurrency, ACID Properties, States of Transaction<br>**1.6 Schema refinement and Normal forms:** Functional dependencies, first, second, third, and BCNF normal forms | **15** |
| **2 Basics of SQL** | **2.1 Relational Algebra:** operations (selection, projection, set operations, union, intersection, difference, cross product, Joins –conditional, equijoin and natural joins, division)<br>**2.2 Categories of SQL Commands:** Creating Databases, Using Database, Data Definition Language, Data Manipulation Language, Data Control Language and | **15** |

| | | |
|---|---|---|
| | Transaction Control Language, Backing Up and Restoring databases<br>**2.3 Integrity Constraints:** Integrity of Data, Entity Integrity Constraints (Primary, Unique, Composite Keys), Domain Integrity Constraint (Check, Not NULL), Referential Integrity Constraints<br>**2.4 Aggregate Functions:** Definition, Average, Count, Sum, Min, Max, Group by and Having Clause<br>**2.5 Clauses:** IN, Between, Distinct, LIKE operator, Limit, Offset, Order By | |
| **3 Advanced SQL** | **3.1 Functions:** String Functions (concat, instr, left, right, mid, length, lcase/lower, ucase/upper, replace, strcmp, trim, ltrim, rtrim), Math Functions (abs, ceil, floor, mod, pow, sqrt, round, truncate) Date Functions (adddate, datediff, day, month, year, hour, min, sec, now, reverse)<br>**3.2 Joining Tables:** inner join, outer join (left outer, right outer, full outer), Cross Join<br>**3.3 Sub queries:** Sub queries with IN, EXISTS, sub queries restrictions, Nested sub queries, ANY/ALL clause, correlated sub queries<br>**3.4 Database Protection:** Security Issues, Threats to Databases, Security Mechanisms, Role of DBA, Discretionary Access Control<br>**3.5 Views:** Creating, altering dropping, renaming and manipulating views | **15** |

**Self – Learning Topics (Unit wise)**

| Sub Unit | Topics |
|---|---|
| **1** | **Entity Relationship Model:** Entities, attributes, entity sets, relations, relationship sets, weak entities, aggregation / generalization, Conceptual Design using ER (entities VS attributes, Entity Vs relationship, binary Vs ternary, constraints beyond ER) |
| **2** | **Relational Algebra:** operations (selection, projection, set operations, union, intersection, difference, cross product, Joins –conditional, equijoin and natural joins, division) |
| **3** | **Database Protection:** Security Issues, Threats to Databases, Security Mechanisms, Role of DBA, Discretionary Access Control |

| **Course Name: Database Management System Practical** | **Course Code** | |
|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | **2** | |
| **Credits** | **1** | |

| List of Practical: Database Management System Practical | |
|---|---|
| **1** | For given scenario, Draw E-R diagram and convert entities and relationships to table. |
| **2** | Write relational algebra queries on the tables created in Practical-1. |
| **3** | Perform queries for: Viewing all databases, creating a Database, viewing all Tables in a Database, Creating Tables (With and Without Constraints), Inserting/Updating/Deleting Records in a Table, Saving (Commit) and Undoing (rollback) |
| **4** | Perform queries for: Altering a Table, Dropping / Truncating / Renaming Tables, backing up / Restoring a Database |
| **5** | Perform queries for: Simple Queries, Simple Queries with Aggregate functions, Queries with Aggregate functions (group by and having clause) |
| **6** | Queries involving: Date Functions, String Functions, Math Functions |
| **7** | Join Queries: Inner Join, Outer Join, Full Outer Join |
| **8** | Sub queries: With IN clause, With EXISTS clause |
| **9** | Views: Creating Views (with and without check option), Dropping views, Selecting from a view |
| **10** | DCL statements: Granting and revoking permissions. |

**Reference books:**


| | |
|---|---|
| **1.** | Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Pearson Education, Sixth Edition, 2010. |
| **2.** | Ramakrishnam Gehrke, Database Management Systems, McGraw-Hill, 2007. |
| **3.** | Joel Murach, Murach's MySQL, Murach, 2012. |
| **4.** | Avi Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, McGraw-Hill |

# Foundations of Machine Learning

| Course Name: Foundations of Machine Learning | | Course Code: | |
|---|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | | **3** | |
| **Credits** | | **3** | |
| | | **Hours** | **Marks** |
| **Evaluation System** | **Theory Examination** | **2** | **60** |
| | **Internal** | **-** | **15** |

**Course Outcomes**

After completion of this course students will be able to:

- To Understand core concepts of Machine Learning.
- To Apply supervised learning algorithms.
- To Implement unsupervised learning techniques.
- To Evaluate and optimize ML models.

| Unit | Content | No. of lectures |
|---|---|---|
| **Unit I: Introduction & Supervised Learning** | Introduction to Machine Learning: Definition, types (Supervised, Unsupervised, Reinforcement Learning), applications<br>ML Pipeline: Data collection, pre-processing, model building, evaluation<br>Data Pre-processing: Missing values, encoding, feature scaling<br>Train-Test Split and Cross Validation (basic)<br>Regression: Simple and Multiple Linear Regression<br>Classification: Logistic Regression<br>Decision Trees (basic concepts)<br>Model Evaluation: Regression and classification metrics, confusion matrix | **15** |
| **Unit II: Advanced Supervised & Unsupervised Learning** | Support Vector Machines: Linear SVM<br>Clustering: k-Means, Hierarchical Clustering, DBSCAN<br>Cluster evaluation: Silhouette score<br>Dimensionality Reduction: PCA (concept and applications)<br>Association Rule Learning: Apriori algorithm (concept) | **15** |
| **Unit III: Model Optimization & Introduction to Advanced ML** | Ensemble Learning: Bagging and Random Forest<br>Boosting: Concept and AdaBoost<br>Bias-Variance Tradeoff<br>Overfitting and Underfitting<br>Hyperparameter Tuning: Grid Search<br>Gradient Boosting (concept)<br>XGBoost (overview)<br>Model Interpretability (basic) | **15** |

| | | |
|---|---|---|
| | Data Leakage and Ethics in ML | |

**Self – Learning Topics (Unit wise)**

| Sub Unit | Topics |
|---|---|
| **1** | Data collection, pre-processing, model building, evaluation, Data collection, pre-processing, model building, evaluation |
| **2** | Support Vector Machines: Linear SVM |
| **3** | Bias-Variance Tradeoff<br>Overfitting and Underfitting |

| **Course Name: Machine Learning Practical** | **Course Code** | |
|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | **2** | |
| **Credits** | **1** | |

Suggestive topics for practical:

- Data Pre-processing and ML Pipeline
- Simple & Multiple Linear Regression
- Logistic Regression (Classification)
- Decision Tree Classifier
- Support Vector Machine (Linear SVM)
- K-Means Clustering
- Hierarchical Clustering & DBSCAN
- Model Optimization & Ensemble learning

**Reference Books:**

1. Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow by **Aurélien Géron**, O'Reilly
2. An Introduction to Statistical Learning, Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, Springer, 2013.
3. Babcock, J. (2016), Mastering Predictive Analytics with Python, PACKT Open Source
4. Miller, J. D. & Forte, R. M. (2015), Mastering Predictive Analytics with R (2nd Ed.), PACKT Open Source
5. Lantz, B. (2013), Machine Learning with R (2nd Ed.), PACKT Open Source

| | | | |
|---|---|---|---|
| **Course Name: Advanced Statistical methods** | | **Course Code:** | |
| **Session Per Week (1 session is 60 minutes)** | | **3** | |
| **Credits** | | **3** | |
| | | **Hours** | **Marks** |
| **Evaluation System** | **Theory Examination** | **2** | **60** |
| | **Internal** | **-** | **15** |

# Advanced Statistical methods

| Unit | Content | No. of Lectures |
|---|---|---|
| 1 | Testing of hypothesis:<br>Concept of hypothesis, Simple Hypothesis and composite hypothesis, Null and alternate hypothesis, Types of errors, Critical region, Level of significance.<br><br>Large sample tests:<br>Test of significance for specified value of mean of Normal population.<br>Test of significance for difference between means of two independent Normal populations with equal variances and unequal variances.<br>Exact tests using t distribution:<br>Independents and Dependent samples (Paired t test)<br><br>Applications of Chi-Square:<br>Testing for association, Testing for variance, Testing for goodness of fit.<br><br>Applications of F:<br>Test procedure for testing equality of variances of two independent Normal populations<br>i. Mean is known<br>ii. Mean is unknown. | 15 |
| 2 | Linear models: Linear parametric function and its estimability, Gauss Markoff theorem, Interval estimates and test of hypothesis, fundamental theorems on conditional error ss, Test of $\beta=d$, generalized least squares<br>Analysis of variance, fixed effect models: (i) One –way classification model. (ii) Checking assumptions of ANOVA Model. (iii) Simultaneous Confidence Intervals: Scheffe's, Bonferroni and Turkey's interval. | 15 |

| | | |
|---|---|---|
| | Two – way classification model with and without interaction effect, one observation per cell .Tukey's test for non-additivity. | |
| 3 | Generalized Linear models:<br>GLM for Binary data: Linear probability model, Logistic regression model and Probit regression model.<br>GLM for Count data: Poissons regression, Negative Binomial regression.<br>Model with constant coefficient of variation: Gamma Regression, Variance function, Canonical link, Multiplicative model- Log link and Linear model- Identity link. | 15 |

**Self-Learning topics (Unit wise)**

| Sub Unit | Topics |
|---|---|
| 1 | Test of significance for difference between means of two independent Normal populations with equal variances and unequal variances.<br>Test procedure for testing equality of variances of two independent Normal<br>ii. Mean is unknown. |
| 2 | Confidence Intervals: Scheffe's, Bonferroni and Turkey's interval. |
| 3 | Probit regression model, Negative Binomial regression. |

| **Course Name: Advanced Statistical Methods Practical** | **Course Code** | |
|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | **2** | |
| **Credits** | **1** | |

| Suggested List of Practical: Advanced Statistical Methods | |
|---|---|
| 1 | Fundamentals of Hypothesis Testing and Error Types |
| 2 | Large Sample and t-Tests |
| 3 | Chi-Square and F-Tests Applications |
| 4 | Linear Models and Estimation Techniques |
| 5 | Analysis of Variance (ANOVA) and Multiple Comparisons |
| 6 | Introduction to Linear and Generalized Linear Models |

**References:**

1. Medhi J. : Statistical Methods, An Introductory Text, Second Edition,New Age InternationalLtd.
2. Agarwal B.L. : Basic Statistics, New Age InternationalLtd.

3. Spiegel M.R. : Theory and Problems of Statistics, Schaum's Publications series. TataMcGrawHill.
4. Kothari C.R. : Research Methodology, Wiley EasternLimited.
5. David S. : Elementary Probability, Cambridge UniversityPress.
6. Hoel P.G. : Introduction to Mathematical Statistics, Asia PublishingHouse.
7. Hogg R.V. and Tannis E.P. : Probability and Statistical Inference. McMillanPublishing Co. Inc.
8. Pitan Jim : Probability, Narosa PublishingHouse.
9. Goon A.M., Gupta M.K., Dasgupta B. : Fundamentals of Statistics, Volume II : The World Press Private Limited,Calcutta.
10. Gupta and Kapoor: Fundamentals of Applied Statistics, S. Chand
11. Gupta and Kapoor: Fundamentals of Mathematical Statistics, S. Chand

| Course Name: Cloud Computing | | Course Code: | |
|---|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | | **3** | |
| **Credits** | | **3** | |
| | | **Hours** | **Marks** |
| **Evaluation System** | **Theory Examination** | **2** | **60** |
| | **Internal** | **-** | **15** |

# Cloud Computing

| Unit | Content | No. of Lectures |
|---|---|---|
| 1 | **Networking Concepts & Distributed Systems**<br>1.1 Introduction to networking<br>1.2 Classification of networks<br>1.3 Cloud Architecture<br>1.4 Cloud DevOps<br>1.5 Virtualization<br>1.6 Types of Operating systems<br>1.7 Hypervisors & Virtual Machines<br>1.8 Parallel Computing | 15 |
| 2 | **Cloud Computing and Security**<br>2.1 Cloud Service Models<br>2.2 Cloud Deployment Models<br>2.3Identity and Access Management | 15 |
| 3 | **Business demands and needs**<br>1.1 Migrating to Cloud<br>1.2 Deployment of cloud based tools<br>1.3 Ease of cloud resource management<br>3.4 Financial projections w.r.t cloud<br>3.5 Comparison between CSPs (AWS, Azure, GCP Etc.) | 15 |

**Self-Learning topics (Unit wise)**

| Sub Unit | Topics |
|---|---|
| 1 | 1.2 Classification of networks |

| | |
|---|---|
| | 1.7 Hypervisors & Virtual Machines |
| 3 | 3.5 Comparison between CSPs (AWS, Azure, GCP Etc.) |

| **Course Name: Cloud Computing Practical** | **Course Code** | |
|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | **2** | |
| **Credits** | **1** | |

**Any 8 practical on topics studied**

**References:**


1. Cloud Computing: Concepts, Technology & Architecture by Thomas Erl, Ricardo Puttini , Zaigham Mahmood (The Pearson Service Technology Series from Thomas Erl)
2. Infrastructure as Code: Dynamic Systems for the Cloud Age, by Kief Morris**,** Second Edition
3. Multi-Cloud Architecture and Governance: Leverage Azure, AWS, GCP, and VMware vSphere to build effective multi-cloud solutions by Jeroen Mulder
4. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things by Hwang

| | | | |
|---|---|---|---|
| **Course Name: Financial Technology** | | **Course Code:** | |
| **Session Per Week (1 session is 60 minutes)** | | **3** | |
| **Credits** | | **3** | |
| | | **Hours** | **Marks** |
| **Evaluation System** | **Theory Examination** | **2** | **60** |
| | **Internal** | **-** | **15** |

# Financial technology

| Unit | Content | No. of Lectures |
|---|---|---|
| 1 | **Introduction to Fintech**<br>Basic of Fintech<br>Categories & Types of Fintech<br>Fintech v/s Traditional Banking & Finance<br>Technology Used in Fintech<br>Rise of Fintech<br>Emerging Sectors in Fintech<br>Impact of Fintech<br>Fintech Ecosystems<br>Fintech Segmentation | 15 |
| 2 | **Working of Fintech**<br>AI and Machine Learning<br>Blockchain Technology<br>Introduction to Crypto Currency, Cryto Wallets<br>Payment Gateways<br>Algorithm Trading<br>Data Analytics application in Fintech<br>Valuation of a fintech organization at different stages | 15 |
| 3 | **Sectors in Fintech**<br>Digital Lending<br>Digital Banking<br>Digital Identity<br>Digital Wallet<br>Asset Management<br>Alternative Insurance Underwriting<br>Alternative Credit Score<br>**Regulations in Fintech & Case Studies** | 15 |

| | | |
|---|---|---|
| | **Regulations**<br>FinTech Regulations<br>Global FinTech-enabling Regulations Database<br>Evolving Regulations<br>Regulatory and policy developments in the use and governance of blockchain and cryptocurrencies<br>**Case Studies**<br>M-Pesa<br>Goldman Sachs' Digital Journey<br>The NEAT Account : Fintech Innovation in Hongkong<br>Paytm : Building a Payment Network<br>Binance<br>Fidelity Investments<br>**Analysis** :<br>How Existing products can benefit from Fintech Trends | |

**Self-Learning topics (Unit wise)**

| Sub Unit | Topics |
|---|---|
| 1 | Rise of Fintech<br>Emerging Sectors in Fintech |
| 2 | Data Analytics application in Fintech<br>Valuation of a fintech organization at different stages |
| 3 | **Case Studies**<br>M-Pesa<br>Goldman Sachs' Digital Journey |

| **Course Name: Financial Technology Practical** | **Course Code** | |
|---|---|---|
| **Session Per Week (1 session is 60 minutes)** | **2** | |
| **Credits** | **1** | |

**Any 8 practical on topics studied**

**References:**


1. Fintech and the Future of Finance: Market and Policy Implications by Erik Feyen, Harish Natarajan, Matthew Saal
2. Foundations in Fintech and Cryptocurrency by Shoba Premkumar