# DEPARTMENT OF DATA SCIENCE AND ARTIFICIAL INTELLIGENCE

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# SYLLABUS OF

# BACHELOR OF TECHNOLOGY

# [Effective for 2021batch]

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| **Course Structure & Syllabus for B. Tech (Data Science & AI)** | | | |
| **1st SEM.** | | | |
| **Sub. Code** | **Subject Name** | **Credits** | **Total Credits** |
| MA 1101 | Engineering Mathematics–I | 4 | 20 |
| CE 1102 | Mechanics of Solids | 3 |
| PH 1103 | Engineering Physics | 4 |
| ME 1105 | Engineering Graphics | 3 |
| BA 1106 | Communication Skills | 3 |
| ME 1161 | Workshop Practice | 1.5 |
| PH 1162 | Engineering Physics Lab | 1.5 |
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| **Course Structure & Syllabus for B. Tech (Data Science & AI)** | | | |
| **2nd SEM.** | | | |
| **Sub. Code** | **Subject Name** | **Credits** | **Total Credits** |
| MA 1201 | Engineering Mathematics–II | 4 | 18 |
| CH 1108 | Engineering Chemistry | 4 |
| EE 1109 | Elements of Electrical Engineering | 3 |
| CS 1110 | Computer Programming using C | 4 |
| CH 1191 | Environmental Science\* | 0 |
| CH 1163 | Engineering Chemistry Lab | 1.5 |
| CS 1164 | Computer Programming Lab | 1.5 |
| \*Mandatory audit course | | | |
| **Course Structure & Syllabus for B. Tech (Data Science & AI)** | | | |
| **3rd SEM.** | | | |
| **Sub. Code** | **Subject Name** | **Credits** | **Total Credits** |
| MA 1301 | Mathematical Foundations for Data Science-I | 3 | 22.5 |
| HU 1302 | Finance & Econometrics | 3 |
| DS 1303 | Introduction to Data Analytics | 3 |
| DS 1304 | Object Oriented Programming | 3 |
| DS 1305 | Data Structures | 3 |
| DS1306 | Computer System Architecture | 3 |
| BP 1391 | Constitution of India\* | 1 |
| DS 1361 | Data Analytics Lab | 1.5 |
| DS 1362 | Object Oriented Programming Lab | 1.5 |
| DS 1363 | Data Structures Lab | 1.5 |
| \*Mandatory audit course | | |

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| **Course Structure & Syllabus for B. Tech (Data Science & AI)**  **4th SEM.** | | | | |
| **Sub. Code** | **Subject Name** | **Credits** | **Total Credits** |
| MA 1401 | Mathematical Foundations For Data Science-II | 3 | 22.5 |
| DS 1402 | Database Systems | 3 |
| DS 1403 | Machine Learning | 3 |
| DS 1404 | Design & Analysis of Algorithms | 3 |
| DS 1405 | Data Communications and Networks | 3 |
| DS 1431 | Program Elective-I. | 3 |
| DS 1461 | Database Lab | 1.5 |
| DS 1462 | Machine Learning Lab | 1.5 |
| DS 1463 | Design & Analysis of Algorithms Lab | 1.5 |
| **Course Structure & Syllabus for B. Tech (Data Science & AI)**  **5th SEM.** | | | | |
| **Sub. Code** | **Subject Name** | **Credits** | **Total Credits** |
| MA 1501 | Mathematical Foundations For Data Science-III | 3 | 21.5 |
| DS 1501 | Deep Learning | 3 |
| DS 1502 | Operating Systems | 3 |
| DS 1503 | Natural Language Processing | 3 |
| DS 1504 | Cloud Computing | 3 |
| DS 1531 | Program Elective – II | 3 |
| DS 1562 | Operating Systems Lab | 1.5 |
| DS 1563 | Web Technologies Lab | 1.5 |
| DS 1581 | Industrial Training, I | 0.5 |
| **Course Structure & Syllabus for B. Tech (Data Science & AI)**  **6th SEM.** | | | | |
| **Sub. Code** | **Subject Name** | **Credits** | **Total Credits** |
| HU 1601 | Operations Research | 3 | 23.5 |
| DS 1601 | Artificial Intelligence | 3 |
| DS 1602 | Parallel Programming | 3 |
| DS 1603 | Big Data Analytics | 3 |
| DS 1604 | Data Privacy & Security | 3 |
| DS 1605 | Remote Sensing in Data Science | 3 |
| DS 1561 | Artificial Intelligence and Deep Learning Lab | 1.5 |
| DS 1662 | Big Data Analytics Lab | 1.5 |
| DS 1671 | Mini Project | 2 |
| DS 1681 | Industrial Training II | 0.5 |

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| **Course Structure & Syllabus for B. Tech (Data Science & AI)** | | | |
| **7th SEM.** | | | |
| **Sub. Code** | **Subject Name** | **Credits** | **Total Credits** |
| DS 1751 | Software Engineering | 4 | 20 |
| DS 1752 | Internet of Thing | 4 |
| DS 1733\* | Program Elective - III | 3 |
| DS 1734\* | Program Elective - IV | 3 |
| DS 1735\* | Program Elective - V | 3 |
| DS 1721\* | Open Elective - I | 3 |

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| **Course Structure & Syllabus for B. Tech (Data Science & AI)** | | | |
| **8th SEM.** | | | |
| **Sub. Code** | **Subject Name** | **Credits** | **Total Credits** |
| DS 1871 | Project Work/ Practice School (MAJOR PROJECT) | 12 | 12 |

**Total Credits:- 20+18+22.5+22.5+21.5+23.5+20+12 = 160**

**Promotion Criteria**

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| **Minimum No. of credits to be earned for promotion (2021-2022 Admitted Batch)** | | |
| **B. Tech** | | |
| **From** | **To** | **Min. credits to be earned** |
| I Year | II Year | 23/38 |
| II Year | III Year | 55/83 |
| III Year | IV Year | 95/128 |
| Final | Final | 160/160 |
| **B. Tech (Lateral Entry)** | | |
| II Year | III Year | 27/45 |
| III Year | IV Year | 60/90 |
| Final | Final | 122/122 |

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| **PROGRAM ELECTIVES & OPEN ELECTIVES of DATA SCIENCE & AI** | |
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| **PROGRAM ELECTIVE I** | |
| **Sub. Code** | **Subject Name** |
| DS 1431 | IOT, Robotics and Automation in Data Science |
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| **PROGRAM ELECTIVE II** | |
| DS 1531A | Quantum Computing |
| DS 1531B | Data Forensics |
| DS 1531C | Soft Computing Techniques |
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| **PROGRAM ELECTIVE III** | |
| DS 1733A | Computer Vision |
| DS 1733B | Finance & Accounting |
| DS 1733C | Information Retrieval |
| DS 1733D | Digital Marketing |
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| **PROGRAM ELECTIVE IV** | |
| DS 1734A | Biostatistics |
| DS 1734B | Applied Econometrics |
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| **PROGRAM ELECTIVE V** | |
| DS 1735A | Finance & Security Analytics |
| DS 1735B | Business Analytics |
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| **OPEN ELECTIVE I** | |
| DS 1721A | Supply Chain Management |
| DS 1722B | Bioinformatics |
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**SEMESTER – I**

**MA 1101: ENGINEERING MATHEMATICS –I, Credit: 4 (L-3, T-1, P-0)**

Successive differentiation, Leibnitz’s theorem, Polar curves, Tangent and normal of Polar curves, Angle between radius vector and tangent, Angle of intersection of two curves, Derivatives of arcs (Cartesian and Polar), Asymptotes, Curvature, Rolle’s theorem, Mean value theorems, Expansion of series, Partial differentiation, Total differential, Differentiation of composite and implicit functions. Tracing of curves, Integral calculus, Analytical solid geometry- Direction Cosines, Planes, Straight lines, Spheres, Right circular cone and Right circular cylinder, Convergence, Divergence, Comparison test, Ratio test, Raabe’s test, Cauchy’s root test, Cauchy’s integral test, Alternating series, Leibnitz’s test, Absolute and conditional convergence.

**Text-Books & Reference Books:**

1. B. S. Grewal, Higher Engineering Mathematics, (42e), Khanna Publishers, 2013
2. Kreyzig E., Advanced Engineering Mathematics, (10e), Wiley Eastern, 2011
3. David C. Lay, Linear Algebra and applications, (3e), Pearson Education, 2009
4. Sastry S. S., Introductory methods of Numerical analysis, (4e), PHI, 2007
5. Rainville E. D. and Bedient P.E., A short course in differential equations, (4e), Macmillan Publishers, 1969

**CE 1102: MECHANICS OF SOLIDS, Credit: 3 (L-2, T-1, P-0)**

Introduction to mechanics of rigid bodies, Resolution of force, Composition of forces, Moment of a force, Varignon's theorem, couple, Conditions of Equilibrium, Space and free body diagrams, Lami's theorem, Types of beams, Support reactions, Types of loading, Friction, Centroid and moment of inertia of simple and composite areas, Introduction to rigid bodies, Normal stress and strain, Mechanical properties of materials, Hooke's law, Modulus of elasticity, Stress – Strain behaviour of ductile and brittle materials, Factor of safety, Allowable stress, Stresses and deformations in tapered bars, Stepped bars, Poisson's ratio, Shear stress and Shear strain, Modulus of rigidity, Relationship between modulus of elasticity, modulus of rigidity and bulk modulus, Compound bars, stresses due to temperature, Stresses in thin cylinders, Concepts of bending moment & shear force diagrams.

**Text-Books & Reference Books:**

1. Meriam J. L., Kraige L. G., Engineering Mechanics: Statistics (5e), John wiley & sons, 2004.
2. Beer F. P., Johnston Jr. E. R., Dewolf J. T., Mazurek D. F., Sanghi S., Mechanics of Materials (7e), Tata McGraw-Hill, 2017.
3. Pytel A., Singer F.L., Strength of Materials (4e), HarperCollins College Div, 1987.
4. Bhavikatti S. S., Strength of Materials (4e), Vikas Publishers, 2013.
5. Basavarajaiah B. S., Mahadevappa P., Strength of Materials (3e), Universities Press, 2010.

**PH 1103: ENGINEERING PHYSICS, Credit: 4 (L-3, T-1, P-0)**

Vibrations, Oscillators, Resonance, Waves, Interference of light waves, Young’s experiment, Thin film interference, Newton’s ring, Diffraction of light, Fraunhofer diffraction and plane transmission grating, Rayleigh criterion, Polarization, Double refraction, Plane, Circularly and elliptically polarized light, Inadequacy of classical mechanics, Black body radiation, Rayleigh Jeans’ law, Wien’s displacement law, Planck’s radiation law, Planck’s quantum hypothesis, Photoelectric effect, Wave particle duality, de Broglie waves, Matter waves (Davisson-Germer experiment), Group velocity and phase velocity, Wave packets and Heisenberg’s uncertainty principle, Wave function and its physical significance, Schrodinger’s equation, Schrodinger’s 1-D time independent equations, Potential well, potential barrier and quantum tunneling. Concept of free electron theory, Quantum theory of free electrons, Fermi energy, Effect of temperature in Fermi-Dirac distribution, Bloch theorem, Concept of energy levels and bands, Distinction between Insulator, Semi-conductors and Conductors in terms of energy band, p-n junction. Lecture(s) on recent trends in Physics in engineering perspective (Non-credit).

**Text-Books & Reference Books:**

1. Jewett & Serway; PHYSICS for Scientists and Engineers with Modern Physics (7e), Cengage Learning 2008.
2. Halliday, Resnick, Krane, PHYSICS (5e), Volume 2, John Wiley & Sons, Inc 2002.

**ME 1105 ENGINEERING GRAPHICS, Credit: 3 (L-1, T-0, P-3)**

Introduction – Geometrical constructions, Dimensioning and conventions of lines. Projection of points in first Quadrant only. Projection of straight lines inclined to both horizontal and vertical planes, Traces of lines, Application problems on lines. Projection of regular plane when the surface is inclined to both HP and VP. Projection of regular solids like prisms, pyramids cone and cylinder when the axis is inclined to both HP and VP.

**Text-Books & Reference Books:**

1. Gopalkrishna K. R. and Sudhir Gopalkrishna., A textbook of Computer Aided Engineering Drawing, (37 e), Subhas Stores, Bangalore 2012.
2. Bhat N. D. and Panchal V. M., Engineering Drawing, (50 e), Charotar Publishing House, Anand, India 2010.
3. Venugopal K., Engineering Drawing and Graphics + Auto CAD, Newage International Publishers, Delhi 2002.
4. Narayana K. L. and Kannaiah P., Text book on Engineering Drawing, Scitech Publications, Chennai, 2002.
5. Basant Agrawal and Agrawal C. M., Engineering Drawing, Tata McGraw Hill, New Delhi 2010.

**BA 1106: COMMUNICATION SKILLS, Credit: 3 (L-3, T-0, P-0)**

Introduction and Understanding Communication Skills, 7 C’s of Communication, Verbal Communication- 3 V’s of Communication, Non-Verbal Communication, Essay Writing, Expansion of idea, Comprehension, Vocabulary, Report Writing, Business Correspondence, E-mail Writing. Grammar, Class Room Practice / Language Lab (Not to be included in Question Paper), Oral Communication, Extempore, Group Discussion, Power Point Presentation, Role Play. Reading- Analysis of reading passages – Articles, Text, Online reading material; Types of reading- skimming, scanning, critical reading; comprehension, analysis, response; Familiarization- pronunciation, accent, intonation. Writing- Structures- grammar and usage competence, writing a paragraph, writing an evaluative response, writing an argumentative response, writing a creative response, writing a critical response; Composition -editing and writing; Vocabulary building – etymology, words of foreign origin; Sensitivity in communication- Social Networks and Public communication – Etiquette. Speaking – Discussion and debates on contemporary topics – current affairs, scientific enquiry, philosophical debates, literary sensibilities, socio-political awareness and cultural sensitivity; Exploring multiple perspectives- critical reasoning, constructive feedback, persuasive arguments and effective interpersonal communication. Listening - Response to audio/video texts- comprehension, analysis, critical evaluation; Listening to groups and individuals- active listening, feedback and response.

**Text-Books & Reference Books:**

1. Raman, M & Sharma, S., Technical Communication: Principles and Practice. Oxford University Press, New Delhi 2014.
2. Swan, Michael, Practical English Usage, (4e) Oxford University Press, London 2017
3. Lewis, Norman, Word Power Made Easy 2010.
4. Balasubramanian. P., Phonetics for Indian Students, (2e), Mc Milan, Mumbai 2013.

**ME 1161: WORKSHOP PRACTICE, Credit: 1.5 (L-0, T-0, P-3)**

Mechanical Engineering Practices - Sheet metal, Plumbing exercises, Study of Automotive systems like Transmission and Suspension, Demonstration on the working of Lathe and Drilling machine, Civil Engineering Practices - Material Testing by conducting Tensile test, Shear test and Compression test, Surveying exercises using chain and tape, Prismatic compass, Dumpy level, Electrical and Electronics Engineering Practices – Study of wiring tools, Fuses, Circuit breakers, Lighting sources, Wiring, Electrical energy in Single phase and three phase circuits, Energy tariff calculations. Testing of Electronic components, IC based experiments comprising Digital counter, Buzzer and Musical door-bell, Soldering practice, Building a DC regulated power supply. Demonstration of Carpentry, Fitting, Plumbing and Soldering.

**Text-Books & Reference Books:**

1. Hajra Choudhury S. K and Bose S. K, “Elements of Workshop Technology, Vol I”, Media Promoters & Publishing Pvt. Ltd., Mumbai, 2012.
2. Raghuvanshi S.S, “Workshop Technology”, Dhanpat Rai and Sons, Delhi, 2002.
3. Punmia B. C, “Surveying”, Laxmi Publications, Bangalore, 2012
4. Uppal S.L., Electrical Wiring, Estimating and Costing, Khanna Publishers, 1978
5. Bishop Owen, Electronics: A First Course, (2e), NEWNES, An Imprint of Elsevier, 2006.

**PH 1162: ENGINEERING PHYSICS LAB, Credit: 1.5 (L-0, T-0, P-3)**

Experiments on interference of mechanical waves, Experiments on interference, diffraction, and double refraction of light. Experiments on quantum theory of radiation. Experiments on free-electron theory of metals, band theory of solids, semiconductors. Experiments on resonance circuits, Hall- effect.

**Text-Books & Reference Books:**

1. Jewett & Serway, PHYSICS for Scientists and Engineers with Modern Physics (7e), Cengage Learning 2008.
2. Worsnop & Flint, Advanced Practical Physics for Students (9e), Methuen & Co. Ltd, London 1987.

**SEMESTER – II**

**MA 1201: ENGINEERING MATHEMATICS-II, Credit: 4 (L-3, T-1, P-0)**

Ordinary differential equations (ODE) – I, Ordinary differential equations (ODE)- II, Laplace transforms, Vector spaces and subspaces, Simple examples. Matrices, Solution by Gauss elimination. Taylor's theorem for a function of two variables, Extreme values of a function of two variables, Lagrange’s method of undetermined multipliers, Multiple integrals, Beta and Gamma functions.

**Text-Books & Reference Books:**

1. B. S. Grewal, Higher Engineering Mathematics, (42e), Khanna Publishers, 2013
2. Kreyzig E., Advanced Engineering Mathematics, (10e), Wiley Eastern, 2011
3. David C. Lay, Linear Algebra and applications, (3e), Pearson Education, 2009
4. Sastry S. S., Introductory methods of Numerical analysis, (4e), PHI, 2007
5. Rainville E. D. and Bedient P.E., A short course in differential equations, (4e), Macmillan Publishers, 1969

**CH 1108: ENGINEERING CHEMISTRY, Credit: 4 (L-3, T-1, P-0)**

Electrochemical changes - half reactions, origin of electrode potential – measurement of electrode potential, Nernst equation and its applications, electrochemical series & its applications, electrochemical cell and its classifications (galvanic cell, electrolytic cell), types of electrodes (reference electrodes- standard hydrogen electrode, calomel electrode, silver-silver chloride electrode and indicator electrodes- hydrogen electrode, quinhydrone electrode), electromotive force, standard cell, determination of EMF (Poggendrop compensation method), concentration cell, EMF of concentration cell, liquid junction potential, salt bridge. Overview on Primary and secondary cell: The lead-acid storage cell, lithium-ion battery. Fuel Cell: H2–O2 fuel cell. Corrosion – cause of corrosion, types and mechanism of corrosion - dry corrosion, Pilling Bedworth rule, electrochemical or wet corrosion (mechanism via Hydrogen evolution & Oxygen absorption), types of electrochemical corrosion (galvanic corrosion, concentration cell corrosion, water line corrosion, stress corrosion - caustic embrittlement, passivity, galvanic series, factors influencing corrosion, corrosion control-corrosion inhibitors, cathodic protection - sacrificial anodic and impressed current cathodic protection. Fuels – Introduction – Classification – Calorific value – Numerical problems –Liquid fuels – Petroleum- Refining – Cracking – Synthetic petrol –Petrol knocking – Diesel knocking – Octane and Cetane ratings – Anti-knock agents – Power alcohol – Bio-diesel – Gaseous fuels – Natural gas, LPG and CNG –Combustion – Calculation of air for the combustion of a fuel – Flue gas analysis – Orsat apparatus – Numerical problems on combustion. Explosives: - Rocket fuels. Challenges – Clean energy source. Liquid crystals: Introduction, classification of liquid crystals-thermotropic & lyotropic liquid crystal, different phases of thermotropic & lyotropic liquid crystal, chemical constitution and liquid crystalline behaviour, liquid crystalline behavior in homologous series, molecular ordering in different meso phases, applications of liquid crystals in displays (LCD), OLED. Polymer: Definition, type of polymerization with example, natural rubber, Ziegler-Natta polymerization, tacticity (atactic, isotactic, syndiotactic), conducting polymers, molecular weight analysis of polymers, definition of monodisperse and polydisperse polymers, polydispersity index, different ways to express molar mass of polymers such as number average molar mass, MN, weight average molar mass, MW, viscosity average molar mass, MV, and Z-average molar mass, MZ, and problems based on them. Semiconductors from chemistry perspective.

**Text-Books & Reference Books:**

1. Kuriacose J. C., Rajaram J., Chemistry in Engineering and Technology, volume I/II Tata McGraw - Hill, New Delhi, 2001
2. Jain P. C., Jain M. Engineering Chemistry, (16e)., Dhanpat Rai and Sons, New Delhi, 2015
3. Fischer T., Materials Science for Engineering Students, Academic Press, London, 2009

**EE 1109: ELEMENTS OF ELECTRICAL ENGINEERING, Credit: 3 (L-2, T-1, P-0)**

DC circuits, Independent sources, Resistance, Network reduction techniques, Mesh and Node voltage analysis, Superposition, Thevenin's and Maximum power transfer theorems, Transient behaviour of inductance and capacitance, Series and Parallel magnetic circuits, Self and Mutual inductances, Coupled coils, Dot rule, Average and RMS values of sinusoidal waves, Series and Parallel AC circuits, Power factor improvement, Series and Parallel resonance, Three phase star and delta connected loads, Measurement of power in three phase circuits, Electrical power system, Transformers, DC motors, BLDC, Induction motors, Synchronous motors, Stepper motors, Measurement of energy.

**Text-Books & Reference Books:**

1. Hughes E., Electrical and Electronic Technology (9e), Pearson Education, 2008
2. D. C. Kulshreshtha, Basic Electrical Engineering, McGraw Hill, 2012.
3. Kothari D. P. & Nagarath I. J., Basic Electrical Engineering, TMH 2013
4. http://www.nptel.ac.in/courses/108108076/

**CS 1110: COMPUTER PROGRAMMING USING C, Credit: 4 (L-3, T-1, P-0)**

Introduction to computing, Importance of Problem solving using computers, Algorithms and Flow charts, Introduction to C language, Simple C programs, Syntax and Logical Errors in compilation, Object and executable code, Variable names and declaration, Data types, Sizes and Constants, Various operators, Type conversion and expressions, Precedence and order of evaluation, Statements and blocks, Control flow, Break and continue, 1-D and 2-D Arrays and Strings, Searching and Sorting, Multidimensional Arrays and Matrices, Modular programming and Recursive functions, Structure and Pointers, Defining Structures and Array of Structures, Pointer arithmetic, Pointer to Structures, File Management and Cyber Security.

**Text-Books & Reference Books:**

1. Dromey. R. G, How to solve it by computers, Pearson, 1982.
2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming language (2e), Pearson Education, 1988.
3. Deital. P. J and Deitel. H. M, C: How to program (7e), Pearson Education, 2010.
4. Balagurusamy, E, Computing fundamentals and C programming (1e), McGraw-Hill, 2008.

**CH 1191: ENVIRONMENTAL SCIENCE, Credit: 0 (L-2, T-0, P-0)**

Fundamentals of Environmental Science current environmental issues, socio-economic reasons behind degradation of environment. Environmental Science – an interdisciplinary subject, Difference between Environmental Science and Ecology. Periodicity: Ionization Energy, Electron Affinity, Electronegativity. Unique features, resources, and natural services of earth, Tragedy of Commons & Ecological Footprint Environmental Geology Lithosphere and Asthenosphere, Physico-chemical properties of crust, mantle and core, theory of plate tectonics, Types of rocks – igneous, sedimentary and metamorphic, polarity of water, unique properties of water, Importance of hydrogen bond in biomolecules, amphipathic substances, Composition & characteristics of sea & river water, Composition of atmosphere, Layers of atmosphere, Transformation of atmosphere to present oxidizing form, Ecology, Components and functions of Ecosystem, Analysis of Techno ecosystems, Environmental Chemistry, Carbonaceous BOD test, BOD numerical, Environmental pollution, Mathematical model of dry adiabatic lapse rate, Stability of atmosphere and air pollution, Radiation inversion, Global Environmental Issue, Simple global temperature model and Greenhouse effect.

**Text-Books & Reference Books:**

1. Mohan kanda, Disaster Management in India evolution of institutional arrangements & operational strategies, 2017.
2. Y.Anjaneyulu, Introduction to Environmental science, 2017.
3. R.K.Trivedy, Handbook of Environmental laws, acts, guidelines, compliances & standards, 3rd edition, 2nd volume, 2017.
4. Benny Joseph, Environmental Studies, Tata McGraw-Hill Publishing Company Ltd., New Delhi ,2008.
5. Aloka Debi, “Environmental Science and Engineering”, Universities Press (India) Pvt. Ltd. 2012.
6. R.J.Ranjit Daniels and Jagadish Krishnaswamy, “Environmental Studies”, Wiley India Private Ltd., New Delhi, 2009.
7. G.Swarajya Lakshmi, Environmental science: A Practical Manual, 2010.
8. Student guide: Environment Reader for Universities, based on UGC syllabus published by Centre for Science and Environment, 2017.

**CH 1163: ENGINEERING CHEMISTRY LAB, Credit: 1.5 (L-0, T-0, P-3)**

Alkalimetric titration; Estimation - Total hardness of water, percentage of copper in brass, weight of iron in haematite, percentage of manganese dioxide in pyrolusite, percentage of ammonia nitrogen in a fer tilizer; pK value of a weak acid by potentiometric titration; Conductometric acidbase ntitrations; Determination of concentration of copper using colorimeter; Determination of coefficient of viscosity of liquid; Chloride content of water; Analysis of lead pigment

**Text-Books & Reference Books:**

1. Vogel A.I. Text book of Quantitative Inorganic Analysis, (5e), ELBS, 1998
2. Laboratory Manual for Engineering Chemistry Laboratory, M.I.T., 2014

**CS 1164: COMPUTER PROGRAMMING LAB 1.5 (L-0, T-0, P-3)**

Introduction to Computing, Simple C programming, Branching Control Structures, Looping Control Structures, 1D and 2D Array programming, String programming, Modular and Recursive Function Programming – Programs using Pointers, Structures and File manipulation – MATLAB Programming with Simulink.

**Text-Books & Reference Books:**

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming language (2e), Pearson Education, 1988.
2. Deital. P. J and Deitel. H. M, C: How to program (7e), Pearson Education, 2010.
3. Balagurusamy. E, Computing fundamentals and C programming (1e), McGraw-Hill, 2008.
4. Duane Hanselman and Bruce Littlefield, Mastering Matlab 7, Pearson Publication, 2008.
5. Stormy Attaway, Matlab: A practical Introduction to Programming and Problem Solving, Elsevier, ISBN: 978-0-75-068762-1.

**SEMESTER – III**

**MA 1301 Credit: 3 (L-3, T-0, P-0)**

**MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE-I**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To introduce the students with the Measures of central tendency and designing of finite sample spaces, conditional probability. In this subject, students are introduced with mathematical foundations for data science and basic of that.

**Pre-requisites:** Basic Mathematical Knowledge

**UNIT – I**

1. Statistics: Measures of central tendency – mean, median, mode, measures of dispersion – mean deviation, standard deviation, quartile deviation, skewness and kurtosis. Correlation coefficient, regression, least squares principles of curve fitting. [9 hrs]
2. Probability: Introduction, finite sample spaces, conditional probability and independence, Baye’s theorem, one dimensional random variable, mean, variance. Two and higher dimensional random variables: mean, variance, correlation coefficient. [9 hrs]

**UNIT – II**

1. Distributions: Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential distributions, simple problems. Moment generating function, Functions of one dimensional and two dimensional random variables, Sampling theory, Central limit theorem and applications. [9 hrs]
2. Partial Differential Equations: Numerical solutions of partial differential equations by finite difference methods, five-point formula, Laplace Poisson Equations, Heat equation, Crank Nicolson’s method, Wave equation. Application of Finite Difference technique. [9 hrs]

**Text Books:**

1. The Nature of Statistical Learning Theory By Vladimir Vapnik.
2. Pattern Classification by Richard O Duda (2007-12-24) By Richard O Duda

**Reference Books:**

1. Machine Learning: An Algorithmic Perspective, Second Edition (Chapman & Hall/Crc Machine Learning & Pattern Recognition) By Stephen Marsland.

**HU 1302 Credit: 3 (L-3, T-0, P-0)**

**FINANCE & ECONOMETRICS**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To introduce the students with the Finance & Econometrics like Basic Economics, Mathematics of Finance, Information about Financial Investment Companies etc.

**Pre-requisites:** Basic Mathematical knowledge

**UNIT – I**

* 1. Basic Economics: Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates,basics of investment and consumption function.
  2. Mathematics of Finance: Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with the return, Rate of return method.
  3. Financial Investment Companies: Mutual fund companies, types of mutual funds, Calculation of Net Asset Values, Venture Capital Companies, Investment and Merchant Banking companies.

**UNIT – II**

* 1. Accounting: Concept of Financial Accounting, Difference between financial, cost and management accounting, Depreciation of fixed assets: Physical & functional depreciation, Straight-line depreciation, Declining balance method of depreciation, Sum-of-the years digits method of depreciation, Sinking fund and service output methods, basics of cost accounting methods – Job costing and Process costing, Cost sheet format and its uses.
  2. Financial Statements: Introduction to balance sheet and profit & loss statement. Basic financial ratios.
  3. Financial Econometrics: Nature of Econometrics and Economic Data. Regression Model, General Linear Model, Auto-regressive and distributed Lag Models, Simultaneous Equation Models. Multi-collinearity and Heteroscedasticity, autocorrelation, Qualitative and Limited Dependent Variables Models, Simultaneous Equation Models: Estimation Methods, Panel Data Regression Models and Time Series Econometrics

**Text Books:**

1. Schaum's Outline of Probability and Statistics, 4th Edition by Spiegal, Schiller and Srinivasan
2. Schaum's Outline of Statistics and Econometrics, 2nd Edition by Salvatore and Reagle

**Reference Books:**

1. A Guide to Econometrics, 6th Edition by Kennedy

**DS 1303 Credit: 3 (L-3, T-0, P-0)**

**INTRODUCTION TO DATA ANALYTICS**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To introduce the students with the Data Analytics, Data Cleaning, Statistical Inference. Association rule mining, Visualization: etc.

**Pre-requisites:** Basic statistical knowledge

**UNIT – I**

1. Data Analytics: Steps in Data Analytics Projects, Data Analytics tasks and methods, Data Gathering and Preparation: Data Formats, Parsing and Transformation, Scalability and Real-time Issues;
2. Data Cleaning: Consistency Checking, Heterogeneous and Missing Data, Data Transformation and Segmentation;
3. Exploratory Analysis: Descriptive and comparative statistics, Hypothesis testing,
4. Statistical Inference. Association rule mining: Apriori, FP Growth, Partitioning, measures of pattern interestingness. Clustering: Partitioning, Hierarchical, Density based approaches. Recommender Systems, Anomaly Detection.

**UNIT – II**

1. Visualization: Visual Representation of Data, Gestalt Principles, Information Overloads; Creating Visual Representations: Visualization Reference Model, Visual Mapping, Visual Analytics, Design of Visualization Applications;
2. Classification of Visualization Systems: Interaction and Visualization Techniques, Visualization of One, Two and Multi-Dimensional Data, Text and Text Documents; Visualization of Groups: Trees, Graphs, Clusters, Networks, Software, Metaphorical Visualization; Visualization of Volumetric Data: Vector Fields, Processes and Simulations, Visualization of Maps, Geographic Information, GIS systems, Collaborative Visualizations, Evaluating Visualizations;
3. Recent Trends in Various Perception Techniques: Various Visualization Techniques, Data Structures used in Data Visualization.

**Text Books:**

1. A General Introduction to Data Analytics, João Moreira, Andre Carvalho, Tomás Horvath
2. Artificial Intelligence: A Guide for Thinking Humans By Melanie Mitchell

**Reference Books:**

1. Developing Analytic Talent: Becoming a Data Scientist By Vincent Granville

**DS 1304 Credit: 3 (L-3, T-1, P-0)**

**OBJECT-ORIENTED PROGRAMMING**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To introduce the students with Java, Basics of that, I/O basic, package handling and basic GUI.

**Pre-requisites:** Basic programming like C, C++ knowledge.

**UNIT – I**

1. Introduction: Object-oriented Paradigm and Pillars such as Abstraction, Encapsulation, Inheritance and Polymorphism;
2. Java Basics: Compilation and Execution of a Java Program, Access Modifiers; Class and Objects: Class Definition, Creating Objects, Role of Constructors, Method Overloading, Argument Passing, Objects as Parameters, Access Control;
3. I/O Basics: Reading Console Input, Writing Console Output; Array and Strings: Arrays in Java, 1-D, 2-D and Dynamic Arrays, String Basics, String Comparison and Manipulation; Inheritance: Inheritance and its Types, Abstract Class, Inner and Outer Class, Super, Final, Static Keywords;

**UNIT – II**

1. Package and Interface: In-Built Packages and User Define Packages, Role of Interface, Polymorphism via Inheritance;
2. Collection Framework & Generics: List, Set, Map, Generic Classes; Exception Handling: Errors and Exceptions, Types of Exceptions, Handling Exceptions, Multithreading: Thread Class, Runnable, Thread Life Cycle, Synchronization, Thread Priority;
3. Event Handling and GUI Programming: Events, Action Listener, Important Swing Package Classes.

**Text Books:**

1. Python 3 Object-Oriented Programming, Author Dusty
2. Object-Oriented Thought Process by Matt Weisfeld

**Reference Books:**

1. Head First Design Patterns, Eric Freeman

**DS 1305 Credit: 3 (L-3, T-1, P-0)**

**DATA STRUCTURES**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To introduce the students with Pointers and Pointer Application, Recursion, Stacks, queues Linked lists representations.

**Pre-requisites:** Basic programming like C, C++ knowledge.

**UNIT – I**

* 1. Introduction - Pointers and Pointer Application, Accessing variables through pointers, pointers to pointers, pointer arithmetic and arrays, pointers and functions,
  2. Recursion- definition, recursive programs, efficiency of recursion,
  3. Stacks, queues, evaluation of expressions, multiple stacks and queues and its application,

**UNIT – II**

* 1. Linked lists representations- Singly, doubly, header node, circular along with the applications,
  2. Trees-Binary trees, representation, recursive/ non recursive inorder, preorder and post order tree traversal, level order traversal, Binary search tree, creation, insertion deletion operations on binary search tree, Additional Binary Tree Operations, Threaded Binary Tree and applications and Introduction to the concepts of Optimal Binary Search Trees.

**Text Books:**

* 1. Introduction to Algorithms by Thomas H. Cormen
  2. Algorithms by Robert Sedgewick & Kevin Wayne

**Reference Books:**

* 1. The Algorithm Design Manual by Steve S. Skiena

**DS 1306 Credit: 3 (L-3, T-0, P-0)**

**COMPUTER SYSTEM ARCHITECTURE**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To introduce the students with Number Representation and Arithmetic Operations, computer architecture, hardware and software allocation, memory allocation etc.

**Pre-requisites:** Basic programming knowledge.

**UNIT – I**

* 1. Number Representation and Arithmetic Operations: Character Representation, Memory locations and addresses, Memory operations, Addressing modes, CISC and RISC.
  2. Implementation: Hardware for addition and subtraction: Multiplication, Hardware implementation, Booth's algorithm, Division, Floating point representation, IEEE standard floating point representation, Floating point arithmetic.
  3. Bus organization: Bus organization, comparison of hardwired and micro-programmed approach, hardwired control design, Booths multiplier design, Micro-programmed multiplier control unit. Internal organization of memory chips, Structure of Larger Memories, Cache mapping functions

**UNIT – II**

1. Algorithims: Replacement algorithms, Virtual memories. Accessing I/O devices, Interrupts, Enabling and Disabling Interrupts, DMA. Pipeline Organization, Data Dependencies,
2. Handling Data Dependencies: Hardware Multithreading, SIMD Processing, Graphics Processing Units (GPUs), Shared Memory Multiprocessors, Interconnection Networks,
3. Cache Coherence: Cache Coherence, Write-Through Protocol, Write-Back protocol, Directory-Based Cache Coherence.

**Text Books:**

* 1. Essentials of Computer Architecture, 2nd, by Douglas Comer
  2. Computer Architecture by Morris Mano

**Reference Books:**

* 1. Computer Architecture: Fundamentals and Principles of Computer Design, 2nd Edition, by Joseph D. Dumas II

**BP-1391 Credit: 0 (L-2, T-0, P-0)**

**CONSTITUTION OF INDIA**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**UNIT I**

1. Meaning of constitution law and constitutionalism
2. Evolution of Indian Constitution- Nationalist Movement and Philosophical Foundations; Preamble of Indian constitution.
3. Indian Federation- Features of federation; Centre – State Relations – Recent Trends; Fundamental Rights and Duties and Directive Principals of state policy.
4. Parliamentary form of government: Executive: President; Prime Minister and Council of Ministers -Election, Powers and Functions; Legislature: Lok Sabha and Rajya Sabha– Composition, Powers and Functions
5. Judiciary– Supreme Court, Composition, Powers, Functions and Judicial Review- Judicial Activism.

**UNIT II**

1. Amendment of the constitution: Powers and procedure; State Government – Governor, Chief Minister and Council of Ministers – Powers and Functions.
2. Party System: National and regional Parties; Trends in Party System Election Commission – Electoral Reforms and voting Behavior.
3. Rural Local Government: Evolution Structure and Function; Gram Sabha; Gram Panchayat; Panchayat Samiti; Zila Panchayat.
4. Urban Local government: Evolution structure and function; Municipal corporation; Nagar panchayat.

**Text Books:**

1. Our Constitution: An Introduction to India’s Constitution and Constitutional law by Kashyap Subhash
2. Introduction to the Constitution of India by D. D. Basu
3. Encyclopedia of Social Sciences (Vol.4, 1931)
4. History of Political Theories from Luther to Montesquieu by Dunning
5. The Indian Constitution: Cornerstone of a Nation by Austin Graville
6. Indian Government and Politics by S. S. Awasthy
7. Contemporary Indian Politics by Limaye Madhu
8. Indian polity by M. Laxmikanth

***Experiment List Will Be Generated Later:***

**DS 1361** **Credit: 1.5 (L-0, T-0, P-3)**

**DATA ANALYTICS LAB**

Tutorial on tools for Data Analytics & Visualization. Suggested tools are R, MATLAB, WEKA, RapidMiner. Experiments with datasets to be defined in lab manual, to implement concepts of data preprocessing, exploratory analysis, comparative statistics, statistical inference, Association and clustering. Creating Visual Representations- Suggested tools are MSExcel, Power BI, Tableau. MSExcel Pivot Tables and charts, Visualization of Groups, Volumetric Data, Case Studies in Various Perception Techniques.

**DS 1362 Credit: 1.5 (L-0, T-0, P-3)**

**OBJECT ORIENTED PROGRAMMING LAB**

Class and Objects: Class Definition, Creating Objects; Array and Strings: Programs Based Upon 1-D, 2-D and Dynamic Arrays, String Comparison and Manipulation; Inheritance: Inheritance and Its Types, Abstract Class, Inner and Outer Class, Super, Final, Static Keywords; Collection Framework & Generics: Using Collection Classes such as Array Lists and Linked Lists Writing Generic Classes; Exception Handling: Errors and Exceptions, Types of Exceptions; Multithreading: Thread Class, Runnable, Synchronization, Thread Priority; Event Handling and GUI Programming: Action Listener, Swing Package.

**DS 1363 Credit: 1.5 (L-0, T-0, P-3)**

**DATA STRUCTURES LAB**

Reviewing the concepts of pointers, structures and recursion, Studying the operation of stacks and queues and the associated application programs, Creating dynamic allocation of memory for linked list and applying it to examples using singly, doubly and circular linked list and their applications, Creation of binary trees and the application associated with the trees.

**SEMESTER – IV**

**MAT 1401 Credit: 3 (L-3, T-0, P-0)**

**MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE-II**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objectives:** Objective of teaching Probability is to provide some basic idea on Probability and Random processes (or Stochastic Processes) its applications in the field of Science and Engineering. Random process has enormous applications in Digital Communications & Modeling of physical problems. This will equip students to tackle problems which are non-deterministic in nature and arrive at solutions of physical problems which require a very high degree of precision.

**Pre-requisites:** Engineering Mathematics, Mathematical Foundations for Data Science-I.

**UNIT-I**

**Stochastic Process:** Markov chains with stationary transition probabilities, properties of transition functions, classification of states, Stationary distribution of a Markov chain, existence and uniqueness, convergence to the stationary distribution. Methods based on Markov chains for simulation of random vectors. MCMC algorithm. Random Walks, queueing processes, branching processes. Gambler’s ruin problem, transient states.

**UNIT-II**

**Multivariate Analysis:** Multivariate distributions: multivariate normal distribution and its properties, distributions of linear and quadratic forms, tests for partial and multiple correlation coefficients and regression coefficients and their associated confidence regions. Data analytic illustrations. Wishart distribution (definition, properties), construction of tests, union- intersection and likelihood ratio principles, inference on mean vector, Hotelling's T2. MANOVA- Inference on covariance matrices. Classification methods: Discriminant analysis, principal component analysis and factor analysis, Canonical Correlation analysis, Correspondence Analysis, Multidimensional Scaling, Cluster analysis. Nonparametric and robust methods of multivariate analysis. Graphical representation of multivariate data.

**Text Books & Reference Books:-**

1. W. Feller: An Introduction to Probability Theory and its Applications, Vol.-II.
2. S. Karlin and H. M. Taylor, A First Course in Stochastic Processes.
3. William J. Stewart, Probability, Markov Chains, Queues and Simulation.
4. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Stochastic Processes.
5. S. Ross, Introduction to Probability Models.
6. T. W. Anderson, An Introduction to Multivariate Statistical Analysis.

**DS 1402 Credit: 3 (L-3, T-0, P-0)**

**DATABASE SYSTEMS**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objectives:** Students will be able to learn about maintaining and handling various Data and applying them with different methods and strategies.

**Pre-requisites:** Data Structure.

**UNIT-I**

**Introduction:** Database System Applications, View of data, Database languages, Database users and Administrator. Introduction to Relational Model: database schema, keys, schema diagrams, Relational Query Languages, Relational Operations.

**Introduction to SQL:** Data Definition, Basic structure of SQL queries, Basic operations, Set operations, Null values, Aggregate Functions, Nested subqueries, Modification of the database.

**Intermediate SQL:** Join expressions, Views, Transactions, Integrity Constraints, SQL Data types and schemas, Authorization, Advanced SQL-PL/SQL, Cursors, Functions, Procedures, Triggers, recursive queries, advanced aggregation features.

**Database Design and Entity-Relationship Model:** Design Process, ER Model, Reduction to Relational schema.

**UNIT-II**

**Relational Database Design:** Functional dependencies, Normal forms, Closure, Canonical cover, Lossless joins, dependency preserving decomposition, Storage and File structure, Indexing & Hashing. Query Processing, Overview, Measure of query cost, selection, Join operation, sorting, Evaluation of expressions.

**Query Optimization:** Overview, Estimating statistics of expression results, Materialized Views.

**Transactions:** Concepts, Simple transaction model, Transaction atomicity and durability, based protocols, Deadlock Handling, Multiple granularity, Timestamp-based Protocols, Validation-based Protocols.

**Recovery System:** Failure classification, Storage, Recovery algorithm, Buffer Management.

**Unstructured Database:** Introduction to NoSQL, Basics of document-oriented database.

**Text Books & Reference Books:-**

1. Abraham Silberschatz, Henry Korth, S. Sudarshan, Database System Concepts, 6th Edition, McGraw Hill, 2010.
2. Ramez Elmasri, Shamkant Navathe, Fundamentals of Database System, 6th Edition, Addison Wesley Publications Co., 2010.
3. Raghu Ramakrishnan, Johannes Gehrke, Database Management System, 3rd Edition, WCB/McGraw Hill Publisher, 2014.
4. Ivan Bayross, SQL, PL/SQL-The Programming Language of Oracle, 4th Edition, BPB Publications, 2010.
5. Shashank Tiwari, Professional NoSQL, Wiley, 2015.

**DS 1403 Credit: 3 (L-3, T-1, P-0)**

**MACHINE LEARNING**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objectives:** The objective of this course is to provide a concise introduction to the fundamental concepts in machine learning and popular machine learning algorithms. The standard and most popular supervised learning algorithms including linear regression, logistic regression, ensembling and boosting algorithms and neural networks with an introduction to Artificial Neural Networks.

**Pre-requisites:** Probability and Random Process, Linear Algebra, and Optimization Techniques.

**UNIT-I**

**Machine Learning Basics:** Types of Machine Learning, Supervised vs. Unsupervised Learning, Parametric vs. non-parametric models.

**Instance Based learning**: k-nearest neighbors.

**Simple Regression Models:** Linear, Logistic, Cost functions, Gradient Descent, Batch Gradient Descent, Overfitting, Model Selection, No free lunch theorem, bias/variance trade-off, union and Chernoff bounds, VC dimensions.

**Bayesian Models:** Bayesian concept learning, Bayesian Decision Theory, Naïve Bayesian, Laplacian Correction, Bayesian Belief Networks.

**Tree Models:** Information theory, decision tree induction, tuning tree size, ID3, C4.5, CHAID, Decision Stump.

**UNIT-II**

**Support Vector Machines:** kernel functions.

**Regression Models:** Ridge and Lasso Regression, GLM and the exponential Family. Bagging algorithm, Random Forests, Grid search and randomized grid search, Partial dependence plots.

**Ensembling and Boosting Algorithms:** Concept of weak learners, Adaptive Boosting, Extreme Gradient Boosting (XGBoost).

**Artificial Neural Networks:** Perceptron, Back propagation, Hopfield Network.

**Curse of Dimensionality:** Factor Analysis, Principal Component Analysis (PCA), Difference between PCAs and Latent Factors.

**Text Books & Reference Books:-**

1. K. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. G. James, D. Witten, T Hastie, R Tibshirani, An introduction to statistical learning with applications in R, Springer, 2013.
3. J. Han, M. Kamber, J. Pei, Data Mining concepts and techniques, (2e), Morgan Kaufmann- Elsevier, 2011.
4. T. Hastie, R. Tibshirani, J. Friedman, The Elements of Statistical Learning, (2e), Springer, 2009.
5. T. M. Mitchell, Machine Learning, (Indian Edition), MacGraw Hill, 2017.
6. C. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 2019

**DS 1404 Credit: 3 (L-3, T-1, P-0)**

**DESIGN & ANALYSIS OF ALGORITHMS**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objectives:** The objective of this course is to provide an introduction to the different algorithms and its analysis. Mathematical approach of such algorithms along with problem solving will also be discussed.

**Pre-requisites:** Data Structure.

**UNIT-I**

Fundamentals of Algorithms, Important Problem Types, Analysis of algorithm efficiency. Analysis Framework: Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Nonrecursive and Recursive Algorithms. Brute force Techniques, Divide and Conquer, Decrease and Conquer: Insertion Sort, Depth First Search, Breadth First Search, Topological Sorting. Transform and Conquer: Presorting, BST, Heapsort. Space and Time tradeoffs: Input Enhancement in String Matching.

**UNIT-II**

Dynamic Programming: Warshall's and Floyd's Algorithms, The Knapsack Problem. Greedy Techniques: Prim's, Kruskal's and Dijkstra's Algorithm, Huffman Trees. Coping with limitations of algorithmic power, P, NP,and NP-complete Problems, Backtracking: n–Queens problem, Hamiltonian Circuit Problem, Subset–Sum Problem. Branch and Bound: Assignment Problem, Knapsack Problem, TSP.

**Text Books & Reference Books:-**

1. Anany Levitin, Introduction to the Design and Analysis of Algorithms, (3e), Pearson Education, 2011
2. Ellis Horowitz and Sartaj Sahni, Computer Algorithms/C++, (2e), University Press, 2007.
3. Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, Introduction to Algorithms, (2e), PHI, 2006

**DS 1405 Credit: 3 (L-3, T-0, P-0)**

**DATA COMMUNICATION AND NETWORKS**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objectives:** The objective of this course is to identify the different approaches towards computer networking, compare and contrast the underlying technologies and problem solving based on case studies.

**Pre-requisites:** Database Systems.

**UNIT-I**

Basic concepts of computer networks, Layered architecture and comparison between ISO/OSI, TCP/IP layered models. Significance of Datalink layer and protocols. Network layer functionalities, classful, classless IP addressing, address allocation and role of forwarding module in forwarding the packet using routing table. Roles played by IP, ARP, RARP, ICMP & IGMP protocols in network layer. Inter-domain and intra-domain routing algorithms for routing tables.

**UNIT-II**

Importance of transport layer in achieving process-to-process communication. Insight of connection oriented protocol TCP and connectionless protocol UDP. Features of TCP in achieving flow control, error control and congestion control. Requirement of different timers in TCP. Drawbacks of IPv4 addressing and new IP addressing scheme IPv6. Migrating from IPv4 to IPv6. Introduction to application layer, a client/server application program and a case study. Client-server application program-Dynamic Host Configuration Protocol (DHCP).

**Text Books & Reference Books:-**

1. Behrouz A. Forouzan, TCP/IP Protocol Suite, 4th Edition, Tata McGraw Hill, 2010.
2. Tannenbaum, A.S, Computer Networks, 5th Edition, Prentice Hall of India EE Edition, 2011.
3. Behrouz A. Forouzan, Data Communications and Networking, 5th Edition, Tata McGraw Hill, 2013.
4. Leon Garcia and Widjala, Communication Networks, 5th Edition, Tata McGraw Hill, 2017.

**DS 1431 Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-I (ROBOTICS & AUTOMATION)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objectives:** To serve as a course in acquiring knowledge in Robotics. After the completion of the course, students should be able to design and analyze automatic robot system. Also they will gather sufficient knowledge to understand the direction of the research activities going on in the field of robot automation.

**Pre-requisites:** C++ programming and Computer Organization & Architecture, Data Communications and Networks.

**UNIT-I**

**Introduction:** Definition, Applications of mobile robotics, History of mobile robotics.

**Design of system and navigation architecture:** Reference control scheme of a mobile robotics environment, Temporal decomposition of architecture, Control decomposition, Hybrid architecture, Mobile architecture, Perception, Representation and the mapping process.

**Locomotion:** Issues for locomotion, Legged mobile robots, Wheeled mobile robots.

**Kinematics:** Kinematics introduction, Forward and reverse kinematics, Wheeled kinematics and its constraints, Mobile system locomotion, Human biped locomotion as a rolling polygon, Representation of robot position through the reference frame.

**UNIT-II**

**Power Sources and Sensors:** Hydraulic, pneumatic and electric drives, determination of HP of motor and gearing ratio, variable speed arrangements, path determination, micro machines in robotics, machine vision, ranging, laser, acoustic, magnetic, fiber optic and tactile sensors.

**Manipulators, Actuators and Grippers:** Construction of manipulators, manipulator dynamics and force control, electronic and pneumatic manipulator control circuits, end effectors, U various types of grippers, design considerations.

**Navigation:** Localization overview, Path planning. Computational intelligence: Swarm intelligence, Evolutionary computation, Artificial immune system, Ant algorithm.

**Mobile robot programming:** This chapter is included to provide hands on introduction to the field of mobile robotics and various issues in designing and planning of robot work environment. It includes construction and programming of robotic agents using robotic kits and microcontrollers applying concepts of locomotion, perception, navigation and computational intelligent algorithms.

**Text Books & Reference Books:-**

1. Ronald Siegwart, Illah R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, MIT Press,
2. Andries P. Engelbrecht , “Computational Intelligence: An Introduction”, Wiley 2nd Edition, 2007
3. Ronald C. Arkin , “Intelligent Robotics and Autonomous Agents”, MIT Press, 1997
4. Ulrich Nehmzow, “Mobile Robotics: A practical Introduction”, Springer-Verlag London, 2003
5. Robin R. Murphy, “Introduction to AI Robotics”, MIT Press, 2000
6. Leandro N. de Castro and Jonathan Timmis, “Artificial Immune system: A new Computational Intelligence Approach”, Springer-Verlag, Germany 2002.

***Experiment List Will Be Generated Later:***

**DS 1461 Credit: 1.5 (L-0, T-0, P-3)**

**DATABASE LAB**

Introduction to SQL, Integrity Constraints in SQL, Simple and complex queries, PL/SQL Basics, Exception Handling, Cursors, Transactions, Procedures, Functions and Packages, Triggers, Exercises on NoSQL MongoDB, MsAccess. Mini Project.

**DS 1462 Credit: 1.5 (L-0, T-0, P-3)**

**MACHINE LEARNING LAB**

Tutorial on tools for Machine Learning. Python suggested. Experiments with datasets to be defined in lab manual to perform preprocessing and deploy classifiers such as Bayesian, Decision Trees, Support Vector Machines, k-nearest neighbor, Regression Models. Classification accuracy measures, improving classifier performance through ensembling, boosting etc.

**DS 1463** **Credit: 1.5 (L-0, T-0, P-3)**

**DESIGN & ANALYSIS OF ALGORITHMS LAB**

Exercises to implement doubly linked list & Binary Search Tree, GCD Techniques. Sorting algorithms. String Matching, DFS, BFS, Topological sorting, AVL tree, 2-3 tree, Horspool algorithm, Open hash table, Floyd's algorithm, Warshall's algorithm, Greedy Techniques, Dijkstra's algorithm, Backtracking.

**SEMESTER – V**

**MA 1501 Credit: 3 (L-3, T-0, P-0)**

**MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE –III**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To introduce the students with Number Representation and Arithmetic Operations, Computer architecture, hardware and software allocation, memory allocation etc.

**Pre-requisites:** Basic programming knowledge and Mathematical base.

**UNIT – I**

* 1. Propositional and predicate logic. Number Theory- Divisibility, Euclidean algorithm, prime numbers, Fundamental Theorem of Arithmetic, greatest common divisors, Fermat’s little theorem, Congruences, solution of congruences, Chinese remainder theorem, Euler’s phi function, Quadratic residues and reciprocity, Jacobi Symbol,
  2. Binary quadratic forms, equivalence and reduction of binary forms, sums of two squares, greatest integer function, arithmetic functions, Combinatorial number theory, the inclusion-exclusion principle, Techniques of numerical calculation, Public key Cryptography.

**UNIT – II**

* 1. Graph Theory- Introduction to graphs. Order, size, degree. Walks, paths, cycles. Complements. Subgraphs, cliques. Isomorphism. Connectedness and connected components. Trees and spanning trees. Distance, radius, diameter, girth. Vertex connectivity, edge connectivity. Eulerian and Hamiltonian graphs.
  2. Measures of centrality – degree centrality, closeness centrality, betweenness centrality. Matrices associated with graphs – adjacency, incidence, Laplacian, and distance matrices. Eigenvalues and eigenvectors. Directed graphs. Graph algorithms – spanning tree algorithm, Dijkstra’s algorithm, Floyd-Warshall algorithm.

**Text Books:**

* 1. The Nature Of Statistical Learning Theory by Vladimir Vapnik.
  2. Machine Learning: An Algorithmic Perspective, Second Edition (Chapman & Hall/Crc Machine Learning & Pattern Recognition).

**Reference Books:**

1. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition By Trevor Hastie, Robert Tibshirani, Jerome Friedman.

**DS 1501: Credit: 3 (L-3, T-0, P-0)**

**DEEP LEARNING**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To introduce the students with Number Representation and Arithmetic Operations, Computer architecture, hardware and software allocation, memory allocation etc.

**Pre-requisites:** Basic programming language knowledge and Mathematical base.

**UNIT – I**

1. Introduction, Neural Network Basics: Multi-layer perceptron, Back propagation algorithm, training procedures,
2. Shallow Neural Networks: Review, Gradient descent and Activation Function
3. Deep Feed Forward Networks: Forward and Backward Propagation, Hidden units, architecture design, Dimensionality reduction, learning time.
4. Regularization for Deep Learning: Parameter Norm Penalties, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise-Robustness, Bagging and Other Ensemble Methods, Dropout, Adversarial Training.
5. Optimization for Training Deep Models: Challenges in Neural Network Optimization. Deep Neural Networks and the Brain.

**UNIT – II**

1. Convolutional Networks: convolution operation, pooling Object detection and Face recognition Sequence Modeling: Recurrent and Recursive Networks,
2. Stacked Auto Encoders: Under complete, Regularized, sparse, de-noising, Monte Carlo Methods. Markov Models, Hidden Markov models: evaluation problem, finding the state sequence, HMM as graphical model.
3. Deep Generative Models: Boltzmann Machines-the physics, randomness, impact on cognitive learning. Deep Boltzmann Machines,
4. Deep Belief Networks-its relationship to Boltzmann Machines, concept of greedy networks, application to drug discovery.
5. Generative Adversarial Networks, Auto-regressive Networks. Practical Methodology: Performance Metrics, Default Baseline Models, Selecting hyper parameters, Debugging Strategies.
6. Case Studies in: Large Scale Deep Learning, Computer Vision, Speech Recognition, Economics, Fraud detection, Crime detection.

**Text Books:**

* 1. Deep Learning By Ian Goodfellow, Yoshua Bengio and Aaron Courville.
  2. Deep Learning Tutorial By LISA Lab, University of Montreal

**Reference Books:**

* 1. Deep Learning: Methods and Applications By Li Deng and Dong Yu

**DS 1502 Credit: 3 (L-3, T-0, P-1)**

**OPERATING SYSTEMS**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To introduce the students with operating system, operationg sytem architecture, services, scheduling and related algorithms etc

**Pre-requisites:** Basic computer architecture.

**UNIT – I**

1. Operating System Structure: Operating System Structure and Operations, Process Management, Memory Management, Storage Management,
2. Operating System Services: User Operating System Interfaces, Types of System Calls, System Programs, Operating System Structure, System Boot, Overview, Process Scheduling,
3. Operations on Processes: Inter-process Communication, Multithreaded Models, Thread Libraries,

**UNIT – II**

1. Scheduling Algorithms, Thread Scheduling, Linux scheduling
2. Critical Section Problem, Peterson’s Solution, Synchronization Hardware, Semaphores, Logical Versus Physical Address Space,
3. Segmentation, Contiguous Memory Allocation, Paging, Structure of Page Table, Segmentation, Demand Paging, Copy-On-Write, Page Replacement
4. Allocation of Frames, Thrashing, Disk Scheduling, Swap-Space Management, System Model, Deadlock: Deadlock prevention, Avoidance, Detection, Recovery, File Concept, Protection.

**Text Books:**

1. How Implementing an Operating System Clarifies Vision, Improves Decision-Making, and Stimulates Growth by Doug Parks, Bart Rendel
2. Operating Systems,Three Easy Pieces by Andrea Arpaci-Dusseau Remzi Arpaci-Dusseau.

**Reference Books:**

* 1. Linux Command Line, A Beginner's Guide by Ray Yao.

**DS 1503 Credit: 3 (L-3, T-0, P-0)**

**NATURAL LANGUAGE PROCESSING**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To introduce the students with finite State Automata, Knowledge in Speech and related algorithms etc

**Pre-requisites:** Basic computer Architectue.

**UNIT – I**

* 1. Basics of automata: Basics of Finite State Automata, Knowledge in Speech and Language Processing, Ambiguity, Models and Algorithm.
  2. Survey of English Morphology: Survey of English Morphology, Finite-State Morphological Parsing, Building a Finite- State Lexicon, FSTs for Morphological Parsing, Lexicon-Free FSTs.
  3. Words and sentence tokenization: Words and sentence tokenization, Detecting and Correcting Spelling Errors.

**UNIT – II**

1. Case study: Normalizing Text, Segmentation. N-Grams, Unsmoothed N-Grams, Smoothing, Interpolation, and Backoff.
2. English Word Classes: Tag-sets for English, Part-of-Speech Tagging, The Noisy Channel Model for Spelling.
3. Case study: Automatic Tagging. Constituency, Some Grammar Rules for English, The Penn Treebank project, Dependency Grammar. Parsing with Context Free Grammars, CKY algorithm, Statistical Parsing.

**Text Books:**

1. Natural Language Processing with Python Written by Steven Bird, Ewan Klein and Edward Loper.
2. Text Mining with R Written by Julia Silge and David Robinson.

**Reference Books:**

* 1. Foundations of Statistical Natural Language Processing Written by Christopher Manning and Hinrich Schütze.

**DS 1504 Credit: 3 (L-3, T-0, P-0)**

**CLOUD COMPUTING**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To introduce the students with Introduction to Cloud Computing, Virtualization and related algorithms, infustructures, programming etc

**Pre-requisites:** Basic computer architecture and programming languages.

**UNIT – I**

1. Introduction to cloud computing: Introduction to Cloud Computing, Virtualization and Infrastructure as a service, Hyper converged Infrastructure,
2. Virtual Machines Provisioning: Virtual Machines Provisioning and Migration Services, Services and Service Oriented Architectures, Message-Oriented Middleware, Portals and Science Gateways,

**UNIT – II**

1. Cloud programming: Cloud Programming and Software Environments: Features of Cloud and Grid Platforms, Parallel and Distributed Programming Paradigms, Sla Management, SLA Management in Cloud,
2. Policy Management: Automated Policy-based Management. Cloud Security Fundamentals, Vulnerability Assessment, Security and Privacy, Cloud Computing Security Architecture. AWS, AWS Solution, AWS Services (IAM, VPC, etc.

**Text Books:**

1. Architecting the Cloud: Design Decisions for Cloud Computing Service Models, by Michael J. Kavis
2. Cloud Computing: Concepts, Technology & Architecture by Thomas Erl

**Reference Books:**

* 1. Cloud Computing Design Patterns by Thomas Erl.

**DS 1531A Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-II (QUANTUM COMPUTING)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** The objective of this course is to provide the students an introduction to quantum computation. Much of the background material related to the algebra of complex vector spaces and quantum mechanics is covered within the course.

**Pre-requisites:** Discrete Structures.

**UNIT – I**

1. Introduction to Quantum Computation: Quantum bits, Bloch sphere representation of a qubit, multiple qubits.
2. Background Mathematics and Physics: Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis.
3. Quantum Circuits: single qubit gates, multiple qubit gates, design of quantum circuits

**UNIT – II**

1. Quantum Information and Cryptography: Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem.
2. Quantum Algorithms: Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch’s algorithm, Deutsch’s-Jozsa algorithm, Shor factorization, Grover search.
3. Noise and error correction: Graph states and codes, Quantum error correction, fault-tolerant computation

**Text Books:**

* 1. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press. 2002
  2. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific. 2004

**Reference Books**

1. Pittenger A. O., An Introduction to Quantum Computing Algorithms.

**DS 1531B Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-II (DATA FORENSICS)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To correctly define and cite appropriate instances for the application of computer forensics Correctly collect and analyze computer forensic evidence, Identify the essential and up-to-date concepts, algorithms, protocols, tools, and methodology of Computer Forensics

**Pre-requisites:** Discrete Structures.

**UNIT – I**

* 1. Cyber Crime and computer crime Introduction to Digital Forensics, Definition and types of cybercrimes, electronic evidence and handling, electronic media, collection, searching and storage of electronic media, introduction to internet crimes, hacking and cracking, credit card and ATM frauds, web technology, cryptography, emerging digital crimes and modules.
  2. Basics of Computer Computer organisation, components of computer- input and output devices, CPU, Memory hierarchy, types of memory, storage devices, system softwares, application softwares, basics of computer languages.
  3. Computer Forensics Definition and Cardinal Rules, Data Acquisition and Authentication Process, Windows Systems-FAT12, FAT16, FAT32 and NTFS, UNIX file Systems, mac file systems, computer artifacts, Internet Artifacts, OS Artifacts and their forensic applications

**UNIT – II**

* 1. Forensic Tools and Processing of Electronic Evidence Introduction to Forensic Tools, Usage of Slack space, tools for Disk Imaging, Data Recovery, Vulnerability Assessment Tools, Encase and FTK tools, Anti Forensics and probable counters, retrieving information, process of computer forensics and digital investigations, processing of digital evidence, digital images, damaged SIM and data recovery, multimedia evidence, retrieving deleted data: desktops, laptops and mobiles, retrieving data from slack space, renamed file, ghosting, compressed files.

**Text Books:**

* 1. C. Altheide& H. Carvey Digital Forensics with Open Source Tools, Syngress, 2011. ISBN: 9781597495868.

**Reference Books**

1. Online Course Management System: https://esu.desire2learn.com/Reference Books

**DS 1531C Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-II (SOFT COMPUTING TECHNIQUES)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To correctly define and cite appropriate instances for the application of Artificial Intelligence and neural Networks

**Pre-requisites:** Discrete Structures.

**UNIT – I**

1. Artificial Intelligence – a Brief Review – Pitfalls of Traditional AI – Need for Computational Intelligence – Importance of Tolerance of Imprecision and Uncertainty - Constituent Techniques – Overview of Artificial Neural Networks - Fuzzy Logic - Evolutionary Computation.
2. Neural Network: Biological and Artificial Neuron, Neural Networks, Supervised and Unsupervised Learning. Single Layer Perceptron - Multilayer Perceptron – Backpropagation Learning.

**UNIT – II**

1. Neural Networks as Associative Memories - Hopfield Networks, Bidirectional Associative Memory. Topologically Organized Neural Networks – Competitive Learning, Kohonen Maps,
2. Fuzzy Logic: Fuzzy Sets – Properties – Membership Functions - Fuzzy Operations. Fuzzy Logic and Fuzzy Inference System
3. Evolutionary Computation - Overview of other Bio-inspired Algorithms - Swarm Intelligence Algorithms

**Text Books:**

* 1. Kumar S., “Neural Networks - A Classroom Approach”, Tata McGraw Hill, 2004.
  2. Ross T. J., “Fuzzy Logic with Engineering Applications”, McGraw Hill, 1997.
  3. Eiben A. E. and Smith J. E., “Introduction to Evolutionary Computing”, Second Edition, Springer, Natural Computing Series, 2007.

**Reference Books:**

1. Engelbrecht A. P., “Fundamentals of Computational Swarm Intelligence”, John Wiley & Sons, 2006.
2. Konar. A, “Computational Intelligence: Principles, Techniques and Applications”, Springer Verlag, 2005.

***Experiment List Will Be Generated Later:***

**DS 1562 Credit: 1.5 (L-0, T-0, P-3)**

**OPERATING SYSTEMS LAB**

Linux basic commands shell concepts and file filters, shell scripting-1,shell scripting-2, linux system calls ,thread programming, inter-process communication, process synchronization, cpu scheduling algorithms, deadlock algorithms, memory management schemes, page replacement algorithms, disk scheduling algorithms

**DS 1563 Credit: 1.5 (L-0, T-0, P-3)**

**WEB TECHNOLOGIES LAB**

Introduction to HTML, CSS AND Javascript. Web applications using any technology stack or frameworks. MVC Architecture, Web forms and web controls, State management, validation, themes and master page. Working with databases, XML, AJAX. Content Management Systems. Developing mini project using web concepts.

**DS 1581**

**INDUSTRIAL TRAINING I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Subject** | **Objectives** | **Total Credits** |
| 1. | Industrial Training/ Industrial Visit I | The students are required either to undergo 2 weeks after 4th semester in the summer break/ Vacation Straining in industries or to attend summer training course on courses beyond the scope of normal curriculum organized by the Department by calling experts from outside or to visit in industry for gaining valuable knowledge. | **0.5** |
| **Total Credits** | | | **0.5** |

1. Students have to undergo an internship (Industrial Training I, DS 1581) of minimum 2 weeks from an industry of repute during the summer break between 4th semester and 5th semester.
2. Students have to undergo an internship (Industrial Training II, DS 1681) of minimum 4 weeks from an industry of repute during the summer break between 6th semester and 7th semester.
3. Students have to submit completion certificate and present PPT related to training imparted at the industry.
4. For industrial training/ viva-voce/ seminar it will be evaluated out of 100 at the end of the semester.

**SEMESTER – VI**

**HU 1601 Credit: 3 (L-3, T-0, P-0)**

**OPERATIONS RESEARCH**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objectives:** Students will be able to acquire the idea of different research and computational methods.

**Pre-requisites:** C++ programming and Computer Organization & Architecture, Object Oriented Programing, Deep Learning, Operating Systems.

**UNIT-I**

**Introduction:** Definition, Phases, Applications, Advantages and Limitations of Operations Research.

**Linear Programming problems:** Assumptions, Formulation of LPP for business and non-business applications. Graphical solutions, Special cases – Degeneracy, Infeasible Solution, Unbalanced and Multiple optimal solutions. Minimization and Maximization cases. Simplex algorithm, Concept of dual, Sensitivity analysis with respect to objective function coefficients and R.H.S. values.

**Transportation problem:** Formulation, North-West Corner (NWC) Method, Least Cost (LC) Method, Vogel's Approximation Method (VAM). Testing the solution by Stepping stone, Modified Distribution (MODI) Method. Maximization, Multiple optimal solutions, Degeneracy and Unbalanced problems. Post optimality analysis.

**Assignment problem:** Solution algorithm for Assignment Problems. Unbalanced, multiple optimal solutions, Maximization and Application problems.

**UNIT-II**

**Travelling salesman / Job sequencing problem:** Solution algorithm for Travelling Salesman Problem, Application to job sequencing problem Game theory: Introduction to game theory, Two person- zero sum games, Pure and Mixed Strategies, Solution methods for 2 x 2 games, Graphical method (2 x n games; m x 2 games), Simulation of queuing system - Steps in simulation, Application and Limitations, Monte- Carlo technique-Problems involving Waiting line situations and Selection of crew members.

**Critical Path Method (CPM):** General frame work, Introduction to elements of network, conventions adapted in drawing network, analyzing the network. Calculation of event and Activity times, Total Float, Free Float, Independent float, Critical path, Determination of project duration, Project Crashing. Applications and Limitations of CPM.

**Project Evaluation and Review Technique (PERT):** Calculation of Probabilistic/Expected event and Activity times, Variance of activity duration, Determination of critical path, probability/expectation of project completion.

**Text Books & Reference Books:-**

1. Taha H. A., Operations Research, Pearson Education (7e), 2002.
2. W.L. Winston, Operations Research, Thomson Asia, 2003.
3. Vohra N. D., Quantitative Techniques in Management, 2007.
4. Sharma S. D., Operations Research (14e), Kedar Nath Ramnath Publications, 2005
5. Kanthiswaroop, Gupta and Manmohan, Operations Research, Sultan Chand and Sons, 2003.

**DS 1601 Credit: 3 (L-3, T-1, P-0)**

**ARTIFICIAL INTELLIGENCE**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objectives:** Students will be able to to understand basic principles of Artificial Intelligence, learn and design intelligent agents. They will also understand the basic areas of Artificial Intelligence including problem solving, knowledge representation, reasoning, decision making, planning, perception and action.

**Pre-requisites:** Computer Organization & Architecture, Object Oriented Programing, Deep Learning, Operating Systems, Robotics and Automation, Machine Learning.

**UNIT-I**

**History of AI-** Aristotle to the Dartmouth AI Conference.

**Foundations of AI-** Philosophy, Mathematics, Psychology, Computing, Linguistics, Neurosciences, Controls, and Economics.

**AI Approaches -** Cognitive Modeling. The Turing Test, Rational thinking - Logic.

**Computing streams of AI-** NLP, Machine Learning, Knowledge Representation, Automated Reasoning, Computer Vision and Robotics.

**Intelligent Agents and Environments-** the concept of Rationality, Classification, working of agents, Single and Multi-Agent System, Performance Evaluation of Agents, Architecture of Intelligent Agents.

**AI Problems:** Problem Space, Problem analysis.

**Problem Solving Techniques;** Heuristic Search, Uninformed Search, Adversarial Search- games, Constraint Satisfaction Problems.

**Games:** Optimal decision in games, Alpha Beta Pruning Knowledge based agents, The Wumpus World.

**UNIT-II**

**Knowledge and Reasoning, Representation:** Logical Agents, First order logic and inference, Classical Planning.

**Propositional logic:** Propositional Theorem Proving, Representation. Classical Planning, Fuzzy Logic. Ontological Engineering, Semantic Web, RDF data models, RDFS, Querying Semantic Web: SPARQL, filters, Ontology and Information Systems, OWL, Ontology Reasoning: Monotonic rules, Rule interchange format, Semantic web rules languages, RuleML. Quantifying Uncertainty, Probabilistic Reasoning, Making Simple & Complex Decisions.

**Reinforcement learning:** Passive, Active, Generalization, Policy Search, Markov Decision Process, Bellman equations, value and policy iteration, Linear Quadratic Regulation, Linear Quadratic Guassian, Q-learning, policy search, POMDPs.

**Applications:** NLP, Parsing, Machine translation, speech recognition.

**Perception:** Image formation, Image Processing, Object Recognition, Robotics: software agents, Hardware, perception, software architectures.

**Future of AI:** Cognitive Modeling approach, Layers of Mental Activities, Layered Knowledge Representation, Cognitive Architectures.

**Quantum Computing:** Quantum mechanics and its impact, Brain –Machine Convergence.

**Text Books & Reference Books:-**

1. Russell S., and Norvig P., Artificial Intelligence A Modern Approach (3e), Pearson 2010.
2. Marvin Minsky, Society of Mind. Simon & Schuster, 1998
3. Marvin Minsky, The Emotion Machine: Commonsense Thinking, Artificial Intelligence, and the Future of the Human Mind. Simon & Schuster, 2007.
4. Rich E., Knight K., Nair S.B., Artificial Intelligence (3e), Tata McGraw Hill, 2008.
5. Grigoris Antoniou, Paul Groth, Frank van vanHarmelen and Rinke Hoekstra, A Semantic Web Primer, MIT Press, 2012.
6. Ray Kurzweil, The Age of Spiritual Machines: When Computers Exceed Human Intelligence,

Penguin (USA), 2000.

1. Douglas R.Hofstadter, Godel, Escher, Bach: An Eternal Golden Braid, Penguin (UK), 2000

**DS 1602 Credit: 3 (L-3, T-1, P-0)**

**PARALLEL PROGRAMMING**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem only] / FIVE selecting at least TWO from each unit.

**Course Objectives:** Students will be able to understand basic principles and various techniques of parallel programming.

**Pre-requisites:** C++ Programming, Object Oriented Programing.

**UNIT-I**

**Introduction:** Traditional Systems, Processor Architectures, Performance Metrics and enhancement, Laws of Parallel Programming, Bottlenecks, Parallel Programming.

**Multicore Systems:** Uniprocessor Systems, Multiprocessor Systems.

**Introduction to OpenMP, Overview of OpenMP:** Creating threads, threads synchronization, performance considerations.

**OpenMP language features:** Parallel Construct, sharing work among threads, clauses to control parallel and work-sharing constructs If Clause, Num., threads Clause, Ordered Clause, Reduction Clause, Copyin Clause, Copy private Clause, Advanced OpenMP Constructs, Nested Parallelism, Flush Directive, Thread private Directive; Open MP Case studies.

**Many Core Systems:** Heterogeneous Parallel Computing.

**UNIT-II**

**Introduction to Data Parallelism; Data parallelism and CUDA C:** Data Parallelism, CUDA Program Structure, Device Global Memory and Data Transfer, Kernel Functions and Threading;

**Data-Parallel Execution Model:** CUDA Thread Organization, Mapping Threads to Multidimensional Data, Matrix-Matrix Multiplication, Synchronization and Transparent Scalability, Assigning Resources to Blocks, Thread Scheduling and Latency Tolerance.

**CUDA Memories:** Importance of Memory Access Efficiency, CUDA Device Memory Types Strategy for Reducing Global Memory Traffic, Tiled Matrix, Memory as a Limiting Factor to Parallelism.

**Performance Considerations:** Warps and Thread Execution, Global memory bandwidth, Dynamic partitioning of execution resources; CUDA Case Studies.

**Text Books & Reference Books:-**

1. D. Kirk, W. Hwu, “Programming Massively Parallel Processors”, 2nd Edition, Elsevier Inc. 2012.
2. A. Grama et al., “Introduction to Parallel Computing”, 2nd Edition, Addison Wesley 2003.
3. E. Stotzer, C. Terboven,” Using OpenMP – The Next Step”, 1st Edition, MIT Press, 20017.
4. S. Cook, “CUDA Programming: A Developer's Guide to Parallel Computing with GPUs”, 1st edition, Morgan Kaufmann, 2012.
5. J. Sanders, E. Kandrot, “CUDA by example: an introduction to general-purpose GPU programming”, Addison-Wesley Professional, 2010.

**DS 1603 Credit: 3 (L-3, T-1, P-0)**

**BIG DATA ANALYTICS**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objectives:** Students will be able to understand the methods for Big Data analytics, design solutions for data analytics solutions using computer programming and learn and apply machine learning algorithms for business data analysis**.**

**Pre-requisites:** C++ Programming, Object Oriented Programing, Big Data, Cloud Computing.

**UNIT-I**

**Introduction to Big Data:** evolution, structuring, elements, big data analytics, distributed and parallel computing for big data, Hadoop, Cloud computing and big data, in-memory computing technology for big data, Big Data Stack, Virtualization and Big Data.

**Hadoop:** ecosystem, Hadoop Distributed File System (HDFS).

**MapReduce:** MapReduce Framework, optimizing MapReduce jobs, MapReduce Applications, Understanding YARN architecture, HBase, Exploring Hive, Analyzing data with Pig, Using Oozie, Introduction to Mahout, role of HBase in Big Data Processing, RHadoop: Data Analysis Using the MapReduce Technique in RHadoop,

**UNIT-II**

**Spark:** Core Concepts, Spark’s Python and Scala shells, Programming with RDD: RDD Operations, Passing Functions to Spark, Common Transformations and Actions.

**Mining Data Streams:** Streams Concepts, stream Data Model and Architecture, stream computing, filtering Streams, estimating Moments, decaying window, Real time Analytics Platform (RTAP) Applications.

**Case Studies:** Real Time Sentiment Analysis, Stock Market Predictions.

**Text Books & Reference Books:-**

1. Vignesh Prajapathi, Big Data Analytics with R and Hadoop, Packt Publishing, 2013.
2. Holden Karau, Andy Konwinski , Patrick Wendell, Matei Zaharia, Learning Spark: Lightning-Fast Big Data Analysis, 1st Edition, O’Reilley Media Inc, 2015.
3. Michael Minnelli, Michele Chambers, Big Data Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Wiley India Pvt. Ltd., 2013.
4. Arvind Sathi, Big Data Analytics, MC Press, LLC, 2012.

**DS 1604 Credit: 3 (L-3, T-1, P-0)**

**DATA PRIVACY AND SECURITY**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objectives:** Students will be able to introduce models of Data Security and impart necessary skills to understand privacy preserving data sharing, introduce the procedure to secure big data and enable to understand on Hadoop Kerberos security.

**Pre-requisites:** C++ Programming, Object Oriented Programing, Big Data, Cloud Computing.

**UNIT-I**

Introduction to Data Privacy, types of privacy attacks, Data linking and profiling, access control models, role-based access control, privacy policies, their specifications, privacy policy languages, privacy in different domains-medical, financial, etc. Mathematical model for comparing real-world data sharing practices, computing privacy and risk measurements. Demographics and Uniqueness. Protection Models-Null-map, k-map, Wrong map. Survey of Techniques-Protection models (null-map, k-map, wrong map), Disclosure control, Inferring entity identities, entry specific databases. Computation systems for protecting delimited Data-Min Gen, Datafly, Mu-Argus, k-Similar.

**UNIT-II**

Introduction to Security: The OSI Security Architecture, Security Attacks, Services and Mechanisms, Model for Network Security, Number theory, Cryptographic Hash Functions, Digital Signatures, System Security, Symmetric Encryption and Message Confidentiality, Substitution ciphers, Stream ciphers, Public-key cryptography and Message Authentication, Key Distribution and Authentication, Transport Layer Security, Wireless Network Security, E-mail Security, IP Security, Security Management Systems, Need for IT Security, Intrusion Prevention and Detection Systems, Cyber Security.

Security metrics: Design, Data sources, Analysis of security metrics data, Measuring security cost and value, Different context for security process management. Acquisition and Duplication: Sterilizing Evidence Media, Acquiring Forensics Images, Acquiring Live Volatile Data, Data Analysis, Metadata Extraction, and File System Analysis.

**Text Books & Reference Books:-**

1. Ronald Leenes , Rosamunde van Brakel , Serge Gutwirth , De Hert, Paul, Data Protection and Privacy: The Age of Intelligent Machines (Computers, Privacy and Data Protection), Hart Publishing (December 28, 2017)
2. B. Raghunathan, The Complete Book of Data Anonymization: From Planning to Implementation, Auerbach Pub, 2016.
3. L. Sweeney, Computational Disclosure Control: A Primer on Data Privacy Protection, MIT Computer Science, 2017
4. William Stallings, Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson Education, 2017.
5. William Stallings, Network Security Essentials: Applications and Standards, 6th Edition, Pearson Education, 2014.
6. Atul Kahate, Cryptography and Network Security, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, 2013.
7. Lance Hayden, IT Security Metrics, Tata McGraw Hill, 2016.

**DS 1605 Credit: 3 (L-3, T-0, P-0)**

**REMOTE SENSING IN DATA SCIENCE**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective: Students will learn** bioinformatics and data generation and Biological Database and its Types Introduction to data types and Source.

**Pre-requisites:** Students should be familiar with basic Biology and related field.

**UNIT-I**

Orbital mechanics – Orbital elements – Ground trace – Remote sensing satellite (RSS) classification based on orbits and purpose – Two-line element (TLE) – Sun-synchronous orbit (SSO) – Orbital perturbations – MultiSSO – Space environment –

Atmospheric density models – Attitude determination and control system (ADCS) – ADCS sensors – Reference frames – Ephemeris – Orbital lifetime and decay – Ballistic coefficients – RSS classifications based on mission requirements – Performance parameters – Navigation and tracking – Beta angle –

GPS & Autonomous navigation/control – Communications – Link equation – Hardware – Central processing – RSS structural design – RSS constellations – Mission simulations software – Orbital parameter estimation using cloud computing.

**UNIT-I**

New generation Big data using Functional Programming in Scala: Basic Syntax- type inference and static types- function types and value types, closures. Immutability and immutable types

Generic type Parameters Recursive arbitrary collections-cons list- Iterative Arbitrary Collections-Arrays-Tail recursion- factorial example-functional abstractions with examples-square root, fixed point, sequence summations.

Higher order functions- MapReduce Template-Pattern Matching syntax. Similar higher order (Cons) List operations on arbitrary Collections-filter, fold, partition, span. Basic entity classes and object in Scala. Apache Spark: - Resilient Distributed Data Sets- Creating RDDs, Lineage and Fault tolerance, DAGs, Immutability, task division and partitions, transformations and actions, lazy evolutions and optimization - Formatting and housing data from spark RDDs-Distributed File systems, HDFS and Tachyon-Persistance.

**Text Books & Reference Books: -**

1. Learning Spark: Lightning-Fast Big Data Analysis 1st Edition by Holden Karau , Andy Konwinski, Patrick Wendell, MateiZaharia
2. Programming in Scala: A Comprehensive Step-by-Step Guide Third Edition by Martin Odersky, Lex Spoon, Bill Venners.
3. High Performance Spark: Best Practices for Scaling and Optimizing Apache Spark 1st Edition, by Holden Karau, Rachel Warren
4. Spark: The Definitive Guide: Big Data Processing Made Simple 1st Edition, Kindle Edition by Bill Chambers, MateiZaharia

**DS 1661 Credit: 1.5 (L-0, T-0, P-3)**

**ARTIFICIAL INTELLIGENCE & DEEP LEARNING LAB**

Intelligent Agents and case study, AI Problems- Problem Space: Heuristic search Techniques; Constraint satisfaction problems, Semantic Networks, Propositional and Predicate Logic: Propositional and Predicate calculus, semantics for predicate calculus, theorem prover, inference rules, unification, Resolution, Refutation in predicate logic; Communicating, Perceiving, and Acting case study, Genetic Algorithm and its use cases. Fuzzy Logic and its case study.

Tutorial on tools for Machine Learning. Tensorflow, Python-Keras suggested. Experiments with datasets to be defined in lab manual to deploy deep learning algorithms. Case studies or mini projects in topics such as Sentiment Analysis, Anomaly Detection, Recommender Systems.

**DS 1662 Credit: 1.5 (L-0, T-0, P-3)**

**BIG DATA ANALYTICS LAB**

Tutorial on tools for Big Data tools and technologies. Cloudera Distribution for Hadoop, Apache Cassandra, MongoDB suggested. Experiments with big datasets to be defined in lab manual, to deploy big data implementations of machine learning algorithms. Case studies or mini projects to be defined for big data.

**DS 1671**

**MINI PROJECT**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Subject** | **Objectives** | **Total Credits** |
| **1.** | Mini Project | The students are required to undertake innovative and research-oriented project under the direct supervision of a faculty member of the department. The mini project should not only to reflect their knowledge gained in the previous seven semesters but also to acquire additional knowledge and skill of their own effort. The mini projects are assigned at the end of the Vth semester and the final evaluation and grades are awarded at the end of VIth semester. | |
| **2.** | Mini Project Reviews | The progress is being evaluated in phases through interim seminars/presentations to make the department aware of his/her project. | **1** |
| **3.** | Awarded by  Project Guide | The Faculty-guide assesses the work of the group(s) working under. | **1** |
|  |  | **Total Credits** | **2** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl. No.** | **Subject Code** | **Internal Marks** | **External Marks** | **Credits** |
| 1 | DS1671 | 50 | 50 | 2 |

**DS 1681**

**INDUSTRIAL TRAINING-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Subject** | **Objectives** | **Total Credits** |
| 1 | Industrial Training/ Industrial Visit II | The students are required either to undergo minimum of 4 weeks training in industries or to attend summer training course on courses beyond the scope of normal curriculum organized by the Department by calling experts from outside. | **0.5** |
| **Total Credits** | | | **0.5** |

**SEMESTER – VII**

**DS 1751 Credit: 4 (L-4, T-0, P-0)**

**SOFTWARE ENGINEERING**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To make student understand the software engineering discipline-evaluation and impact, Programs vs. software products, Changes in software development practice, System engineering, handling complexity through Abstraction and Decomposition.

**Pre-requisites:** Basic computer architecture and programming languages.

**UNIT – I**

1. Introduction: The software engineering discipline-evaluation and impact, Programs vs. software products, Changes in software development practice, System engineering, handling complexity through Abstraction and Decomposition.
2. Software life cycle: Waterfall model, Iterative waterfall model, Prototype model, Evolutionary model, Spiral model, RAD model, Agile models, comparison of different life cycle models.
3. Software project management: Responsibilities of project manager, Project planning, Metrics for project size estimation techniques, Empirical estimation techniques, COCOMO, Halstead’s software science, Staffing level estimation, Scheduling, Organization and team structure, Staffing, Risk management, Software configuration management.
4. Requirements analysis and specification: Requirements gathering and analysis, Software requirement specification (SRS), Traceability, Characteristics of a Good SRS Document, IEEE 830 guidelines, overview of formal system development techniques.
5. Software design: Good Software Design, Cohesion and coupling, Control Hierarchy: Layering, Control Abstraction, Depth and width, Fan-out, Fan-in, Software design approaches, object oriented vs. function oriented design.
6. Function-oriented and Object Oriented software design: Overview of SA/SD methodology, structured analysis, Data flow diagram, Extending DFD technique to real life systems, Structured design, Detailed design, Design review. Unified Modeling Language (UML), UML Diagrams: Static and Dynamic

**UNIT – II**

1. User interface design: Characteristics of a good user interface, User Guidance and Online Help, Mode-based Vs Mode-less Interface, Types of user interfaces, Component-based GUI development, User interface design methodology: GUI design methodology, Task and object modeling, Selecting a metaphor, Interaction design and rough layout, User interface inspection.
2. Coding and testing: Coding, Code testing, Test driven development, testing tools, Introduction to Agile software development and DevOps.
3. Software reliability and quality management: Software reliability, Statistical testing, Software quality and management, ISO 9000, SEI capability maturity model, Personal software process (PSP), Six sigma, Software quality metrics
4. Computer aided software engineering: Case and its scope, Case environment, Case support in software life cycle, Other characteristics of case tools, Towards second generation case tool, Architecture of a case environment. Legal Aspects of Software Engineering, Business Aspects of Software Engineering.
5. Software maintenance and reuse: Characteristics of software maintenance, Software reverse engineering, Software maintenance processes model, Estimation maintenance cost. Basics issues in any reuse program, Reuse approach, Reuse at organization level.
6. Model: CUDA Thread Organization, Mapping Threads to Multidimensional Data, Matrix- Matrix Multiplication, Synchronization and Transparent Scalability, Assigning Resources to Blocks, Thread Scheduling and Latency Tolerance; CUDA Memories: Importance of Memory Access Efficiency, CUDA Device Memory Types Strategy for Reducing Global Memory Traffic, Tiled Matrix, Memory as a Limiting Factor to Parallelism; Performance Considerations: Warps and Thread Execution, Global memory bandwidth, Dynamic partitioning of execution resources; CUDA Case Studies.

**Text Books:**

1. Clean Code: A Handbook of Agile Software Craftsmanship is a book written by Robert. C. Martin. The writer brings Agile principles from a practitioner's point of view of thousands of programmers.
2. Design Patterns: Elements of Reusable Object-Oriented Software is a book written by Richard Helm, Erich Gamma Ralph Johnson, John Vlissides, and Grady Booch.

**Reference Books:**

1. Patterns of Enterprise Application Architecture by Martin Fowler.

**DS 1752 Credit: 4 (L-4, T-0, P-0)**

**INTERNET OF THINGS**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:** To make student understand the internet of things and its associated fundamentals on its Gobal context and its Design principle and Data management system related to the IOT.

**Pre-requisites:** Basic computer architecture and Networking knowledge.

**UNIT – I**

1. Introduction to IOT: Introduction to internet of things, IoT in global context,
2. Design principle to IOT: Design Principles, IoT Technology
3. Fundamental: Devices and gateways, Local and wide area networking,
4. DBMS relate to IOT: Data management, Business processes in IoT, IoT reference Architecture, IoT Domain Model, Functional Model.

**UNIT – II**

1. Information Model: Communication Model.
2. Deployment: Deployment and associated and Operational View,
3. IoT Prototyping- Prototyping Embedded Devices, Electronics, Sensors, Actuator, Embedded Computing Basics, Arduino, Raspberry Pi, BeagleBone Black,
4. IoT Use Cases - Industrial Automation, Smart Home, Smart City, Commercial Building Automation.

**Text Books:**

1. “The Internet of Things” by Samuel Greengard
2. “The Fourth Industrial Revolution” by Klaus Schwab

**Reference Books:**

* 1. “Getting started with Internet of Things” by Cuno Pfister

**DS 1733A Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-III (COMPUTER VISION)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:** In this course students will learn basic principles of image formation, image processing algorithms and different algorithms for 3D reconstruction and recognition from single or multiple images (video). This course emphasizes the core vision tasks of scene understanding and recognition. Applications to 3D modelling, video analysis, video surveillance, object recognition and vision based control will be discussed.

**Pre-requisites:** Programming and Mathematics course

**UNIT – I**

1. Introduction: Image Processing, Computer Vision and Computer Graphics, What is Computer Vision - Low-level, Mid-level, High-level, Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality
2. Image Formation Models: Monocular imaging system, Radiosity: The ‘Physics’ of Image Formation, Radiance, Irradiance, BRDF, color etc., Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems, Multiple views geometry, Structure determination, shape from shading, Photometric Stereo, Depth from Defocus, Construction of 3D model from images
3. Image Processing and Feature Extraction: Image preprocessing, Image representations (continuous and discrete), Edge detection
4. Motion Estimation: Regularization theory, Optical computation, Stereo Vision, Motion estimation, Structure from motion

**UNIT – II**

1. Shape Representation and Segmentation: Contour based representation, Region based representation, Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multiresolution analysis.
2. Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition
3. Image Understanding: Pattern recognition methods, HMM, GMM and EM
4. Applications: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application: Surveillance – foreground-background separation – particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians

**Text Books:**

1. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.
2. Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Publisher: Prentice Hall.
3. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc., 1992.

**Reference Books:**

1. D. H. Ballard, C. M. Brown. Computer Vision. Prentice-Hall, Englewood Cliffs, 1982.
2. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA). Springer, 2010
3. Image Processing, Analysis, and Machine Vision. Sonka, Hlavac, and Boyle. Thomson.
4. E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012
5. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012

**DS 1733B Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-III (FINANCE & ACCOUNTING)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:** In this course students will learn basic principles of Need, development, and definition of accounting

**Pre-requisites:** Finance and Accounts in brief.

**UNIT – I**

1. Meaning and Scope of Accounting: Need, development, and definition of accounting; Bookkeeping and accounting; Persons interested in accounting; Disclosures; Branches of accounting; Objectives of accounting.
2. Accounting Principles: International Accounting Standards (only outlines); Accounting principles; Accounting Standards in India
3. Accounting transactions: Accounting Cycle; Journal; Rules of debit and credit; Compound journal entry; Opening entry; Relationships between Journal and Ledger; Rules regarding posting; Trial balance; Subdivisions of a journal.
4. Capital and Revenue: Classification of income; Classification of expenditure; Classification of receipts Accounting concepts of income; Accounting concepts and income measurement; Expired costs and income measurement Final Accounts; Manufacturing account; Trading account; Profit and loss account; Balance Sheet; Adjustment entries, Rectification of errors; Classification of errors; Location of errors; Suspense accounts; Effects on profit.

**UNIT – II**

1. Depreciation Provisions and Reserves: Concept of depreciation; Causes of depreciation; Depreciation, depletion, amortization, and dilapidation; Depreciation accounting; Methods of recording depreciation; Methods for providing depreciation; Depreciation of different assets; Depreciation of replacement cost; Depreciation accounting as per accounting standard; Depreciation accounting; Provisions and reserves
2. Introduction to Company Accounts: Introduction, Kinds of Companies, Formation of Companies, Share Capital, Issue of Shares, Under Subscription & Oversubscription, Issue of Shares at Premium & Discount, Buyback of Shares and Treasury Stock, Accounting Treatments and Ledger Preparation.
3. Company Accounts: Introduction, Forfeiture of Shares, Reissue of Shares, Issue of Bonus Shares, Rights Issue, Share Split, Buy Back of Shares, Redemption of Preference Shares, Debentures

**Text Books:**

1. Warren Buffett Accounting Book: Reading Financial Statements for Value Investing Buffett Book Edition
2. Accounting All-in-One for Dummies

**Reference Books:**

1. Accounting Made Simple: Accounting Explained

**DS 1733C Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-III (INFORMATION RETRIEVAL)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:**

* 1. To provide an overview of Information Retrieval.
  2. To introduce students about insights of the several topics of Information retrieval such as – Boolean retrieval model, Vector space model, Latent semantic indexing, XML and Image retrieval model.
  3. To provide comprehensive details about various Evaluation methods. d. To provide implementational insight about the topics covered in the course

**Pre-requisites:** Finance and Accounts in brief.

**UNIT – I**

1. Introduction to Information retrieval Information retrieval process, Indexing, Information retrieval model, Boolean retieval model.
2. Dictionary and Postings Tokenization, Stop words, Stemming, Inverted index, Skip pointers, Phrase queries.
3. Tolerant Retrieval Wild card queries, Permuterm index, Bigram index, Spelling correction, Edit distance, Jaccard coefficient, Soundex.
4. Term Weighting and Vector Space Model Wild card queries, Permuterm index, Bigram index, Spelling correction, Edit distance, Jaccard coefficient, Soundex.
5. Evaluation Precision, Recall, F-measure, E-measure, Normalized recall, Evaluation problems

**UNIT – II**

1. Latent Semantic Indexing Eigen vectors, Singular value decomposition, Lowrank approximation, Problems with Lexical Semantics
2. Query Expansion Relevance feedback, Rocchio algorithm, Probabilistic relevance feedback, Query Expansion and its types, Query drift
3. Probabilistic Information Retrieval Probabilistic relavance feedback, Probability ranking principle, Binary Independence Model, Bayesian network for text retrieval
4. XML Indexing and Search Data vs. Text-centric XML, Text-Centric XML retrieval, Structural terms
5. Content Based Image Retrieval Introduction to content Based Image retrieval, Challenges in Image retrieval, Image representation, Indexing and retrieving images, Relevance feedback

**Text Books:**

1. Introduction to Information Retrieval by Christopher D. Manning.

**Reference Books:**

1. Natural Language Processing And Information Retrieval by Tanveer Siddiqui and U. S. Tiwary

**DS 1733D Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-III (DIGITAL MARKETING)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:** The aim of the Digital Marketing Course is to provide students with the knowledge about business advantages of the digital marketing and its importance for marketing success; to develop a digital marketing plan; to make SWOT analysis; to define a target group; to get introduced to various digital channels, their advantages and ways of integration; how to integrate different digital media and create marketing content; how to optimize a Web site and SEO optimization; how to create Google AdWords campaigns; social media planning; to get basic knowledge of Google Analytics for measuring effects of digital marketing and getting insight of future trends that will affect the future development of the digital marketing. The application of the gained knowledge, skills and competences will help future managers in forming digital marketing plan in order to manage a digital marketing performance efficiently.

**Pre-requisites:** Finance and Accounts in brief.

**UNIT – I**

1. Introduction to the Course and Work plan • Introduction of the digital marketing • Digital vs. Real Marketing • Digital Marketing Channels
2. Creating initial digital marketing plan • Content management • SWOT analysis • Target group analysis • EXERCISE: Define a target group (working in groups)
3. Web design • Optimization of Web sites • MS Expression Web • EXERCISE: Creating web sites, MS Expression (working in groups)
4. SEO Optimization • Writing the SEO content • Exercise: Writing the SEO content (working in groups)
5. Google AdWords- creating accounts • Google AdWords- types • Exercise: Google AdWords (working in groups)

**UNIT – II**

1. Introduction to CRM • CRM platform • CRM models • Exercise: CRM strategy (working in groups)
2. Creating business accounts on YouTube • YouTube Advertising • YouTube Analytics
3. Facebook Ads • Creating Facebook Ads • Ads Visibility
4. E-mail marketing • E-mail marketing plan • E-mail marketing campaign analysis • Keeping up with conversions
5. Digital Marketing Budgeting - resource planning - cost estimating - cost budgeting - cost control
6. Recapitulation: - lessons learned - student satisfaction survey - closing

**Text Books:**

1. Ryan, D. (2014). Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation, Kogan Page Limited.

**Reference Books:**

* 1. The Beginner's Guide to Digital Marketing (2015). Digital Marketer.
  2. Pulizzi,J.(2014) Epic Content Marketing, Mcgraw Hill Education.

**DS 1734A Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-IV (BIOSTATISTICS)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:** Student will learn statistical analysis and Collection, Classification and Tabulation of data

**Pre-requisites:** Mathematics and fundamentals of statistical distribution.

**UNIT – I**

1. Collection, Classification and Tabulation of data, Bar diagrams and Pie diagrams, Histogram, Frequency curve and frequency polygon, Ogives. Mean, median, mode, Standard deviation.
2. Correlation and Regression analysis: Correlations and regressions-: Relation between two variables, scatter diagram, definition of correlations, curve fitting, principles of least squares, Two regression lines, Karl Pearson’s coefficient of correlation, Rank correlation, Tied ranks.
3. Probability theory: Random experiments, sample space, probability theory, conditional probability. Baye’s theorem.

**UNIT – II**

1. Random variable, (discrete and continuous), Probability density function (discrete and continuous), Distribution function for discrete random variable. Distribution function for continuous random variable, Joint probability distribution, Conditional and marginal distribution.
2. Mathematical expectations: Introduction, the expected value of a random variable, moments, Moment generating functions, Product moments, Conditional expectations. Standard distributions -: Uniform distribution. (Discrete and continuous).
3. Exponential distribution Gamma distribution, Beta distribution. Binomial distribution, Poisson distribution, Normal distributions. Standard normal distributions.

**Text Books:**

1. Fundamentals of Biostatistics. by Irfan A Khan
2. An introduction to Biostatistics. by PSS Sunder Rao.
3. Introduction to the Practice of Statistics by Moore and McCabe

**Reference Books:**

1. Principles of Biostatistics. Marcello Pagano
2. Course Manuals: S-PLUS Command Line Essentials, The Analysis of Microarrays

**DS 1734B Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-IV (APPLIED ECONOMETRICS)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:** The goal of this course is for students to learn a set of statistical tools and research designs that are useful in conducting high-quality empirical research on topics in applied microeconomics and related fields. Since most applied economic research examines questions with direct policy implications, this course will focus on methods for estimating causal effects. This course differs from many other econometrics courses in that it is oriented towards applied practitioners rather than future econometricians. It therefore emphasizes research design (relative to statistical technique) and applications (relative to theoretical proofs), though it covers some of each.

**Pre-requisites:** Students should be familiar with basic probability and statistics, matrix algebra, and the classical linear regression model.

**UNIT – I**

1. Econometrics – definitions – scope – methodology – types.
2. Two variable regression model – assumptions – method of least squares – properties – BLUE – R-square – maximum likelihood method – testing of hypotheses using point and interval estimates – forecasting – solving problems using SPSS and STATA.
3. Nonlinear relationships – transformation of variables – functional forms – three variable regression model – applications using SPSS and STATA.

**UNIT – II**

1. General linear model (matrix approach) – specification – OLS estimators – testing significance of individual and overall regression coefficients – restricted least squares – structural regression models – dummy variables – problems and application using STATA.
2. Violation of classical assumptions – multicollinearity – autocorrelation – hetroscedasticity – problems – causes – consequences – remedial measures – model specification and diagnostic testing.

**Text Books:**

1. Damodar N. Gujarathi: Basic Econometrics, New Delhi: Tata McGraw Hill.

**Reference Books:**

1. J.Johnston: Econometric Methods, McGraw Hill. 3. STATA Version 8.0: User’s Guide, Texas: Stata Press.

**DS 1735A Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-V (FINANCE & SECURITY ANALYTICS)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:** The goal of this course is for students to learn Investment Fundamental and Analysis of Economy

**Pre-requisites:** Students should be familiar with basic Economics.

**UNIT – I**

1. Investment – A Conceptual Framework: Investment process, risks of investment and the common mistakes made in investment management
2. Investment Environment: Features and composition of money market and capital market, money market, capital market instruments and financial derivatives
3. Risk and Return: Concepts of risk and return, how risk is measured in terms of standard deviation and variance, the relationship between risk and return
4. Fundamental Analysis: Economy analysis, industry analysis and company analysis, weaknesses of fundamental analysis
5. Technical Analysis: Tools of technical analysis, important chart formations or price patterns and technical indicators
6. Efficient Market Hypothesis: Concept of ‘Efficient Market’ and its implications for security analysis and portfolio management.
7. Behavioral Finance: Meaning of Behavioral finance, deals with when, how and why psychology influences investment decisions
8. Valuation of bonds and shares: Elements of investment, bond features and prices, call provisions on corporate bonds, convertible bonds and valuation of bonds

**UNIT – II**

1. Portfolio Management – Risks and Returns: Concept of portfolio and portfolio management, concept of risk, types of portfolio management
2. Markowitz Portfolio Selection Model: Concept of portfolio analysis and diversification of risk. Also discusses Markowitz Model and Efficient Frontier
3. Capital Asset Pricing Model (CAPM): Deals with the assumptions of CAPM and the inputs required for applying CAPM and the limitations of this Model
4. Sharpe-The Single Index Model: Measurement of return on an individual stock, measurement of portfolio return and measurement of individual stock risk
5. Factor Models and Arbitrage Pricing Theory: Arbitrage Pricing Theory and its principles, Comparison of Arbitrage Pricing Theory with the Capital Asset Pricing Model.
6. International Portfolio Investments: Investment avenues for foreign portfolio investors, risks and returns associated with such investment.
7. Mutual Fund Operations: Mutual funds as a key financial intermediary, mobilizing savings and investing them in capital markets.

**Text Books:**

1. Security Analysis is a book written by professors Benjamin Graham and David Dodd

**Reference Books:**

1. Business Analysis and Valuation: Using Financial Statements

**DS 1735B Credit: 3 (L-3, T-0, P-0)**

**PROGRAM ELECTIVE-V (BUSINESS ANALYTICS)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:** 1. Understand the different basic concept / fundamentals of business statistics. 2. Understand the importance of measures of Descriptive statistics which includes measures of central tendency, Measures of Dispersion, Time Series Analysis, Index Number, Correlation and Regression analysis and their implication on Business performance. 3. Understand the concept of Probability and its usage in various business applications. 4. Understand the Hypothesis Testing concepts and use inferential statistics- t, F, Z Test and Chi Square Test 5. Understand the practical application of Descriptive and Inferential Statistics concepts and their uses for Business Analytics.

**Pre-requisites:** Students should be familiar with basic Economics.

**UNIT – I**

1. Descriptive Statistics Meaning, Scope, types, functions and limitations of statistics, Measures of Central tendency – Mean, Median, Mode, Quartiles, Measures of Dispersion – Range, Inter quartile range, Mean deviation, Standard deviation, Variance, Coefficient of Variation, Skewness and Kurtosis.
2. Time Series & Index Number Time series analysis: Concept, Additive and Multiplicative models, Components of time series, Trend analysis: Least Square method - Linear and Non- Linear equations, Applications in business decision-making. Index Numbers:- Meaning , Types of index numbers, uses of index numbers, Construction of Price, Quantity and Volume indices:- Fixed base and Chain base methods.
3. Correlation & Regression Analysis Correlation Analysis: Rank Method & Karl Pearson's Coefficient of Correlation and Properties of Correlation. Regression Analysis: Fitting of a Regression Line and Interpretation of Results, Properties of Regression Coefficients and Relationship between Regression and Correlation.

**UNIT – II**

1. Probability Thoery & Distribution Probability: Theory of Probability, Addition and Multiplication Law, Baye’s Theorem Probability Theoretical Distributions: Concept and application of Binomial; Poisson and Normal distributions.
2. Hypothesis Testing& Business Analytics Hypothesis Testing: Null and Alternative Hypotheses; Type I and Type II errors; Testing of Hypothesis: Large Sample Tests, Small Sample test, (t, F, Z Test and Chi Square Test)
3. Concept of Business Analytics- Meaning types and application of Business Analytics, Use of Spread Sheet to anlayze data-Descriptive analytics and Predictive analytics. MBA (Business Analytics) CURRICUL

**Text Books:**

1. G C Beri – Business Statistics, 3rd ed, TATA McGrawHill.
2. Chandrasekaran & Umaparvathi-Statistics for Managers, 1st edition, PHI Learning
3. Davis , Pecar – Business Statistics using Excel, Oxford
4. Ken Black – Business Statistics, 5th ed., Wiley India
5. Levin and Rubin – statistics for Management, 7th ed., Pearson

**Reference Books:**

1. Lind, Marchal, Wathen – Staistical techniques in business and economics, 13th ed, McGrawHill
2. Newbold, Carlson, Thorne – Statistics for Business and Economics, 6th ed., Pearson
3. S. C.Gupta – Fundamentals of Statistics, Himalaya Publishing 9. Walpole – Probability and Statistics for Scientists and Engineers, 8th ed., Pearson

**DS 1721A Credit: 3 (L-3, T-0, P-0)**

**OPEN ELECTIVE I (SUPPLY CHAIN MANAGEMENT)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:** The distinction between logistics and supply chain management is identified and a framework for SCM is presented. A class session will be devoted to each of the eight supply chain processes as well as to topics such as: the management components of supply chain management; electronically linking the supply chain; integrating supply chain strategy to corporate strategy; supply chain mapping; supply chain metrics; developing and implementing partnerships in the supply chain; and, implementing supply chain management.

**Pre-requisites:** Students should be familiar with basic Economics and logistics management.

**UNIT – I**

1. Introduction to Course & Objectives Supply Chain Management: Logistics v SCM
2. Supply Chain Management: Key Processes
3. Customer Service Management Demand Management
4. Demand Management Order Fulfillment

**UNIT – II**

1. Manufacturing Flow Management
2. Supplier Relationship Management Product Development and Commercialization
3. Supply Chain Mapping
4. Developing and Implementing Partnerships in the Supply Chain
5. Supply Chain Performance Measurement

**Text Books:**

1. Supply Chain Management: Key Processes 1. Anon., “The Physical Internet – A Survey of Logistics,” The Economist, (June 17, 2006), pp. 3-18.
2. Siems, “Supply Chain Management: The Science of Better, Faster, Cheaper,” Federal Reserve Bank of Dallas – Southwest Economy, March/April (2005), pp. 1,7-12.
3. Laura R. Kopczak and M. Eric Johnson, “The Supply Chain Management Effect”, MIT Sloan Management Review, Vol. 44 No 3 (Spring 2003): 27-34

**Reference Books:**

1. Hammer, “The Super-efficient Company, Harvard Business Review, 79:9 (2001), pp. 82-91.
2. Rice and Hoppe, “Supply Chain vs. Supply Chain – the Hype & the Reality,” Supply Chain Management Review, 79:9-10 (2001), pp. 46-54.

**DS 1722B Credit: 3 (L-3, T-0, P-0)**

**OPEN ELECTIVE I (BIOINFORMATICS)**

**Questions to be set:** SIX (Q1, Q2 from Unit-I, Q3, Q4 from Unit-II, Q5, Q6 - 50% from Unit-I and 50 from Unit-II [3rd sem. only] / EIGHT (FOUR from UNIT I and FOUR from UNIT II).

**Questions to be answered:** Q1-Q4 compulsory, and any one of Q5 or Q6 [3rd sem. only] / FIVE selecting at least TWO from each unit.

**Course Objective:** Students will learn bioinformatics and data generation and Biological Database and its Types Introduction to data types and Source.

**Pre-requisites:** Students should be familiar with basic Biology and related field.

**UNIT – I**

1. Introduction to bioinformatics and data generation What is bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases GENBANK, Pubmed, PDB) and software (RASMOL Ligand Explorer). Data generation; Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics.
2. Biological Database and its Types Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum)

**UNIT – II**

1. Data storage and retrieval and Interoperability Flat files, relational, object oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, SwissProt). Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search. The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts. General Introduction to XML, UMLS, CORBA, PYTHON and OMG/LIFESCIENCE.
2. Sequence Alignments and Visualization Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm). Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization.
3. Gene Expression and and Representation of patterns and relationship General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies, and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

**Text Books:**

1. Data Analytics in Bioinformatics, A Machine Learning Perspective By Rabinarayan Satpathy, Tanupriya Choudury, Suneeta Satapathy, Sachi Nandan Mohanty

**Reference Books:**

1. Introduction to Bioinformatics with A Practical Guide for Biologists By Edward Curry

**SEMESTER – VIII**

**DS 1871 Duration of Project: 16 weeks**

**MAJOR PROJECT**

The students are required to undertake innovative and research oriented project, not only to reflect their knowledge gained in the previous seven semesters but also to acquire additional knowledge and skill of their own effort. During their major project, the students are required to submit progress of their work in phases to make the department aware of his/her project. At the end of 16 weeks, students have to report to the internal guides/faculty member for final refinement and documentation. It is mandatory to follow software/hardware methodologies in carrying out the project work. The project is evaluated through internal presentation before the panel of faculty members followed by the evaluation by external examiner appointed by the university.

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| --- | --- | --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Subject Code** | **Internal Marks** | **Seminar/Viva** | **External Marks** | **Duration of Project** | **Credits** |
| 1 | DS1871 | 50 | 50 | 50 | 16 Weeks | 12 |

## \*\* Project Evaluation:

1. One interim evaluation to be followed [Candidate has to present PPT/demonstration].
2. Final Evaluation with PPT presentation/demonstration to be followed at the end of session.