SYLLABUS

(Tentative)

Bachelor of Technology

(B. Tech.)

Data Science And Artificial Intelligence

(DSAI)

INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY,
NAYA RAIPUR

DEPARTMENT OF DATA SCIENCE & ARTIFICIAL INTELLIGENCE

Programme Educational Objectives

The DSAI Programme of IIIT - NR is offered to encourage students who would like to provide innovative solutions to real world problems including society's pressing challenges using data science and artificial intelligence (AI) techniques. The flexible curriculum structure helps the students to solve real-life problems in different applications domains ranging from healthcare, agriculture, forestry, environmental sustainability, and many more.

The main PEOs of the program are to produce graduate students who are well prepared:

PEO 1: to undertake industry careers involving application of Data Science and Artificial Intelligence (DSAI) techniques to solve real world problems
PEO 2: to undertake research careers or higher studies in the general areas of data science and artificial intelligence
PEO3: to exhibit innovation and entrepreneurial capabilities

Programme Outcomes

PO 1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3. Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and

management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO 1: Apply AI/ML concepts in solving complex engineering problems which are data rich in nature.

PSO 2: Apply the knowledge of computer science, mathematics, statistics and the applied domain areas contributing to data science towards solving real time problems.

SEMESTER 1

Course Title	Discrete Mathematics	Course Code	MA101C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-0-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Faculty Choice

Course Outcomes

At the end of the course the students will be able to:

- Understand the notion of mathematical logic & proofs and be able to apply them in problem solving.
- Solve problems which involve discrete data structures such as relations and discrete functions
- Apply basic counting techniques and combinatorics in the context of discrete probability.
- Demonstrate knowledge of fundamental concepts in graphs, trees and its properties using various modeling techniques.
- Solve problems on number theory and its applications

Contents

Set Theory : Sets, functions, equivalence and partial order relations, partition and equivalence classes, lattices
Logic : Propositional logic (formulae, truth tables, proof systems, soundness and completeness of proof systems), predicate logic (formulae, interpretations, proof systems, soundness and completeness of proof systems)
Combinatorics and Recurrences : Sum and product rule, Pigeonhole principle, recurrence relations, solving homogeneous and non-homogeneous recurrence relations, generating functions
Groups : Binary operations, semigroups, groups, subgroups, Lagrange theorem, homeomorphisms of groups

Text Book

1. C.L.Liu, Element of Discrete Mathematics, McGraw Hill Education.
2. J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill
3. Kenneth H Rosen, Discrete Maths and its applications, McGraw Hill Education

Course Title	Linear Algebra & Matrix Analysis	Course Code	MA102C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-1-0-[3])
Offered for	All Programs	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Faculty Choice

Course Outcomes

At the end of the course the students will be able to:

- Solve systems of linear equations using multiple methods, including Gaussian elimination and matrix inversion.
- Carry out matrix operations, including inverses and determinants.
- Determine eigenvalues and eigenvectors and solve eigenvalue problems.
- Apply principles of matrix algebra to linear transformations.
- Demonstrate understanding of inner products and associated norms.

Contents

System of linear equations, Inverse and rank of a matrix by using elementary transformations, Properties of determinants
Vector space over real and complex fields, Linear dependence, independence and spanning set, Linear transformation and its matrix, Change of basis, Eigenvalues and eigenvectors. Diagonalization of matrices.
Inner product spaces, Gram-Schmidt orthonormalization, Singular Value Decomposition (SVD).

Text Book

1.	Seymour Lipschutz, Marc Lipson, Schaum's outlines of Linear Algebra ,McGraw-Hill Education
2.	J. Defranza and D. Gagliardi, Introduction to Linear Algebra with Applications, McGraw-Hill
3.	K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall.
4.	Strang, Gilbert. Introduction to Linear Algebra. 4th ed. Wellesley-Cambridge Press ,2009.

Course Title	**Probability & Statistics**	**Course Code**	**MA106C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-1-0-[3])**
Offered for	**All Programs**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Faculty Choice**

Course Outcomes

At the end of the course the students will be able to:

- Use the basic probability rules, including additive and multiplicative laws, using the terms, independent and mutually exclusive events.
- Analyze statistical data using measures of central tendency, dispersion and location.
- Identify the characteristics of different discrete and continuous distributions.
- Translate real-world problems into probability models.
- Identify the type of statistical situation to which different distributions can be applied.

Contents

Axiomatic definition of probability, Probability on finite sample spaces, Joint and conditional probabilities, independence, total probability; Bayes' rule and applications.
Random variables, Definition of random variables, continuous and discrete random variables, Bivariate and Multivariate random variables, Sampling and Sampling Distributions, Central Limit Theorem;
Cumulative distribution function (cdf) for discrete and continuous random variables; probability mass function (pmf); Probability density functions (pdf) and properties, Jointly distributed random variables, conditional and joint density and distribution functions, independence.
Measures of central tendency, Dispersion, Skewness, Kurtosis, Data Representation using Histogram, Pie Chart, Boxplot, Biplot, Multidimensional Scaling etc.
Methods of Estimation, Unbiased estimators; Confidence Interval Estimation: Z-interval, t-interval;
Hypothesis Testing, Types of Errors, Rejection Region Approach and p-value Approach.

Text Book

1.	Anthony J Hayter; Probability and Statistics for Engineers, Cengage learning, 4th Edition, 2012.
2.	S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand and Sons, 11th Edition, 2014.
3.	Paul L. Meyer, Addison-Wesley, Introductory Probability and Statistical Applications, 1966.
4.	Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press, 2014.

Course Title	Introduction to Programming	Course Code	CS101C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	All Programs	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes	At the end of the course the students will be able to: • Given a computational problem, identify and list the programming task involved. • Implement conditional branching, iteration, and recursion. • Use arrays, pointers, and structures to develop algorithms and programs.

Contents

The basic organization of a computer, Computer Languages, Algorithm, Flowchart, Features of C, Structure of C Program, Basic elements of C programming, Conditional instruction, Iterations, Unconditional statements, Arrays, Stings, Functions, recursion, Pointers, Pointers with arrays, and Functions. Dynamic Memory allocation, Structures and Unions, and Files.

Text Book

1.	The C Programming Language Brian W. Kernighan and Dennis M. Ritchie (2nd Edition, 1988), Prentice Hall (ISBN:978-0131103627)
2.	Schaum's Outline of Programming with C by Byron S Gottfried (1996), McGraw-Hill Education (ISBN:978-0070240353

Course Title	Digital Logic Design	Course Code	EC101C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes	At the end of the course the students will be able to: • Understand the basics of any digital systems such as number system, logic gates, Boolean logic simplification, FFs etc. • Understand basic digital system design using standard ICs • Analyze and design combinational and sequential circuits using above concepts. • Perform simple course projects using above design technique

Contents

Number system and Logic Gates, Truth tables of different logic gates. Boolean Algebra and K-maps, NAND/NOR implementations, Logic Simplification using Tabular method, etc, Combinational Circuit Design: Design procedure, Different Adders and Subtractors-Half Adder, Full Adder, Half Subtractor, Full Subtractor, 4-bit Ripple Carry Adder, Carry Look Ahead Adder, Decoder, Encoders, Multiplexers, De-Multiplexers, Magnitude Comparator, etc. Sequential Circuit Design: Basics, Latches and Flip-flops, conversion from one FF to another, Serial and Parallel shift Registers, Synchronous and Asynchronous Counter Designing, Mealy and Moore Machine.

Text Book

1.	R.P. Jain, "Modern Digital Electronics", 3rd Edition, Tata McGraw Hill, 2003.
2.	T.L. Floyd, "Digital Fundamentals", 10th Edition, Pearson education, 2011
3.	M. Morris Mano, Michael D. Ciletti, "Digital Design- with an Introduction to the Verilog HDL", 5th Ed, 2013, Pearson.

Course Title	Sensors & Actuators	Course Code	DA102C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Understand the basic concepts of different measurement & Mechatronics systems, the function, suitability of different Sensors and Actuators and understand in depth the concepts of Input/Output Signal conditioning
- Solve numerical problems which involve different Sensors and Actuators
- Apply basic knowledge in different sensors and actuator hands-on projects.
- Demonstrate knowledge of fundamental concepts to understand the physics behind most of the sensors such as Temperature, pressure, force, gas, optical fiber based sensors etc.
- Solve problems on sensor and actuators and its applications.

Contents

Introduction, Sensor & Actuators Characteristics- Accuracy, Calibration, Nonlinearity, Hysteresis, Resolution, Temperature Sensors and Thermal Actuators- Thermistor, RTD, Thermocouple, p-n junction types; SMA, Thermomechanical Sensors and Actuators, Mechanical Sensors and Actuators: Force, Strain Sensors, Pressure Sensors, Velocity & Acceleration, Acoustic Sensors and Actuators- Piezoelectric Effect, Piezoelectric Sensors, Ultrasonic Sensors and Actuators, Electric and Magnetic Sensors and Actuators, Optical Sensors and Actuators, Chemical & Bio-Sensor and Actuators- Electrochemical Sensors; Humidity and Moisture Sensors; Chemical Actuation, MEMS and IoT based Sensors & Actuators, Sensor Design & Simulation.

Text Book

1. Ernest o Doebelin, Dhanesh N Manik, Measurement Systems, 6th ed. McGrawHill
2. Alok Barua, Fundamentals of Industrial Instrumentation, 1st ed. Wiley India
3. Fraden, J. Handbook of Modern Sensors: Physics, Designs, and Applications. 4th ed. Springer, 2010
4. MIT open courseware (Sensor Technologies for Interactive Environments).

Course Title	Environmental Engineering & SDG	Course Code	HS103C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-0-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Faculty Choice

Course Outcomes

At the end of the course the students will be able to:

- Understand the concepts and methods from ecological and physical sciences and their application in environmental problem solving.
- Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
- Articulate the interdisciplinary context of environmental issues.
- Identify and justify key stakeholders in humanities and social sciences that need to be a part of sustainable solutions.
- Formulate an action plan for sustainable alternatives that integrate science, humanist, and social perspectives.

Contents
Earth Systems:- Earth Science Concepts, Environment, Lithosphere, Hydrosphere, Atmosphere, Biosphere and their interactions with each other, Soil and Soil Dynamics – Soil formation, structure, properties Natural Resources:- Renewable and non-renewable resources, Major natural resources – forest, water, mineral, Food, energy and land resources Ecosystem - The Living World :- Ecosystem concept, Nature, Structure, Food chain, Food web, Trophic structure, Energy Flow, Biogeochemical Cycles, Major ecosystems – forest, grassland, aquatic, deserts Biodiversity :- Biodiversity, factors determining degree of diversity, types, importance, threats to biodiversity, conservation of biodiversity Environmental Pollution :- Pollution Types: Air pollution, Noise pollution, Water pollution, Soil pollution, Nuclear Pollution Impacts on the Environment and Human Health, Economic Impacts, Solid waste management, Role of an individual in preventing pollution Human Population and the Environment :- Population growth: an overview, Population characteristics and variations among nations, Demographic transition, Population explosion, Theories on population growth, Population stabilization, Environment and human health Social Issues and SDG:- Sustainable and unsustainable development, Measures of sustainable development, Urban problems related to energy, Consumerism, Water conservation, Rain water harvesting, Watershed management, Rehabilitation and resettlement, Climate Change, Global warming, Acid rain, Ozone layer depletion, Environmental ethics, Environmental legislation Green Computing:- Meaning and benefits of green computing, Approaches to Green Computing – Green manufacturing, Green Design, Green usage practices, Green Disposal, Green Applications
Text Book

1.	Anubha Kaushik & C. P. Kaushik, Perspectives in Environmental Studies, New Age International Publishers
2.	Gilbert M. Masters, Introduction to Environmental Engineering & Science, Pearson Education
3.	P. K. Sinha & Priti Sinha, Information Technology: Theory and Practice, PHI
4.	Bharucha Erach for UGC, Environmental Studies

Course Title	**Software Development**	**Course Code**	**DA101I**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(0-0-4-[2])**
Offered for	**All Programs**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**

Course Outcomes	At the end of the course the students will be able to: • Develop essential programming skills in computer programming concepts like data types, containers. • Apply the basics of programming in the Python language. • Solve coding tasks related conditional execution, loops. • Solve coding tasks related to the fundamental notions and techniques used in object- oriented programming.

Contents
Python Program Development Cycle Performing Calculations, Operators. Type conversions, Expressions, More about Data Output. Data Types, and Expression, Decision Structures and Boolean Logic, Repetition Structures, Control Statement, Strings and Text Files. Python library, Classifications and Training. Small Scale Project using python.
Text Book

1.	Fundamentals of Python First Programs, Kenneth. A. Lambert, Cengage.

2.	Python Programming: A Modern Approach, Vamsi Kurama, Pearson.
3.	Introduction to Python Programming, Gowrishankar.S, Veena A, CRC Press.
4.	Introduction to Programming Using Python, Y. Daniel Liang, Pearson.

Course Title	**International Language Competence**	**Course Code**	**HS101C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(1-1-0-[2])**
Offered for	**All Programs**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**

Course Outcomes	At the end of the course the students will be able to: • Develop essential programming skills in computer programming concepts like data types, Communicate effectively in the foreign language in a variety of speaking situations. • Communicate effectively in the foreign language via proficient, articulate, and well-organized writing. • Demonstrate comprehension of the spoken foreign language in a variety of listening situations. • Demonstrate comprehension of a wide range of foreign language written materials.

Contents

Overview of the course and evaluation strategies/Importance of Communication skills Introduction to Communication, Understanding the Basics of Communication, Role and importance of Communication Process of Communication and Types of Communication Barriers to communication
Vocabulary Enhancement & Development of Communicative Competence: asking and answering questions, expressing opinions and attitudes narration and description, word formation and idiomatic expressions, Practice Exercises
Reading Exercise - R.K. Laxman's The Gold Frame, G.B.Shaw's Spoken and Broken English, Robert Forst's The Road Not Taken
Introduction to Technical Report Writing: Importance, Guidelines, and Format
Report Writing Practice Session; Discussion and Chapter Review

Text Book

1.	R.K. Laxman's The Gold Frame
2.	G.B.Shaw's Spoken and Broken English
3.	Robert Forst's The Road Not Taken
4.	Technical Communication Principles and Practice by Raman and Sharma
5.	Class Notes and Practice Sessions

Course Title	**Study of Human Values**	**Course Code**	**HS103C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-0-[2])**
Offered for	**All Programs**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Faculty Choice**

Course Outcomes	At the end of the course the students will be able to: • the ineluctability of values in any situation of human life because of the moral prediction, • unique to man in contrast to other animals. • It is open to man to change his value, move from one frame of value to another that may be totally opposed to it. The option does not include a further option to nullify or negate all values as such. • Impact of science and the advance of technology on human perception and awareness and values • The alienation of the bulk of civilized society that is exposed to science and technology, from time-tested traditional values. • There can be a resultant vacuum of values, exposing civilization to the risk of a collective 'anomic.'

Contents

Man as a socio-political, tool-making, rational animal; the ineluctability of norms and values in any collective set-up; the need for regulation, do's and don'ts, that is to say, the place of rule or order and the regulating, enforcing groups to the state; human collective life as a nomistic order.
'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration; Continuous Happiness and Prosperity- A look at basic Human Aspirations; Right understanding, Relationship and Physical Facilities; Understanding human being as a co-existence of the sentient 'I' and the material 'Body'; Understanding the needs of Self ('I') and 'Body'; Understanding the characteristics and activities of 'I' and harmony in 'I'; Understanding the harmony of I with the Body; Understanding harmony in the Family- the basic unit of human interaction; Understanding values in human-human relationship; Understanding the harmony in the Nature; Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature; Understanding Existence as Co-existence of mutually interacting units in all-pervasive space; Holistic perception of harmony at all levels of existence; Natural acceptance of human values; Definitiveness of Ethical Human Conduct; Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in Professional Ethics; Case studies of typical holistic technologies, management models and production systems; Strategy for transition from the present state to Universal Human Order

Text Book

1.	Michael J. Quinn, Ethics for the Information Age (4th edition), Pearson/Addison Wesley, Boston, MA, 2011.
2.	Web Materials

SEMESTER 2

Subject Name	Calculus	Course Code	MA103C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-0-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Faculty Choice

Course Outcomes

At the end of the course the students will be able to:

- Find limits of functions (graphically, numerically and algebraically)
- Analyse and apply the notions of continuity and differentiability to algebraic and transcendental functions.
- Determine derivatives using implicit differentiation and use to study characteristics of a curve.
- Apply the Fundamental theorem of calculus to evaluate definite integrals.
- Use differentiation and integration to solve real world problems such as rate of change, optimization, and area problems.

Contents

Review of single variable calculus: Review of Limit, continuity and differentiability of single variable functions, Indeterminate forms and L'Hospital rule, Mean Value theorem, Maclaurin and Taylor series expansions of functions of one variable.

Functions of Several variables : Functions of several variables, Limits and continuity, Partial derivatives and differentiability, Linearization and differentials, Chain rule, Gradient vector, Tangent planes, Directional derivatives, Extreme values and saddle points, Lagrange multipliers, Taylor's formula, Partial derivatives with constrained variables.

Multiple integral: Multiple integral, Double integrals, Change of order of integration, Area and volume by double integral, Double integrals in polar form, Triple integrals in rectangular coordinates, Triple integrals in cylindrical and spherical coordinates, Substitutions in multiple integrals.

Text Book

1. M. D. Weir and J. Hass, Thomas' Calculus, 12 th edition, Pearson.
2. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9th Ed, Pearson.
3. Huges-Hallett et al, Calculus: Single and Multivariable, 6 th edition, John-Wiley & Sons (USA).
4. J. Stewart, Multivariable Calculus, Hybrid Edition.

Course Title	Optimization Techniques	Course Code	MA104C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-0-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Faculty Choice

Course Outcomes

At the end of the course the students will be able to:

- Apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems
- Apply optimization techniques in problems of Engineering and Technology
- Solve the mathematical results and numerical techniques of optimization theory to concrete Engineering problems by using computer software

Contents
Classical optimization technics, introduction to Linear Programming Lines and hyperplanes, Convex sets and Convex hull, Formulation of a Linear Programming Problem Theorems dealing with vertices of feasible regions and optimality Graphical solution, Simplex method (including Big-M method and two phase method) Dual problem, Duality theory Dual simplex method, Revised simplex method. Transportation and Assignment Problems Initial basic feasible solutions of balanced and unbalanced assignment problems Initial basic feasible solutions of balanced and unbalanced transportation problems Travelling Salesman Problem.

Text Book	
1.	Suresh Chandr a, Jayadeva , Aparna Mehra , Numerical Optimization with Applications, Alpha Science International Ltd, 2009.
2.	H. A. Taha: Operations Research, An Introduction, PHI, 1987.
3.	Mohan, C. and Deep, K.: "Optimization Techniques", New Age India Pvt. Ltd, New Delhi.2009.
4.	Ravindran, Phillips , Solberg, Operations Research: Principles and Practice, Wiley; Second edition, 2007

Course Title	**Quantum Mechanics**	**Course Code**	**PH102C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/ HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-0-[2])**
Offered for	**All Programs**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Faculty Choice**
Course Outcomes	At the end of the course the students will be able to: • Use with the language of basic quantum mechanics and formalism. • carry out calculations of atoms and molecules and describe quantum phenomenon within the electron physics from quantum mechanical relations. • carry out spectroscopic studies of different subjects and interpret the results in quantized units. • report on applications of quantum physics in nature, technical developments and society		

Contents
Basics of Quantum Mechanics: Basic principles of quantum mechanics, wave function and the uncertainty principle, probability wave amplitude, probability density, wave equation and Schrodinger formalism, time-independent and time-dependent Schrodinger equations, eigenstate and eigenvalues, expectation values. Wave Formalism of Quantum Mechanics: Schrodinger Equation in one dimension, and applications. Hydrogen Atom (Spherically symmetric potential) : Orbital and spin angular momentum operators, eigenstates and eigenvalues of angular momentum, central potential, solutions of Schrodinger equation in a central potential and applications (Hydrogen-like atom). Dirac's bra and ket algebra: Introduction, bra and ket notation, angular momenta, Clebsch-Gordon coefficients, spin-orbit interaction and applications. Hilbert space and concept of Qubits.

Text Book	
1.	Ajoy Ghatak and S. Lokanathan; Quantum Mechanics: Theory and Application

Reference Book	
1.	Griffiths, D.J.; Introduction to Quantum Mechanics, 2nd edition: Pearson Intern.
2.	Leonard I. Schiff; Quantum Mechanics

Course Title	Object Oriented Programming	Course Code	CS102C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	Introduction to Programming	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Understand Object Oriented Programming concepts
- Understand the role that methods play in an object-oriented program and class hierarchy
- Apply syntax of Programming to implement OO Concepts
- Develop simple applications using OO Concepts

Contents

Introduction to the principles of object-oriented programming, classes, objects, messages, encapsulation, Abstraction, inheritance (Member access, Constructors, Creating Multilevel hierarchy, abstract classes), polymorphism, method overriding, overriding, exception handling, and object-oriented containers.

Text Book

1. Herbert Schildt, Java A Beginner's Guide, Seventh Edition, 2017.
2. "Object Oriented Programming With C++" by E. Balagurusamy, McGraw-Hill Education (India) Pvt Limited.
3. "Object-Oriented Programming and Java" Danny Poo, Derek Kiong, Swarnalatha Ashok, Springer
4. Leonard I. Schiff; Quantum Mechanics

Course Title	Signals and Systems	Course Code	EC105C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-1-0-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Faculty Choice

Course Outcomes

At the end of the course the students will be able to:

- Understand different types of signals-continuous and discrete, odd and even, periodic and aperiodic etc.
- Classify systems based on their properties
- Analyse continuous time signals and systems by using appropriate mathematical tools
- Analyse sampling process and sampling of discrete time signals.
- Determine Fourier transforms for continuous-time and discrete-time signals

Contents

Signals: classification of signals; signal operations: scaling, shifting and inversion; signal properties; elementary signals.

Systems: classification of systems; system properties; continuous-time linear time invariant (LTI) and discrete-time linear shift invariant (LSI) systems: impulse response and step response; response to an arbitrary input: convolution; system representation using differential and difference equations; Eigen functions of LTI systems, frequency response and its relation to the impulse response.

Fourier series representation of continuous-time and discrete-time signals, continuous-time Fourier transform and its properties; Parseval's relation, time-bandwidth product; discrete-time Fourier transform and its properties; relations among various Fourier representations, Time and Frequency characterization of Signals and Systems, DFT.

Sampling theorem; aliasing; signal reconstruction: ideal interpolator, zero-order hold, first-order hold.

Definition, region of convergence, properties; transform-domain analysis of LTI/LSI systems, system function: poles and zeros; stability.

Text Book	
1.	A.V. Oppenheim, A.S. Willsky and H.S. Nawab, "Signals and Systems", Prentice Hall of India, 2006
2.	B. P. Lathi,"Signal Processing and Linear Systems", Oxford University Press, 1998.
3.	M. J. Roberts, "Fundamentals of Signals and Systems", Tata McGraw Hill, 2007.
4.	R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4/e, Prentice Hall, 1998.

Course Title	Introduction to AI & ML	Course Code	DA103C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	Linear Algebra and Probability	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Understand how AI is different from machine learning • Appraise the underlying mathematical relationships within machine learning algorithms and the paradigms of supervised and unsupervised learning • Decide what kind of machine learning paradigm can be applied to solve the underlying real-world application • Distinguish a game situation from pure individual decision problem		

Contents

Introduction: What is AI, Evolution of AI, Application of AI (Healthcare, Genomics, Transportation, Retail, Finance, Agriculture and many more), Agents and Environment, the structure of Agents.
Problem Solving: Search algorithms, uninformed search strategies and informed search strategies.
Adversarial search and games: Game theory, optimal decisions in games, heuristic alpha-beta search, limitations of game search algorithms.
Knowledge reasoning and inferencing: Logical agents, propositional logic, types of inferencing
Learning: What is learning, process of machine learning, types of machine learning (unsupervised learning, supervised learning, semi-supervised learning), regression, classification, bias-variance trade-off, overfiting-underfiting, loss function, cross-validation, maximum-likelihood, clustering.

Text Book	
1.	Artificial Intelligence: A Modern Approach, 4th edition by Stuart Russell and Peter Norvig
2.	The hundred page – Machine learning book by Andriy Burkov

Course Title	Introduction to IoT	Course Code	CS103C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	Sensors & Actuators	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Understand the Architectural Overview of IoT and Real World Design Constraints • Implement interfacing of various sensors with Arduino/Node MCU, Raspberry Pi, etc. • Design and Development of prototypes for real-time applications.		

Contents
Introduction to IoT, IoT architectures, Communication Technologies, IoT Sensor Node, and Sensor Node Design, Challenges, Smart Objects and connecting smart objects, Introduction to Networking, IoT & Networking Bluetooth, BLE, IoT & Networking –IEEE 80.15, IoT & Networking Zigbee,RFID and NFC, LoRA, SigFox, NB-IoT and Wi-Fi, IoT communication protocols-MQTT, CoAP, Integration of Cloud computing, Thingspeak and Google Firebase creation, Machine learning for the internet of things data analysis, , Security issue in IoT, IoT case Studies-Health care IoT, Agriculture IoT. Course Projects: Implementation of real-time projects focused on Agriculture, Health care, and Industries using on Hardware (Raspberry pi, Arduino, Smartphones, and sensors).

Text Book	
1.	Sudip Misra, Anandarup Mukherjee, Arijit Roy, “Introduction to IoT”, Cambridge University Press, 2021
2.	Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.
3.	Rob Barton, Gonzalo Salgueiro, David Hanes, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things” Cisco Press Release, June 2017

Course Title	Design & Prototyping Workshop	Course Code	DA102I
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(0-0-2-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	IT Workshop	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Understand the concept of Systems on Chip with their functionality • Identify the hardware and software requirements for developing real time application • Integrate of Hardware and Software for a specific application • Design and develop a working prototype		

Contents
Introduction to hardware aspects and prototyping based on Raspberry Pi; Select a Project using Raspberry Pi and others component; Making PCB and Soldering PCB board of Project work, and Developing a prototype

Text Book	
1.	Raspberry pi notebook available at https://www.raspberrypi.org/
2.	https://electronicsforu.com/raspberry-pi-project
3.	https://projects.raspberrypi.org/en
4.	Other relevant Web Materials

Course Title	Communication and Discourse Strategies	Course Code	HS102C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	IT Workshop	Laboratory Choice	Mandatory

Course Outcomes	At the end of the course the students will be able to: • Identify Common Errors and Rectify Them • Develop and Expand Writing Skills through Controlled and Guided Activities • Develop Coherence, Cohesion and Competence in Oral Discourse through Intelligible Pronunciation. • Ability to handle the interview process confidently • Conduct an effective group discussion

Contents

Overview of the course and evaluation strategies, Introduction to Communication Processes and Models, Forms of Communication; Communication Levels, Ways of Establishing Credible Communication, Evolving Discourse Strategies and Listening Skills
Domain Vocabularies: Building special Vocabularies relating to issues of Commerce/Finance/Politics/Current Affairs/Law/Science & Technology, Common Errors: Indianism, Building advanced vocabulary
Communication Strategies in Contemporary Society: Advertising as Persuasive Process Argument in Science; Argument in Literature, Argument on Stage and in Film
Discourse Markers: Group Discussions; Effective presentations, Dialogues and Debates etc. Contemporary Functional English: Letters and Written Communications; Précis Writing

Text Book

1.	Gumperz, John J. Discourse strategies. No. 1. Cambridge University Press, 1982.
2.	Scollon, Ron, Suzanne Wong Scollon, and Rodney H. Jones. Intercultural communication: A discourse approach. John Wiley & Sons, 2012.

Course Title	**3D Printing**	**Course Code**	**DA103I**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(0-0-4-[2])**
Offered for	**All Programs**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**

Course Outcomes	At the end of the course the students will be able to: • Understand the basic functioning of 3D Printing Technology • Use 3D Printer • Build Models for various use cases using 3D Printer • Understand the various applications of 3D Printing Technology

Contents

Introduction to 3D Printing-Short history of 3D Printing; Additive Manufacturing & Applications; 3D Printing technology- Types of 3D Printing processes: basic principle, main characteristics, advantages and limitations; Materials for 3D Printing; Concept of STL File; Introduction of 3D Printing Lab equipment; 3D Printing equipment-Fused Deposition Modelling (FDM)/Fused Filament Fabrication (FFF) process.
3D CAD modelling using Autodesk 123D, Design Rules for 3D Printing Parts and Assemblies; Project Development using 3D printer; 3D Printing case studies in architecture and art; 3D Printing case studies in digital manufacturing; 3D Printing case studies for the medical field.

Text Book

1.	Horne, Richard, and Kalani Kirk Hausman. 3D printing for dummies. John Wiley & Sons, 2017.
2.	Noorani, Rafiq. 3D printing: technology, applications, and selection. CRC Press, 2017.

Course Title	**Management of Wealth and Well-being**	**Course Code**	**HS104C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(1-0-0-[1])**

Offered for	All Programs	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Faculty Choice
Course Outcomes	At the end of the course the students will be able to: • Basic concepts of finance and wealth management - including diversification, risk and return and market efficiency - and how to grow and manage wealth over time		

Contents

The study shall concentrate on the economic foundations of human health, happiness and prosperity; examine and evaluate man's economic pursuit on environment and ecology as also causes of prosperity of the developed nations and the massive poverty elsewhere and the possible links between the two. Economics of distributive justice. The rise of consumerism.

Text Book

1.	Any good book on the basic principles on Economics
2.	Eric Roll: A History of Economic Thought, Faber/1961, Chapter 6 on Marx and Chapters 8 – 11
3.	Micheal H. Best and William E Connelley: The Politicized Economy, D.C. Heath and Co., 1982.
4.	Marglin, S.A. Public Investment Criteria, G.A.U 1967.
5.	Dorfman, R. ed. Measuring Benefits of Government Investments, Brookings Institution, 1965.
6.	Schumpeter, G.A: Capitalism Socialism and Democracy, G.A.U Part II
7.	Dahrendorf, Ralph: Class & Class Conflict in Industrial Society (RKP, 1959)
8.	Ruskin, John: Unto this Last
9.	Gandhi M.K: Hind Swaraj (Navjivan) + Trusteeship
10.	J.C. Kumarappa: Public Finance and the Poverty of India
11.	Schumacher, E.F. Small is beautiful
12.	Amartya Sen & John Dreze: Hunger and Public Action, Oxford (WIDER)
13.	Any good book on the impact of Industry and Environment on Human life
14.	Any good book on giant business houses and their impact on government policies and public lives.
15.	Nirmal Kumar Bose: Selected Writings of Gandhi (Navjivan)

SEMESTER 3

Course Title	Object Oriented Analysis & Design	Course Code	CS202C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	CSE / DSAI	Type	Compulsory
Prerequisite	Object Oriented Programming	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Demonstrate an understanding of modeling as a design technique, identify and create class and state models for a given case study.
- Create advanced state and interaction models and apply the process of system conception and domain analysis for any given problem.
- Understand the process of application analysis and be able to develop a system design to a given case study using Rational Suite.
- Create a class design and implementation model and understand the reverse engineering process and its importance.
- Demonstrate an understanding of design patters and its implementation to provide solutions to some design problems.

Contents

Introduction, Modeling Concepts, class Modeling: Class Modeling: Object and class concepts; Link and associations concepts; Generalization and inheritance; Advanced object and class concepts; Association ends; N-ary associations; Aggregation; Abstract classes; Multiple inheritance; Metadata. Advanced State Modeling, Interaction Modeling: states generalization; Concurrency, Interaction Modeling. Process Overview, Development life cycle, Domain Analysis, Domain state model. Application Analysis: Application interaction model; Application class model; Application state model; Adding operations. Overview of system design. Class Design: Overview of class design; Bridging the gap; Realizing use cases; Designing algorithms; Recursing downwards, Refactoring; Design optimization; Reification of behavior; Adjustment of inheritance; Organizing a class design. Design Patterns: Relationships between patterns; Pattern description.

Text Book

1. Michael Blaha, James Rumbaugh: Object-Oriented Modeling and Design with UML, 2nd Edition, Pearson Education, 2005.
2. Frank Buschmann, Regine Meunier, Hans Rohnert, Peter Sommerlad, Michael Stal: Pattern-Oriented Software Architecture, A System of Patterns, Volume 1, John Wiley and Sons, 2007.
3. Grady Booch et al: Object-Oriented Analysis and Design with Applications, 3rd Edition, Pearson Education, 2007.
4. Brahma Dathan, Sarnath Ramnath: Object-Oriented Analysis, Design, and Implementation, Universities Press, 2009.

Course Title	Data Structures	Course Code	CS111C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	CSE / DSAI / ECE	Type	Compulsory
Prerequisite	Introduction to Programming	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Illustrate arrays and structures with programming solutions for real time problems
- Able to apply the concepts of stacks and queues for different problems
- Able to solve the real time problems with the help of Linked Lists
- Manage data set operations using variations of linked list
- Devise application to solve tree-oriented problems and develop solutions for problems based on graphs

Contents
Basic Concepts: Stacks, Stacks Using Dynamic Arrays, Queues, Circular Queues. Evaluation of Expressions. Linked Lists: Singly Linked lists, Doubly Linked lists, Circular linked lists. Polynomials, Additional List operations. Trees: Introduction, Binary Trees, Binary Tree Traversals, additional Binary Tree Operations, Heaps, Binary Search Trees. Graphs: The Graph Abstract Data Type, Elementary Graph Operations. Searching and Sorting. Hashing and its implementations.

Text Book

1.	Horowitz, Sahni, Anderson-Freed: Fundamentals of Data Structures in C, 2nd Edition, Universities Press, 2008.
2.	Yedidyah, Augenstein, Tannenbaum: Data Structures Using C and C++, 2nd Edition, Pearson Education, 2003.
3.	Data Structures, Seynour Lipschutz and GAV Pai, Schaum's Outlines, McGraw Hill, 2008.
4.	Richard F. Gilberg and Behrouz A. Forouzan: Data Structures A Pseudocode Approach with C, Cengage Learning, 2005

Course Title	**Computer Organization**	**Course Code**	**CS201C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HU-MANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-0-[2])**
Offered for	**CSE / DSAI / ECE**	**Type**	**Compulsory**
Prerequisite	**Discrete Mathematics**	**Laboratory Choice**	**Faculty Choice**
Course Outcomes	At the end of the course the students will be able to: • Understand ARM instruction set, ARM instruction format & ARM addressing modes • Implement different algorithms used to perform fast multiplication and division also represent floating point numbers in IEEE format. • Design a Datapath for MIPS architecture and understand the importance of pipelining • Assess the cache memory performance and also recognize the advantages of using virtual memory technique. • Demonstrate interfacing of I/O devices with processor, memory & operating systems including data transfer between memory and I/O devices		

Contents
Language of the Computer: Operation of the computer hardware, Operands of the Computer Hardware, Signed and Unsigned numbers, Representing Instructions in the Computer, Logical Operations, Instructions for making Decisions, supporting procedures in the computer hardware, compiling a string copy procedure, showing how to use C strings, ARM addressing for 32-bit immediate and more complex addressing modes. Arithmetic unit. The Processor: Introduction, A basic MIPS Implementation, Logic Design Conventions: Clocking methodology, Building a data path. An overview of pipelining: Designing instruction sets for pipelining, Pipeline hazards, Pipelined data path and control: Graphically representing pipelines. Memory unit: the basics of Caches and management. Virtual memory: Placing a page and finding it again, Page faults, TLB. Input Output Unit.

Text Book

1.	David A. Petterson, John L. Hennessy: Computer Organization and Design, M.K Publishers, 4th edition, 2010
2.	C Hamacher, Z Vranesic, S Zaky: Computer Organization, Tata McGraw Hill, 5th edition, 2011.
3.	John L. Hennessey and David A. Patterson: Computer Architecture, A Quantitative Approach, 5th Edition, Elsevier, 2012.
4.	W. Stallings: Computer Organization and Architecture: Designing For Performance, 8th edition, Prentice hall, 2012.

Course Title	Operating Systems - I	Course Code	CS104C
Department	CSE/ECE/DSAI/SCI. & MATHS/HU-MANITIES & MGMT.	Structure (L-T-P-[C])	1-0-2-[2])
Offered for	CSE / DSAI / ECE	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Functionalities and services provided by the operating system
- How the OS manages several processes concurrently
- Concept of critical section problem and solutions
- Design deadlock, prevention and avoidance techniques

Contents

Evolution of operating system, operating system functions, Types of operating system, System Calls, Process States and Multiprogramming, CPU scheduling algorithms, Inter Process Communication, Critical section, Race condition, Conditions for critical sections problem, Solutions to Critical Sections problems: Software, Hardware and operating system supported solutions: Semaphores, Monitors. Necessary conditions for Deadlock, Deadlock handling methods.

Text Book

1. Operating systems: Three easy pieces, by Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau URL : http://pages.cs.wisc.edu/~remzi/OSTEP/
2. D.M Dhamdhere: Operating systems - A concept based Approach, 3rd Edition, Tata McGraw- Hill, 2012.
3. P.C.P. Bhatt: Introduction to Operating Systems Concepts and Practice, 3rd Edition, PHI, 2010.
4. Harvey M Deital: Operating systems, 3rd Edition, Pearson Education, 2011.

Course Title	Database Management Systems - I	Course Code	CS106C
Department	CSE	Structure (L-T-P-[C])	(2-0-0-[2])
Offered for	CSE / DSAI / ECE	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Differentiate database systems from traditional file systems by enumerating the features provided by database systems.
- Design entity-relationship diagrams to represent simple database applications.
- Construct relational algebraic expressions for queries using the concepts of relational database theory.
- Formulate using SQL, solutions to a broad range of query and data update problems.
- Understand database design through table decomposition

Contents

Introduction: Characteristics of Database approach, Data models, schemas and instances, Entity-Relationship Model, Attributes and Keys, Relationship. Relational Model Concepts, Relational Database Schema. Overview of the SQL Query Language, SQL Data Definition, Null values, Aggregate Functions, nested Sub queries, Modification of the Database, Join Expressions, Views, Integrity Constraints, SQL Data Types and Schemas, Embedded SQL. Informal Design Guidelines for Relation Schemas, Keys concept. Functional dependencies, Equivalence, properties, Decomposition, Attribute Closure, and multivalued dependency. Database Design and Normalization.

Text Book

1. Elmasri and Navathe: Fundamentals of Database Systems, 5th Edition, Addison-Wesley, 2011.

2.	Silberschatz, Korth and Sudharshan: Data base System Concepts, 6th Edition, Tata McGraw Hill, 2011
3.	C.J. Date, A. Kannan, S. Swamynatham: An Introduction to Database Systems, 8th Edition, Pearson education, 2009.
4.	"SQL: The Complete Reference" by James Groff, 3rd edition, McGraw-Hill Education

Course Title	**Representational Learning**	**Course Code**	**DA202C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(1-0-2-[2])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**Linear Algebra & Matrix Analysis**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Establish the reason for using representation. • Differentiate between classical and moderns methods of forming representations. • Understand need of different representation techniques corresponding to different modalities. • Decide what kind of representation need to be extracted to solve the underlying real-world problem.		

Contents

Background: Introduction, Importance of learning, Representations, factor behind good representations, Smoothness and the Curse of Dimensionality, Generalization, categorization, discretization, feature engineering. Dimensionality reduction: need for reducing the dimensionality of features.
Principal Component Analysis (PCA), Linear discriminant analysis (LDA) and Fisher discriminant analysis (FDA). PCA vs LDA vs FDA.
Image representation: Classical (HOG, SIFT, LBP) and modern methods (CNN, CapsuleNet).
Text representation: unstructured vs structured data, Text data and characteristics, need for text to feature conversion, tokens, corpus, standardization, filler words, stop words, Bag of words. Audio representation: audio data and characteristics, need for audio to feature conversion, Spectrogram.

Text Book

1.	"Representation learning " , Nada Lavrav, 1st edition, 2020, Springer
2.	"Representation Learning for Natural Language Processing " , Zhiyuan Liu, 1st edition, 2020, Springer

Course Title	**Data Preprocessing**	**Course Code**	**DA104C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(1-0-2-[2])**
Offered for	**DSAI/CSE**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Clean and transform the data • Select important feature • Suggest advanced pre-processing approaches for any application • Appreciate preprocessing challenges and suggest solutions for the same		

Contents
Introduction: Data- Kind of data- Data Mining- Why data mining- Knowledge discovery process (KDD)- Why preprocess the data- Issues in data mining- Data warehousing. Basic Statistical Descriptions of Data: Mean, Median, Mode, Midrange, Variance, Standard deviation, Correlation, Covariance, Quartiles, and Interquartile Range- Probability and likelihood. Data Visualization, Data Frames, Reshaping data frames. Attributes: Quantitative data (Numerical: interval and ratio, Discrete and continuous attributes) – Qualitative data (Nominal, Ordinal and binary attributes)- Factor variable. Data Cleaning, Handle noisy data, Data value conflict detection and resolution Data Reduction, Feature selection- Aggregation –Normalization- Features encoding (Discretization, Nominal to numeric) - Concept hierarchy generation, Application: Data cleaning as a process in real world data

Text Book	
1.	Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2011.
2.	Salvador García, Julián Luengo, Francisco Herrera Data Preprocessing in Data Mining. Springer International Publishing 2014
3.	Roy Jafari Hands-On Data Preprocessing in Python: Learn how to Effectively Prepare Data for Successful Data Analytics. Packt Publishing (January 21, 2022)

Course Title	**Introduction to Robotics**	**Course Code**	**DA105C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(1-0-2-[2])**
Offered for	**CSE / DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Perform kinematic and dynamic analyses with simulation. • Design control laws for a robot. • Integrate mechanical and electrical hardware for a real prototype of robotic device. • Select a robotic system for given application.		

Contents
Fundamentals: Introduction, What is a Robot?, Classification of Robots, What is Robotics?, History of Robotics, Advantages and Disadvantages of Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages, Robot Applications, Social Issues. Motion Analysis: Basic rotation matrices – Composite rotation matrices Euler Angles – Equivalent Angle and Axis – Homogeneous transformation Problems. Differential Kinematics: Differential Kinematics of planar and spherical manipulators - Jacobians – problems. Robot Dynamics: Lagrange – Euler formulations – Newton-Euler formulations – Problems on planar two link manipulators. Trajectory Planning: Joint space scheme – cubic polynomial fit – Avoidance of obstacles – Types of motion: Slew motion - joint interpolated motion straight line motion – problems.

Text Book	
1.	Nikku, S.B., Introduction to Robotics, Prentice Hall of India Private Limited (2002).
2.	Schilling. R. J., Fundamentals of Robotics: Analysis and Control, Prentice-Hall of India Private Limited (2006).
3.	Introduction to Robotic Mechanics and Control, JJ Craig, Pearson 3rd edition.

Course Title	AI Foundations	Course Code	DA206C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Identify the modern view of AI and its application based on agent philosophy.
- Compare the various searching algorithms commonly used in AI by implementing them.
- Summarize the various knowledge representation and inference techniques.
- Examine the various learning and planning techniques available and its application.
- Review the various methods of handling uncertainty.

Contents

Informed Search and Exploration: Informed search strategies, Heuristic functions, On-line search agents and unknown environment. Constraint Satisfaction Problem, Adversarial Search.
Logical Agents: Knowledge-based agents, The wumpus world, Logic, propositional logic, Reasoning patterns in propositional logic, Effective propositional inference, Agents based on propositional logic.
First-Order Logic: Representation revisited, Syntax and semantics of first-order logic, Using first-order logic, Knowledge engineering in first-order logic. Interference in First-order Logic: Propositional versus first-order inference, Unification and lifting, Forward chaining, Backward chaining, Resolution.
Knowledge Representation.
Planning: The Planning problem, planning with state-space approach, Planning graphs, Planning with propositional logic. Uncertainty: Acting under uncertainty, Basic probability Notations, Inference using full joint distributions, Independence, Bayes' rule and its use. Planning and Acting in the Real World, Learning from observations: Forms of Learning, Inductive learning, learning decision trees, Ensemble learning, Computational learning theory.
Philosophical Foundations of AI, Present and Future of AI: Peer reviews in class room on Advance Topics in AI, AI Programming Languages, Current state of art of AI and its future.

Text Book

1. Stuart Russel, Peter Norvig: Artificial Intelligence - A Modern Approach, 2nd Edition, Pearson Education, 2012.
2. Elaine Rich, Kevin Knight, Shivashankar B Nair: Artificial Intelligence, 3rd Edition, Tata McGraw Hill, 2011.
3. Nils J. Nilsson: Principles of Artificial Intelligence, First Edition, Elsevier, 2002.
4. Luger, G. F., & Stubblefield, W. A., Artificial Intelligence - Structures and Strategies for Complex Problem Solving. New York, NY: Addison Wesley, 5th edition (2005).

Course Title	Graph Theory	Course Code	MA203C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-0-[2])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Faculty Choice

Course Outcomes

At the end of the course the students will be able to:

- Define the basic concepts of graphs, directed graphs, and weighted graphs.
- Understand Eulerian and Hamiltonian graphs
- Understand the concept of plane graph and theory
- Apply graph theoretical principles in real life problems

Contents	
Graphs : Definition of a graph, finite and infinite graphs, incidence of vertices and edges, types of graphs, matrix representation of graphs, incidence and adjacency matrices of graphs, Graph isomorphism, sub-graphs, walks, trails, paths, cycles, connectivity, components of a graph, Eulerian and Hamiltonian graphs, travelling salesman problem, weighted graphs and shortest paths, Planar graphs. Trees : Definition and properties of trees, rooted and binary trees, spanning trees, minimum spanning tree. Network flow and Matchings	
Text Book	
1.	Deo N., "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall India 2004.
2.	West D. B., "Introduction to Graph Theory ", Prentice Hall India (2nd Ed.) 2009
3.	Deistel R., "Graph Theory", Springer (4th Ed.) 2010.
4.	Bondy J. A. and Murty U. S. R., "Graph Theory", Springer

SEMESTER 4

Course Title	Design and Analysis of Algorithms	Course Code	CS204C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	CSE / DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Compulsory

Course Outcomes

At the end of the course the students will be able to:

- Define the basic concepts and analysis of algorithms in terms of complexity.
- Able to apply the Asymptotic analysis to the algorithms.
- Able to design the algorithms for graph related problems.
- Identify how divide and conquer works and analyse complexity of divide and conquer methods by solving recurrence.
- Illustrate Greedy paradigm and Dynamic programming paradigm using representative algorithms.

Contents

Algorithms representations and its properties. Asymptotic analysis. Recurrence Relations. Worst-Average-Best Case Running Times and Brute-Force method. Master Theorem. Divide and Conquer technique, applications and analysis of Time Complexity of D and C. Greedy Algorithms: Optimal Job Scheduling, Prims and Krushkals' algorithms and Single Source Shortest Path Problem. Dynamic Programming Problems, Back Tracking. Problem.

Text Book

1. Algorithm Design - Jon Kleinberg and Eva Tardos, Pearson ,1st Edition (2013).
2. AnanyLevitin: Introduction to The Design & Analysis of Algorithms, 2nd Edition, Pearson Education, 2007.

Course Title	Statistical Data Analysis	Course Code	DA204C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-0-[2])
Offered for	CSE / DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Faculty Choice

Course Outcomes

At the end of the course the students will be able to:

- Define the basic concepts and analyze probability functions.
- Conduct statistical tests
- Estimate various statistical parameters
- Apply statistical data analysis for data intensive applications

Contents

Examples of Probability Functions, Statistical Tests, General concepts of parameter estimation, The method of maximum likelihood, The method of moments, Statistical errors confidence intervals and limits, Characteristic functions and related examples, Unfolding. Variable Subset Selection (Best-Subset Selection, Forward- and Backward-Stepwise Selection, Forward-Stagewise Regression), Assessing the Accuracy of the Model, Shrinkage Methods, the Bias–Variance Tradeoff, Residual Plots, Interpretation of Residual Plots. Assessing Model Accuracy ,Measuring the Quality of Fit, Bias, Variance and Model Complexity, The Bias–Variance Decomposition, Example: Bias–Variance Tradeoff , Optimism of the Training Error Rate , Cross-Validation (K-Fold Cross-Validation, Holdout, Bootstrap Methods

Text Book

1. Reimann, Clemens, et al. Statistical data analysis explained: applied environmental statistics with R. John Wiley & Sons, 2011.
2. Meloun, Milan, and Jiří Militký. Statistical data analysis: A practical guide. Woodhead Publishing Limited, 2011.

3.	Bevan, Adrian. Statistical data analysis for the physical sciences. Cambridge University Press, 2013.

Course Title	Data Mining	Course Code	DA205C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Understand ways in which the methods of data mining differ from the more classical statistical approaches to data analysis, the rationale for data mining methods.
- Illustrate the kinds of patterns that can be discovered by association rule mining.
- Implement different classification and prediction techniques in numerous applications.
- Compute dissimilarities between objects represented by various attributes or variable types and examine several clustering techniques.
- Analyze the results generated from the constructed artifact to determine if patterns of clusters were detected in the data sets.

Contents

Introduction – Data – Types of Data – Data Mining Functionalities –Classification of Data Mining Systems – Issues –Data Preprocessing- C4.5 Algorithm Description- C4.5 Features - Two Illustrative Examples.
Mining Frequent Patterns – Apriori Algorithm Description,. - Two Illustrative Examples- Mining various Kinds of Association Rules – Correlation Analysis – Constraint Based Association Mining.
Classification and Prediction - Basic Concepts - Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction.
Cluster Analysis - Types of Data – Categorization of Major Clustering Methods – K-means– Partitioning Methods – Hierarchical Methods - Density-Based Methods –Grid Based Methods – Model-Based Clustering Methods – Clustering High Dimensional Data - Constraint – Based Cluster Analysis – Outlier Analysis – Data Mining Applications.
Mining the World Wide Web - Page Rank Algorithm, Text mining, Mining Time Series Data, The CART Algorithm Briefly Stated, Ensemble methods-Increasing the Accuracy, Mining genomic data.

Text Book

1.	Jiawei Han and Micheline Kamber: Data Mining Concepts and Techniques, Elsevier, 2nd Edition, 2009.
2.	Xindong Wu and Vipin Kumar: The top ten Algorithms in Data Mining, Chapman and Hall/CRC press.
3.	Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Person Education, 2007.
4.	K.P. Soman, Shyam Diwakar and V. Aja, "Insight into Data Mining Theory and Practice", Eastern Economy Edition, Prentice Hall of India, 2006.

Course Title	Autonomous Mobile Robots	Course Code	DA207C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes	At the end of the course the students will be able to: • Understand robotic systems from a computational perspective • Use sensors to make robots intelligent • Infer mechanisms and behaviour strategies as opposed to electromechanical system design • Use definitional problems in robotics and look at how they are being solved in practice and by the research community • Apply probabilistic modelling and instil the idea that a robot that explicitly accounts for its uncertainty

Contents

Kinematics and Dynamics: how can we model robotic systems using approximate physical models that enable us to make predictions about how robots move in response to given commands?
Feedback Control and Planning: how can we compute the state-(in)dependent commands that can bring a robotic system from its current state to a desired state?
Mapping: how can we combine noisy measurements from sensors with the robot's pose to build a map of the environment?
State Estimation: the state of the robot is not always directly measurable/observable. How can we determine the relative weighs of multiple sensor measurements in order to form an accurate estimate of the (hidden) state?
The Geometry of Computer Vision: how can modeling pixel projections on an RGB camera help us infer the 3D structure of the world? How can we triangulate points seen from two cameras? How can we estimate the camera's pose (and therefore the robot's) while it is moving in the environment?

Text Book

1.	Siegwart, Roland, Illah Reza Nourbakhsh, and Davide Scaramuzza. Introduction to autonomous mobile robots. MIT press, 2011.
2.	Kagan, Eugene, Nir Shvalb, and Irad Ben-Gal, eds. Autonomous mobile robots and multi-robot systems: Motion-planning, communication, and swarming. John Wiley & Sons, 2019.

Course Title	**Numerical Methods**	**Course Code**	**MA204C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-0-[2])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Faculty Choice**

Course Outcomes	At the end of the course the students will be able to: • Understand the definition and source of errors and solutions of nonlinear equations • Apply convergence analysis and newton's methods • Use numerical methods like Runge-Kutta methods appropriately.

Contents

Definition and sources of errors, propagation of errors, solutions of nonlinear equations; bisection method, Newton's method and its variants, fixed-point iterations, convergence analysis; Newton's method for nonlinear systems;
Finite differences, polynomial interpolation; Numerical integration - Trapezoidal and Simpson's rules, Gaussian quadrature; Initial value problems, Taylor series method, Euler and modified Euler methods, Runge-Kutta methods. Curve fitting.

Text Book

1.	K. E. Atkinson, Introduction to Numerical Analysis, 2nd Edn., John Wiley, 1989.
2.	S.S. Sastry, Introductory methods of numerical analysis, 5th edition, PHI publication.
3.	M.K. Jain, S.R.K. Iyenger, R.K. Jain Numerical Methods

Course Title	Reinforcement Learning	Course Code	DA203C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Understand the fundamental problems of reinforcement learning
- Discuss techniques, mathematical concepts, and algorithms used in reinforcement learning
- Understand the limitations of various reinforcement learning algorithms
- Evaluate the performance of reinforcement learning algorithms
- Apply reinforcement learning algorithms in various real time situations

Contents

Introduction to Reinforcement Learning: Elements of Reinforcement Learning, Limitations and Scope; A k-armed Bandit Problem and solutions using reinforcement learning; Finite Markov Decision Processes, The Agent–Environment Interface, Goals and Rewards, Returns and Episodes,
Optimality and Approximation, Dynamic Programming, Efficiency of Dynamic Programming, Asynchronous Dynamic Programming; Monte Carlo Methods, Monte Carlo Control, Off-policy Monte Carlo Control; Temporal-Difference Learning, Optimality of TD(0), Q-learning, Expected Sarsa, Afterstates.

Text Book

1. Reinforcement Learning: An Introduction 2nd Edition by Richard S. Sutton and Andrew G. Barto
2. Python Reinforcement Learning Projects by Rajalingappaa Shanmugamani, Packt Press.
3. Reinforcement Learning Algorithms with Python Learn, understand, and develop smart algorithms for addressing AI challenges by Andrea Lonza, Packt Press
4. Hands-On Reinforcement Learning with Python by Sudharsan Ravichandiran Packt Press

Course Title	Entrepreneurship	Course Code	HS301C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-1-0-[2])
Offered for	All Programs	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Faculty Choice

Course Outcomes

At the end of the course the students will be able to:

- Identify the importance of entrepreneurship.
- To familiarize students with design thinking concepts and principles
- To ensure students can practice the methods, processes and tools of design thinking.
- To ensure students can apply the design thinking approach and have ability to model real world situations

Contents

The Foundations of Entrepreneurship: What's Feeding the Entrepreneurial Fire? The Cultural Diversity of Entrepreneurship. The Power of "Small" Business, The 10 Deadly Mistakes of Entrepreneurship. Putting Failure into Perspective, how to Avoid the Pitfalls. Creativity, Innovation, and Entrepreneurship, Creativity—A Necessity for Survival. Creative Thinking, Barriers to, Creativity How to Enhance Creativity, The Creative Process. Techniques for Improving the Creative Process Protecting Your Ideas. Introduction to Innovation, where does Design-Thinking Fit in? The Human Aspects, Thinking Process, Visualization, Journey Mapping, Mind Mapping, Value Chain Analysis, Brainstorming, Customer Co-creation and Learning Launch, Assumption Testing, Rapid Concept Development, Rapid Prototyping, Leveraging Design Thinking for Innovation.

Text book	
1.	Thomas W. Zimmerer and Norman M. Scarborough: Essentials of Entrepreneurship and Small Business Management (IV Edition), Prentice Hall, 2004.
2.	C. Tripathi, P. N. Reddy: Principles of Management Tata McGraw Hill, 4th Edition, 2010.
3.	Poornima M Charantimath : Entrepreneurship Development - Small Business Enterprises , 1st Edition, Pearson Education – 2006
4.	Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press , 2009.
5.	Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011
6.	Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.

Course Title	**Game Theory**	**Course Code**	**DA209C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-0-[2])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Faculty Choice**
Course Outcomes	At the end of the course the students will be able to: • Understand foundations of combinatorial games and cooperative games • Understand the importance of players, strategies, payoffs, rationality, and equilibrium in Game Theory • Model and analyze conflicting situations using game theory • Analyze strategic interactions among agents in an efficient manner.		

Contents

Introduction: Motivation for the course. Utility Theory
Non-Cooperative Game Theory: Introduction to Game Theory, Extensive Form
Games, Strategic Form Games, Dominant Strategy Equilibria, Pure Strategy Nash Equilibrium, Mixed Strategy Nash Equilibrium, Fixed Point Theorem and Existence of Nash Equilibrium, Computation of Nash Equilibrium, Complexity of Computing Nash Equilibrium, Matrix Games (Two Players Zero-sum Games), Bayesian Games, Subgame Perfect Equilibrium.
Mechanism Design: (A) Without Money: One-sided and two-sided matching with strict preferences, Voting theory, and Participatory democracy. (B) With Money: Auction basics, sponsored search auctions, Revenue optimal auctions, VCG Mechanisms.
Cooperative Game Theory: Correlated Strategies and Correlated Equilibrium, Two-Person Bargaining Problem, Coalitional Games, The Core, and The Shapley Value.
Network Games: Network games, network formation, pairwise stability, pairwise Nash, price of anarchy, and stability.
Applications: Incentive Study in - P2P Networks, Crowdsourcing, Digital currency, Machine Learning, Spectrum Allocation, and Network Selection

Text Book	
1.	R. A. Mccain. Game Theory: A Nontechnical Introduction to the Analysis of Strategy: A Nontechnical Introduction to the Analysis of Strategy. World Scientific Publishing Company; 3rd edition, ISBN: 978-9814578875, 2014.
2.	M. Maschler, E. Solan, and S. Zamir. Game Theory, Cambridge University Press; 1st Edition, ISBN: 978-1107005488, 2013.

Course Title	Controls and Signal Processing	Course Code	DA208C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	Signals and System	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Understand time and frequency domain analysis of signals and systems • Analyse the stability and performance of a system • Design controller for stability and/or desired performance of linear time-invariant systems		

Contents

An Introduction to Signals and LTI Systems; Discrete Fourier Transform (DFT), Laplace Transform (LT), Z-Transform, Digital Filters and Digital Filter Design, Transfer function and state–space representation of Signals and Systems, Transient and steady-state analysis of LTI systems; system stability and robustness analysis, Routh-Hurwitz and Nyquist stability criteria, Bode and root-locus plots, design and analysis of PID control systems, case study

Text Book

1.	J.G. Proakis, D.G. Manolakis and D. Sharma, Digital Signal Processing, Pearson, 3rd edition,
	West D. B., "Introduction to Graph Theory ", Prentice Hall India (2nd Ed.) 2009
2.	S. K. Mitra, Digital Signal Processing: A computer based approach, Tata McGraw Hill, 2nd edition.
3.	M Gopal, Control Systems: Principles and Design, 4th Edition McGraw Hill Education
4.	R. C. Dorf and R. H. Bishop, Modern Control Systems, Prentice Hall.

SEMESTER 5

Course Title	Deep Learning	Course Code	DA301C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Understand the fundamentals of deep learning
- Understand different techniques used in deep learning
- Design and implement deep neural network systems
- Identify new application requirements in various domains

Contents

Brief History of Neural Network, How do Neural Networks work?, How do Neural Networks learn, Programming Environment for Deep Learning Logistic Regression, Keras, Tensorflow, Setting up the machine for Deep Learning, how to handle different types of data, Deep Neural Network, Building blocks of deep neural networks, Activation Functions, Loss Functions, Optimization methods, Hyperparameter Tuning

Text Book

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning MIT Press (2017)
2. Francois Chollet ,Deep Learning with Python (2018)
3. AurÈlien GÈron ,Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems (2017)
4. Antonio Gulli and Amita Kapoor ,TensorFlow 1.x Deep Learning Cookbook12 December (2017)

Course Title	Computer Vision	Course Code	DA304C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Understand the concepts of computer vision which deals with understanding, and extracting information from digital images and videos.
- Understand the foundations of image formation, camera imaging geometry, feature detection and matching, Multiview geometry including stereo, motion estimation and tracking
- Apply machine learning algorithms for image classification, object detection, and image segmentation.

Contents

Digital Image Processing - Image Formation, Image Filtering, Edge Detection, Principal Component Analysis - Corner Detection, SIFT, Applications: Large Scale Image Search
Geometric Techniques in Computer Vision - Image Transformations, Camera Projections, Camera Calibration, Depth from Stereo, Two View Structure from Motion, Object Tracking
Machine Learning for Computer Vision - Image Classification, Object Detection, Semantic Segmentation

Text Book

1. "Computer Vision: A Modern Approach", by Forsyth and Ponce
2. "Multiple View Geometry in Computer Vision", by Hartley and isserman

Course Title	Data Communication & Computer Networks	Course Code	CS209C
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Describe the various application layer protocols used by TCP/IP reference model.
- Differentiate between connection oriented and connection less services of transport layer.
- Solve problems of routing using various routing protocols and algorithms.
- Identify the drawbacks of classful addressing and the need for classless & IPv6 addressing.
- Manage mobility in Internet and cellular networks.

Contents

Introduction to computer networks: Network – Component and Categories – Topologies Transmission Media – Reference Models: ISO/OSI Model and TCP/IP Model. Physical Layer: Types of signals and transmission techniques, Data Link Layer: Error – Detection and Correction – Parity – LRC-CRC – Hamming Code – Flow Control and Error Control – Stop and wait – ARQ – Sliding window – HDLC, Multiple Access Protocols, Network Layer: Packet Switching and Datagram approach – IP addressing methods – Subnetting – Routing – Distance Vector Routing – Link State Routing – Broadcast and Multicast Routing, Transport Layer: Transport Services – UDP -TCP - Congestion Control, Application Layer: HTTP, Domain Name Space (DNS) – Electronic Mail(SMTP, POP)

Text Book

1.	James F. Kurose and Keith W. Ross: Computer Networking: A Top-Down Approach, 5th edition, Addison-Wesley, 2009.
2.	Forouzan: Data Communications and Networking, 5th edition, McGraw Hill Education 2013.

SEMESTER 6

Course Title	Natural Language Processing	Course Code	DA311E
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Interpret how speech and language technology relies on formal models to capture knowledge, and language processing deals with subparts of words (morphology).
- Illustrate the way N-gram tool is used for spelling and pronunciation processing, and part-of-speech tagging mechanism using various categories.
- Describe feature structures and unification operation which is used to combine them, and probabilistic parsing to capture more Outline representations used to bridge the gap from language to common sense Knowledge (semantic processing), and meanings associated with lexical items.
- Emphasize problems that NLP systems face, natural language outputs construction from non-linguistic inputs and machine translation framework approaches.

Contents

Introduction Natural Language Processing and Text Mining, NLTK, APIs, Social Media, Web Scraping, corpus, tokenization, stemming, POS Tagging and Stopwords, Text "Features" and TF-IDF, DTM, Bag of words, Text Classification, LSTM and RNN in Text applications, NLP Applications.

Probabilistic Models of Pronunciation and Spelling, Weighted Automata – N- Grams – Corpus Analysis – Smoothing – Entropy - Parts-of-Speech – Taggers – Rule based – Hidden Markov Models – Speech Recognition. Parsing Techniques, General Grammar rules for Languages, Context Free Grammar, Down Parser, Lexicalised and Probabilistic Parsing. Representing Meaning, Computational Representation, Meaning Structure of Language, – Semantic Analysis, Lexical Semantics, WordNet, Pragmatics.

Text Book

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2nd Edition, 2008.
2. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.

ELECTIVES

Course Title	Resource Constrained AI	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Understand the constraints of implementing AI techniques on edge devices. • Design and implement techniques that efficiently manage inexorable trade-off between computational time and memory footprint while training machine learning models.		
Contents			
Introduction: Establishing the need and importance of resource constrained AI and challenges associated with it. Edge Computing: edge devices and their limitations, distributed computing, fog computing Memory Optimization of Models: KiloByte-size models, floating-point v/s fixed-point, SeeDot Edge AI:Resource-efficient kNN, SVM and deep learning models, Toeplitz matrix, Bonsai, Proto-NN, EMI-RNN, FastRNN, FastGRNN Tiny ML: Framework, Tensorflow Lite, Embedded Learning Library, Tiny ML applications, Tiny ML challenges			
Text Book			
1.	C. ALIPPI (2014), Intelligence for Embedded Systems: A Methodological Approach, Springer, 1st Edition		
2.	Pete Warden, Daniel Situnayake (2019), Tiny ML, Publisher: O'Reilly Media, Inc.		

Course Title	Artificial Intelligence in Transportation	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Understand the application AI in the field of transportation • Apply AI techniques for transforming transportation sector		
Contents			
Introduction: Basic understanding of traffic flow and continuum models of traffic flow. AI in transportation: intelligent transport systems applications, self driving vehicles, pedestrian detection, traffic flow analysis, Computer Vision-Powered Parking Management Advance topics: Driver monitoring, automatic accident detection, future trends			
Text Book			
1.	Alam, M., Ferreira, J., & Fonseca, J. (2016). Introduction to intelligent transportation systems. In Intelligent Transportation Systems (pp. 1-17). Springer, Cham.		
2.	Lipson, H., &Kurman, M. (2016). Driverless: Intelligent Cars and the road ahead. MIT Press.		

Course Title	Artificial Intelligence in Health Care	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory

Prerequisite	NA	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Understand how AI can be applied in Health Care sector • Recommend appropriate imaging modalities for common clinical applications of 2D medical imaging • Translate outputs of medical imaging models for use by a clinician		

Contents

Introduction: Introduction to AI for 2D Medical Imaging, explaining what AI for 2D medical imaging is and why it is relevant.
Clinical Foundations of 2D Medical Imaging: different 2D medical imaging modalities and their clinical applications.
AI in disease diagnosis: some case studies (tumor classification, diabetes prediction, coronary artery diseases etc.)
Natural Language Processing and Data Analytics in Health Care :delivering patient care using the IoT and ambient computing with AI, reducing waste in health
Advance topics : Scope of AI in telemedicine

Text Book

1.	Kerrie L. Holley, Siupo Becker " AI-First Healthcare" by O'Reilly Media, Inc. 2021, ISBN: 9781492063155
2.	Tom Lawry "AI in Health: A Leader's Guide to Winning in the New Age of Intelligent Health Systems, HIMSS Book Series, 2020

Course Title	Biometrics and Bioimaging	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Understand imaging approaches and their application in biomedical research and development • Design and implementation of biometric identification systems • Understand the foundations of imaging theory • Design a small scale biometric identification system		

Contents

Introduction: Biometrics overview (History of Biometrics, Types of biometrics, Applications, challenges), evaluation parameters
Physiological Biometrics: face, iris, ear, hand, voice
Behavioral Biometrics: gait, keystrokes
Advance topics in Biometrics: Adversarial attacks and their countermeasures
Imaging system : theory, basic optics, imaging physics, microscopy, ultrasound imaging (US), magnetic resonance imaging (MRI) and computed tomography (CT)

Text Book

1.	Douglas B. Murphy, Michael W. Davidson, Fundamentals of Light Microscopy and Electronic Imaging
2.	Simon R. Cherry, Ramsey D. Badawi, Jinyi Qi, Essentials of In Vivo Biomedical Imaging
3.	Anil K. Jain, Arun Ross, and Karthik Nandakumar "Introduction to Biometrics" ISBN number: 978-0-387-77325-4

Course Title	Algorithms for AI	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Understand of different AI algorithms that enables them to apply AI techniques in solving various real-world problems
- Identify and formulate appropriate AI algorithms for solving a problem
- Compare different AI algorithms in terms of space and time complexity

Contents

Search algorithms in AI: uninformed search (BFS, DFS, Uniform Cost search), Informed search (Greedy best first search, A* search)
Local search techniques: beam search, heuristic hill climbing search, steepest ascent hill climbing, stochastic hill climbing
Adversarial search: The minimax algorithm, Alpha-Beta pruning, Expectimax search
Advance algorithms: Genetic algorithms, ant colony optimization, Particle Swarm Optimization

Text Book

1. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", SecondEdition, Pearson Education

Course Title	Business Intelligence and Data Analytics	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes

At the end of the course the students will be able to:

- Understand the methods of building applied business models and managerial decision making
- Understand the basic methods for business models producing and critiquing forecasts.
- Apply modelling at varying levels to aid decision-making

Contents

Decision Making and Analytics: An Overview of Business Intelligence, Analytics, and Decision Support, Foundations and Technologies for Decision Making
Descriptive Analytics : Data Warehousing ,Business Reporting, Visual Analytics, and Business Performance Management
Predictive Analytics : Data Mining , Techniques for Predictive Modeling , Text Analytics, Text Mining, and Sentiment Analysis , Web Analytics, Web Mining, and Social Analytics
Prescriptive Analytics : Model-Based Decision Making: Optimization and Multi-Criteria Systems, Modeling and Analysis: Heuristic Search Methods and Simulation , Automated Decision Systems and Expert Systems, Knowledge Management and Collaborative Systems.
Big Data and Future Directions for Business Analytics - Big Data and Analytics, Business Analytics: Emerging Trends and Future Impacts

Text Book	
1.	Sharda, R., Delen, D., & Turban, E. (2015).Business Intelligence and Analytics: Systems for Decision Support (10th ed.). Upper Saddle River, NJ: Pearson. ISBN-13: 978-0-13- 305090-5.
2.	Business Intelligence: A Managerial Approach (2011) Turban, Sharda, Delen, King, Publisher: Prentice Hall, Edition: 2nd, ISBN: 13-978-0-136-
3.	Business Intelligence Roadmap: The Complete Project Lifecycle for Decision-Support Applications by Larissa T. Moss.
4.	Hands-On Reinforcement Learning with Python by Sudharsan Ravichandiran Packt Press

Course Title	**Time Series Analysis**	**Course Code**	**TBD**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-2-[3])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Understand the working knowledge of time series and forecasting methods • Apply techniques and receipts for estimation and assessment of quality of economic models with time series data • Conduct empirical research in fields operating with time series data sets		

Contents

Introduction: Examples of Time Series, Objectives of Time Series Analysis, Some Simple Time Series Models, Stationary Models and the Autocorrelation Function, Estimation and Elimination of Trend and Seasonal Components, Testing the Estimated Noise Sequence

Stationary Processes: Basic Properties, Linear Processes, Introduction to ARMA Processes, Properties of the Sample Mean and Autocorrelation Function, Forecasting Stationary Time Series, The World Decomposition

ARMA Models : ARMA Processes, The ACF and PACF of an ARMA Process, Forecasting ARMA Processes

Spectral Analysis : Spectral Densities, The Periodogram , Time-Invariant Linear Filters, The Spectral Density of an ARMA Process

Multivariate Time Series : Examples, Second-Order Properties of Multivariate Time Series ,Estimation of the Mean and Covariance Function, Multivariate ARMA Processes, Best Linear Predictors of Second-Order Random Vectors, Modeling and Forecasting with Multivariate AR Processes

State-Space Models : State-Space Representations, The Basic Structural Model, State-Space Representation of ARIMA Models, The Kalman Recursions, Estimation For State-Space Models, State-Space Models with Missing Observations, The EM Algorithm, Generalized State-Space Models

Text Book	
1.	P.J. BLOCKWELL, R.A. DAVIS (2017), Introduction to Time Series and Forecasting, Springer, 2nd Edition.

Course Title	**Stream Analytics**	**Course Code**	**TBD**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-2-[3])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Describe GPU Architecture • Understand important models, algorithms, and applications related to stream data. • Apply the practical and algorithmic aspects related to various topics of data streams		

Contents
Introduction: Stream and mining algorithms. Clustering Massive Data Streams : Micro-clustering based stream mining, Clustering evolving data streams, On-line Micro-cluster maintenance, High-dimensional projected stream clustering, Classification of data streams using micro-clustering, On-demand stream classification, Applications of micro clustering. Classification Methods in Data Streams : Ensemble based classification, Very fast decision trees, On demand classification, Online Information Network. Distributed Mining of Data Streams : Outlier and anomaly detection, Clustering, Frequent item set mining, Classification, Summarization. Change Diagnosis Algorithms in Evolving Data Streams - Velocity density method, Clustering for characterizing stream evolution. Multidimensional Analysis of Data Streams using Stream Cubes - Architecture for online analysis of data streams, Stream data cube computation, Performance study. Dimensionality Reduction and - Principal Component Analysis, Auto-regressive models and recursive least squares, Tracking correlations and hidden variables.

Text Book	
1.	C.C. AGGARWAL, (Ed.), Data Stream: Models and Algorithms, Kluwer Academic Publishers, 2007.

Course Title	Graph and Social Networks	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-2-[3])
Offered for	DSAI	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Understand important models, algorithms, and applications related to Graphs and Social Networks. • Understand the basic concepts of social networks • Understand the fundamental concepts in analyzing the large-scale data that are derived from social networks • Implement mining algorithms for social networks • Perform mining on large social networks and illustrate the results.		

Contents
Introduction to Social Network Mining, Graph Models and Node Metrics : Introduction to social network mining. Illustration of various social network mining tasks with real-world examples. Data characteristics unique to these settings and potential biases due to them, Social Networks as Graphs, Random graph models/ graph generators, degree distributions. Models of evolving networks, Node based metrics, ranking algorithms (Pagerank). Social-Network Graph Analysis : Social network exploration/ processing: graph kernels, graph classification, clustering of social-network graphs, centrality measures, community detection and mining, degeneracy (outlier detection and centrality), partitioning of graphs, SNAP system for large networks analysis and manipulation. Social-Network Graph Analysis and Properties : Social network exploration/ processing and properties: Finding overlapping communities, similarity between graph nodes, counting triangles in graphs, neighborhood properties of graph, Pregel paradigm and Apache Giraph graph processing system. Information Diffusion in Social Networks - Strategic network formation: game theoretic models for network creation/ user behavior in social networks, Information diffusion in graphs: Cascading behavior, spreading, epidemics, heterogeneous social network mining, influence maximization, outbreak detection, Opinion analysis on social networks: Contagion, opinion formation, coordination and cooperation. Dynamic Social Networks, Applications and Research Trends : Dynamic social networks, Link prediction, Social learning on networks, Special issues in Information and Biological networks, Research trends.

Text Book	
1.	David Easley and Jon Kleinberg, Networks, crowds, and markets, Cambridge University Press, 2010.
2.	Jure Leskovec, Anand Rajaraman and Jeffrey David Ullman, Mining of massive datasets, Cambridge University Press, 2014.

Course Title	**Data Security and Privacy**	**Course Code**	**TBD**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-2-[3])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Understand Advanced Knowledge in Specialized Areas of Data Security and Privacy • Develop advanced theoretical or practical research skills in the area of privacy		

Contents

Introduction : Privacy and Data Collection, Legislative Privacy, Privacy Policies
Defining Privacy (Foundations) : Social Aspects of Privacy Legal Aspects of Privacy and Privacy Regulations Effect of Database and Data Mining technologies on privacy Privacy challenges raised by new emerging technologies such RFID, biometrics, etc.
Privacy Models Anonymization models : Data Privacy Taxonomy and alternative Privacy Frameworks , K-anonymity, l-diversity, t-closeness, differential privacy Database as a service, cloud computing
Privacy-aware Access Control : Statistical Database security Inference Control Secure Multi-party computation and Cryptography Privacy-preserving Data mining Hippocratic databases, Anonymity models
Emerging Applications : Social Network Privacy Location Privacy Query Log Privacy Biomedical Privacy, privacy in Cloud infrastructure and Big Data

Text Book	
1.	Stanford Encyclopedia of Philosophy (https://plato.stanford.edu/entries/privacy/)
2.	Reports from the Norwegian Data Protection Authority (https://www.datatilsynet.no/en/about-privacy/reports/)
3.	Regulations concerning privacy: GDPR Homepage (https://www.eugdpr.org/), Datatilsynet (https://www.datatilsynet.no/regelverk-og-skjema/nye-personvernregler/)

Course Title	**Financial Data Analytics**	**Course Code**	**TBD**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-2-[3])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Understand how managers use business analytics to formulate and solve business problems and to support managerial decision making • Develop advanced theoretical or practical research skills in the area of financial domain		

Contents
Predictive Analytics : Simple linear regression, multiple linear regression, logistic and multinomial regression, forecasting techniques; application of predictive analytics in retail, direct marketing, financial services, insurance, supply chain, etc. Optimization Analytics – Multi-period linear programming models and applications, network models and project planning, integer programming and its application in capital budgeting, location decisions, etc.; Multi-criteria decision making techniques – goal programming and analytic hierarchy process and applications. Optimization Analytics : Multi-period linear programming models and applications, network models and project planning, integer programming and its application in capital budgeting, location decisions, etc.; Multi-criteria decision making techniques – goal programming and analytic hierarchy process and applications. Stochastic Analytics – Introduction to stochastic models, Markov models, Renewal theory, Markov decision process and applications in sequential decision making Analytics under Uncertainty: Survival analysis and its applications; Six Sigma as a problem solving methodology; Classification and regression trees; lean thinking; dynamic pricing and revenue management; high dimensional data analysis; Analytics in Finance – discounted cash flows, profitability analysis, asset performance measurement tools, introduction to Insurance loss models Stochastic Analytics : Introduction to stochastic models, Markov models, Renewal theory, Markov decision process and applications in sequential decision making Analytics under Uncertainty : Survival analysis and its applications; Six Sigma as a problem solving methodology; Classification and regression trees; lean thinking; dynamic pricing and revenue management; high dimensional data analysis; Analytics in Finance – discounted cash flows, profitability analysis, asset performance measurement tools, introduction to Insurance loss models

Text Book	
1.	Jeanne G. Harris and Thomas H. Davenport, Competing on Analytics: The new science of winning, Harvard Business School Press, 2007
2.	James Evans, Business Analytics, Pearson, 2012
3.	Gert H. N. Laursen, Business Analytics for Managers: Taking Business Intelligence Beyond Reporting, John Wiley & Sons, 2010
4.	S. Christian Albright and Wayne L. Winston, Business Analytics: Data Analysis and Decision Making, South-Western College Publishing, 2014

Course Title	**Ethics, Policy, Law and Regulations in AI**	**Course Code**	**TBD**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-2-[3])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Relate the ethical and legislative aspects and conditions that need to be considered in the design and deployment of AI applications • Understand the ethical special characteristics of AI applications, compared to IT applications in general • Examine existing and hypothetical AI applications from an ethical viewpoint and identify potential issues • Compare the benefits of AI applications against their drawbacks also in a wider, societal context • Apply ethical principles in AI application design.		

Contents
Introduction: What is AI – and what is intelligence? , Definition of morality and ethics, and how that relates to AI, Mapping the main ethical dilemmas and moral questions associated with the deployment of AI: Impact on society, Impact on human psychology, Impact on the financial system, Impact on the legal system, Impact on the environment and the planet, Impact on trust Ethical initiatives in the field of artificial intelligence: International ethical initiatives, Ethical harms and concerns tackled by these initiatives, Case studies: healthcare robots, Autonomous Vehicles, Warfare and weaponisation. AI standards and regulation: 14 IEEE standards working groups National and International Strategies on AI : Europe, North America, Asia, Africa, South America, Australasia, International AI Initiatives, in addition to the EU, Government Readiness for AI Emerging Themes: Addressing ethical issues through national and international strategies, Addressing the governance challenges posed by AI, Summary: approaches to ethics, notable gaps, technology assessment, legislation and policies, disparity, ethical considerations.

Text Book	
1.	https://www.europarl.europa.eu/RegData/etudes/STUD/2020/634452/EPRS_STU(2020)634452_EN.pdf
2.	https://www.niti.gov.in/sites/default/files/2021-02/Responsible-AI-22022021.pdf
3.	Luciano Floridi ,"Ethics, Governance, and Policies in Artificial Intelligence"; Springer Cham 2021; ISBN: 978-3-030-81907-1
4.	Mark Coeckelbergh, " AI Ethics"; MIT Press Essential Knowledge series, April 7, 2020, ISBN: 9780262538190

Course Title	**GPU Architecture and Programming**	**Course Code**	**TBD**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-2-[3])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Describe GPU Architecture • Write programs using CUDA, identify issues and debug them • Implement efficient algorithms in GPUs for common application kernels, such as matrix multiplication • Write simple programs using OpenCL • Identify efficient parallel programming patterns to solve problemsApply ethical principles in AI application design.		

Contents
GPU ARCHITECTURE : Evolution of GPU architectures - Understanding Parallelism with GPU –Typical GPU Architecture - CUDA Hardware Overview - Threads, Blocks, Grids, Warps, Scheduling - Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory CUDA PROGRAMMING: Using CUDA - Multi GPU - Multi GPU Solutions - Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions. PROGRAMMING ISSUES: Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors. OPENCL BASICS: OpenCL Standard – Kernels – Host Device Interaction – Execution Environment – Memory Model – Basic OpenCL Examples. ALGORITHMS ON GPU: Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix - Matrix Multiplication - Programming Heterogeneous Cluster.

Text Book	
1.	Programming Massively Parallel Processors: A Hands-on Approach; David Kirk, Wen-mei Hwu; Morgan Kaufman; 2010 (ISBN: 978-0123814722)
2.	CUDA Programming: A Developer's Guide to Parallel Computing with GPUs; Shane Cook; Morgan Kaufman; 2012 (ISBN: 978-0124159334)
3.	Heterogeneous computing with OpenCL‖; David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang; 3rd Edition, Morgan Kauffman, 2015.

Course Title	**Industry 4.0**	**Course Code**	**TBD**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-2-[3])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Familiarize the basics and advancements of Industry 4.0 • Understand the features of smart technologies using IoT. • Understand the concept of security used in Industry 4.0 • Apply the concepts of cloud computing in networked systems • Study the various issues raised in Industry 4.0 environment.		

Contents

Introduction to Industry 4.0 - The Various Industrial Revolutions, Digitalisation and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, The Journey so far: Developments in USA, Europe, China and other countries, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation
Road to Industry 4.0 - Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Smart Manufacturing, Smart Devices and Products, Smart Logistics, Smart Cities, Predictive Analytics
Technologies for Industry 4.0 - Cyberphysical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Mobile Computing, Related Disciplines, Cyber Security
Cloud Computing In Industry 4.0 - Resource-based view of a firm, Data as a new resource for organizations, Harnessing and sharing knowledge in organizations, Cloud Computing Basics, Cloud Computing and Industry 4.0
Business issues in Industry 4.0 - Opportunities and Challenges, Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world, Industry 4.0 laboratories, IIoT case studies

Text Book	
1.	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016
2.	Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
3.	Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cyber manufacturing Systems" (Springer)

Course Title	**Introduction to Computational Learning Theory**	**Course Code**	**TBD**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(2-0-2-[3])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**

Course Outcomes	At the end of the course the students will be able to: • Understand the basics about a learning machine • Understand basic mathematics behind learning algorithms • Apply different types of leaning. • Construct a learning machine

Contents

Introduction : learning rectangles, approximation error, union bound
The PAC Model: General Setup, Expected error, The PAC Model, Half spaces, Empirical Risk Minimization, Agnostic vc. Realizable model
VC Dimension : Sample complexity lower bounds, VC dimension, VC dimension of rectangles, VC dimension of halfspaces, The fundamental theorem of learning, proper vs. improper learning
Hardness of Learning : Class of DNF and hardness of proper learning, Hardness of (improper) binary classification.
Boosting: Weak learnability, Expert advice model, Multiplicative Weight algorithm, application to boosting.
Stochastic Convex Optimization: Learning with Convex Functions, Generalization bounds (real-valued losses), Generalization bounds (real-valued losses)
Online Learning: Online Learning, Partial Feedback

Text Book

1.	Michael Kearns and Umesh Vazirani. An Introduction to Computational Learning Theory. MIT Press, 1994.
2.	Mehryar Mohri, Afshin Rostamizadeh and Amit Talwar. Foundations of Machine Learning. MIT Press, 2012.
3.	Shai Shalev-Shwartz and Shai Ben-David. Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press, 2014.

Course Title	**Planning and Decision Making of Robotics**	**Course Code**	**TBD**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(1-0-2-[2])**
Offered for	**DSAI**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Discuss about the basics of robot cognition and perception • Illustrate the different methods of map building and the robot simulation and execution of a program • Analyze the various path planning techniques by briefing about the robot's environment and explaining about the programs used • Identify, formulate and solve algorithm related to localization, obstacle avoidance, and mapping • Develop knowledge about simultaneous localization and mapping based techniques and paradigms.		

Contents
Introduction to Probabilistic Robotics: Uncertainty in Robotics, Probabilistic Robotics, Implications, Road Map Recursive State Estimation : Basic Concepts in Probability, Robot Environment Interaction, Bayes Filters, Representation and Computation Gaussian Filters & Nonparametric Filters: Kalman Filter, Histogram Filter, Particle Filter, Extended Kalman Filter, Robot Motion: Velocity Motion Model, Odometry Motion Model, Maps, Occupancy Grid Mapping Range Finders measurement models Mobile Robot Localization : A Taxonomy of Localization Problems, Markov Localization, EKF Localization, Estimating Correspondences, Multi-Hypothesis Tracking, Practical Considerations Simultaneous Localization And Mapping: SLAM with Extended Kalman Filters, EKF SLAM with Unknown Correspondences

Text Book	
1.	Thrun Sebastian, Burgard Wolfram, Fox Dieter (2005); Probabilistic Robotics; MIT Press. ISBN: 978-0-262-20162-9.
2.	https://nptel.ac.in/courses/107106090

Course Title	Soft Computing	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	DSAI / CSE	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Understand Fuzzy logic and its applications. • Understand Artificial neural networks and its applications. • Solve single-objective optimization problems using GAs. • Solve multi-objective optimization problems using Evolutionary algorithms (MOEAs). • Apply Soft computing to solve problems in varieties of application domains		

Contents
Introduction to Soft Computing: Concept of computing systems, “Soft” computing versus “Hard” computing, Characteristics of Soft computing, Some applications of Soft computing techniques Fuzzy logic: Introduction to Fuzzy logic, Fuzzy sets and membership functions, Operations on Fuzzy sets, Fuzzy relations, rules, propositions, implications and inferences, Defuzzification techniques, Fuzzy logic controller design, Some applications of Fuzzy logic. Genetic Algorithms: Concept of “Genetics” and “Evolution” and its application to proablistic search techniques, Basic GA framework and different GA architectures, GA operators: Encoding, Crossover, Selection, Mutation, etc., Solving single-objective optimization problems using GAs. Multi-objective Optimization Problem Solving: Concept of multi-objective optimization problems (MOOPs) and issues of solving them, Multi-Objective Evolutionary Algorithm (MOEA), Non-Pareto approaches to solve MOOPs, Pareto-based approaches to solve MOOPs, Some applications with MOEAs. Rough Sets: Rough Sets, Rule Induction, and Discernibility Matrix, Integration of Soft Computing Techniques.

Text Book	
1.	Neural Networks, Fuzzy Logic and Genetic Algorithms : Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India, 2007.
2.	Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998.
3.	An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, 2000.
4.	Soft Computing, D. K. Pratihar, Narosa, 2008.

Course Title	Advanced Machine Learning Algorithms	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	DSAI / CSE	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Design and implement various enhanced machine learning algorithms in a range of real-world applications • Suggest advanced machine learning approaches for any application • Appreciate machine learning challenges and suggest solutions for the same • Understand the strengths and weaknesses of advanced machine learning algorithms		
Contents			
Introduction: Types of Machine learning- Ensemble learning- Cross validation, - The Curse of dimensionality - Over and under fitting - Advanced Evaluation metrics. Supervised learning: Multiple linear regressions- Random Forest- AdaBoost algorithm- Artificial neural network- Multiclass classification algorithms. Unsupervised learning: Expectation maximization for mixture models (EM)-Dimensionality reduction- Principal Component Analysis (PCA) - Linear Discriminant Analysis (LDA)- Self Organizing Map (SOM)-Fuzzy clustering- Rough clustering. Semi supervised learning & Reinforcement learning: Semi supervised learning Algorithms- Model based - Model Free - Q learning. Applications: Recommender systems, Fraud detection, Churn prediction, Disease prediction.			
Text Book			
1.	Tom Mitchell, “Machine Learning”, First Edition, Tata McGraw Hill India, 2017.		
2.	Shai Shalev-Shwartz and Shai Ben-David. Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press, 2014.		
3.	Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Machine Learning and Pattern Recognition Series, Chapman and Hall/CRC, 2014.		

Course Title	DevOps, DataOps and MLOPs	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	DSAI / CSE	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Understand the benefits of DevOps over other software development processes • Get an overview of different DevOps Tools • Understand how to enable the organization’s business, development and operations to continuously design, deliver and validate new data demands • Design an ML production system end-to-end: project scoping, data needs, modeling strategies, and deployment requirements		

Contents
Introduction: Agile principles-Improve the quality of data- Analytics insights- AI models DevOps: DevOps Process and Lifecycle- Development – Testing- Configuration Management-Integration and Deployment- Monitoring of the software- DevOps tools DataOps: Establish DataOps (Prepare for operation- Optimize for operation) - Iterate DataOps (Know your data, Trust your data, Use your data) - Improve DataOps MLOPs: Introduction to Machine Learning in Production- Machine Learning Data Lifecycle in Production- Machine Learning Modeling Pipelines in Production- Deploying Machine Learning Models in Production Summary : Application of DevOps, DataOps and MLOPs- Challenges of DevOps, DataOps and MLOPs- Tools in DevOps, DataOps and MLOPs

Text Book	
1.	Dr. Kalpesh Parikh Amit Johri. Combining DataOps, MLOps and DevOps: Outperform Analytics and Software Development with Expert Practices on Process Optimization and Automation. BPB Publications (16 June 2022)

Course Title	Financial Engineering	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	DSAI / CSE	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory
Course Outcomes	At the end of the course the students will be able to: • Use Numerical methods to solve practical problems finance • Apply suitable optimization techniques in financial optimization problems • Choose an appropriate time series model for a given set of data • Describe the tools and techniques used in financial reporting and analysis		

Contents
Introduction : Quantitative Finance- Scope- The Functions of the Financial System- Market Organization and Structure Numerical methods for finance: Solving systems of linear equations- Solving non-linear equations- Curve fitting- Interpolation- Numerical Integration-Finite Difference Methods for Partial Differential Equations. Optimization in finance: Linear Programming- Non-linear programming- Quadratic programming- Dynamic Programming Financial time series analysis: Linear Time Series Analysis- Nonlinear Models, Multivariate Time Series Analysis Financial reporting and analysis: Financial Reporting Standards- Income Statements and Balance Sheet- Cash Flow Statements- Financial Analysis Techniques- Inventories- Long Lived Assets-Income Taxes- Applications.

Text Book	
1.	Joerg Kienitz, Daniel Wetterau, “Financial Modelling: Theory, Implementation and Practice with MATLAB Source”, John Wiley & Sons
2.	Gerard Cornuejols et al., Optimization Methods in Finance, Cambridge University press.
3.	Paolo Brandimarte, “Numerical Methods in Finance and Economics “, John Wiley & Sons

Course Title	Introduction to Systems Thinking	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(1-0-2-[2])
Offered for	DSAI / CSE	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Mandatory

Course Outcomes	At the end of the course the students will be able to: • Build individual and organizational capacity to address the systemic problems and challenges in their contexts • Enhance their ability to help their organizations to discover meaningful missions

Contents

Introduction: What is system thinking? - Characteristics of system- Important of system thinking- A close look at system behavior- How to manage system with examples.
Systems theory, concepts and approaches: Connectedness, complexity, hierarchy and emergence- Understanding and modeling the concepts of value, variation, time and constraints- Hard and soft systems analysis-Peter Checkland's soft systems methodology-Viable Systems Model- Systems Dynamics
Systems performance: Systems thinking and its impact on personal vision and professional role- Design' in a systems environment - Leadership in a systems environment- Understanding and managing complexity
Organizational performance: Deming's theory of profound knowledge and organizational learning- Seddon's systems thinking concepts- Purpose Measure Method
Practical application of Systems Thinking : Industrial case study- Public sector case study- Service sector case study

Text Book

1.	Jamshid Gharajedaghi. Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture. Morgan Kaufmann; 3rd edition (9 August 2011)
2.	Gerald M. Weinberg "An Introduction to General Systems Thinking". Dorset House Publishing Co Inc.,U.S.; 25th edition (1 January 2001);

Course Title	**Optimization Methods in ML**	**Course Code**	**DA303C**
Department	**CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.**	**Structure (L-T-P-[C])**	**(1-0-2-[2])**
Offered for	**DSAI / CSE**	**Type**	**Compulsory**
Prerequisite	**NA**	**Laboratory Choice**	**Mandatory**
Course Outcomes	At the end of the course the students will be able to: • Learn efficient computational procedures to solve optimization problems. • Cast engineering minima/maxima problems into optimization framework. • Use Matlab to implement important optimization methods.		

Contents

Introduction : Introduction to Optimization- Classification of Optimization problem- Definition of Global and Local optima- Optimality criteria
Optimization background: Gradient Descent- Stochastic Gradient Descent,- Conjugate Gradient Method- Newton's method- Steepest descent method- Convex Optimiza¬tion Algorithms
Optimization algorithms in ML: Genetic Algorithms – Simulated Annealing — Particle Swarm Optimization-Cuckoo search
Advanced optimization algorithms in ML: Grey wolf optimizer- Whale optimization algorithm- Mayfly algorithm-Ant colony optimization
Applications: Image processing- Health care system- Use of Mat lab to solve optimization problems.

Text Book

1.	Rao S. S. – 'Engineering Optimization, Theory and Practice' – New Age International Publishers – 2012 – 4th Edition.
2.	Bubeck, Sebastien. "Theory of Convex Optimization for Machine Learning." arXiv preprint arXiv 1405.4980, 2014

Course Title	Global Business perspectives	Course Code	TBD
Department	CSE/ECE/DSAI/SCI. & MATHS/HUMANITIES & MGMT.	Structure (L-T-P-[C])	(2-0-0-[2])
Offered for	DSAI / CSE	Type	Compulsory
Prerequisite	NA	Laboratory Choice	Faculty Choice

Course Outcomes	At the end of the course the students will be able to: • Understand the business level view of the system • Idea about new business opportunities • Apply the following skills like evaluation, reflection, analysis, research, collaboration and communication in business

Contents

Introduction: Accounting- Advertising and Marketing Communications- Behavioral Research in Auditing- Corporate Communications; Retailing and Consumer Behavior- Retail Management-Services Marketing/Non-Profit Marketing

Global Perspectives: Diversity Issues and Women in Management-Entrepreneurship/Small Business- Ethics and Social Issues in Business, Finance and GLobal Management/Environment

Human Resources Management and Organizational Behavior: International Accounting- International Business- International Marketing- Internationalization of the Curriculum

Management Information Systems: Management of Quality- Management Science/Decision Science- Marketing Strategy- Marketing Theory and Models- On-Line Technology in Management- Organizational Theory

Issues and Applications: Pedagogical/Instructional Issues: Production/Operations/ Management/Manufacturing/Services- Public Relations/Public Affairs/Lobbying and Media Business Issues- Research Methods in Business- Special Session on Strategic Management.

Text Book

1.	Abbass F. Alkhafaji And Jerry Biberman .Business Research Yearbook, Global Business Perspectives, Volume Iii. University Press Of America / Custom Publishing Program
2.	Karem Roitman Cambridge Lower Secondary Complete Global Perspectives: OUP Oxford; 1st edition (4 February 2021)
3.	U.C.Mathur: Global Business Strategies. I K International Publishing House Pvt. Ltd

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