SCHOOL OF DATA SCIENCE AND FORECASTING

PROGRAMME: M.TECH. (INTEGRATED) – AI&DS

BATCH: 2021-26>>SEMESTER-IV

Code	Title	Credits (L-T- P)
CORE COURSES		
DS6A-202	Discrete Structures	4 (3-1-0)
DS6A-204	Python Programming	4 (3-0-2)
DS6A-206	Database Management Systems	4 (3-0-2)
DS6A-208	Sampling Theory and Applications	3 (2-1-0)
DS6A-210	Automata Theory	3 (2-0-2)

ELECTIVE COURSES-DISCIPLINE CENTRIC (Any One)		
DS6A-222	Digital Logic Design	3 (2-0-2)
DS6A-224	Optimization Algorithms and Techniques	3 (2-1-0)

DS6A-242	Ethics in AI	3 (3-0-0)

Comprehensive Viva-Voce		
DS6A-252	Comprehensive Viva-Voce	4

DETAILED SYLLABUS

Course Code	DS6A-202	**Course Title**	Discrete Structures
Credits	4 (3-1-0)	**Pre-requisite**	Nil
Objective	To provide knowledge of set theory, relation, function, lattice, combinatorial problems, algebraic structures, proposition logic, and graph theory required for building mathematical foundation of computer science.		

COURSE DESCRIPTION:

Unit	Contents	Contact Hours
1.	**Set theory:** Basic concepts of set theory, operations on sets, Cartesian products, Venn Diagrams, proofs of some general identities on sets **Relation:** Definition, types of relation, composition of relations, Pictorial representation of relation, Equivalence relation, Partial ordering relation. **Function:** type of functions, one to one, into and onto function, Definition of sets, countable and uncountable sets, inverse function, recursive functions.	12
2.	**Lattice:** Introduction to lattice, properties of Lattices, bounded and complemented lattices, Hasse diagram, ordered set, isomorphic ordered set, well ordered set. **Combinatorics**: Introduction, fundamental counting principles, Permutation and combination, Binomial Theorem, Recurrence Relation: Linear recurrence relations with constant coefficients, Homogeneous solutions, Particular solutions, Total solutions; Generating functions, pigeonhole principle, Mathematical Induction.	10
3.	**Propositional and First-order logic:** First order logic, truth tables, tautologies, Contradictions, Algebra of Proposition, logical equivalence, predicates, Normal Forms, Universal and existential quantifiers. finite state machines. **Algebraic Structures:** Definition, Properties, Semi Groups, Monoid, Groups, Abelian group, properties of groups, Subgroup, cyclic groups, Cosets, factor group, Homomorphism and isomorphism of Groups, Rings and Fields.	14
4.	**Graph Theory**: Terminology, isomorphic graphs, Planer graphs, Multigraphs and weighted graphs, directed graphs, Euler's formula (Proof); Warshall's algorithms, Euler path & Hamiltonian circuits, Shortest path & minimal spanning trees, Depth-first Search and Breadth First Search, Tree traversal algorithms. Graph coloring, chromatic number, five color theorem, Isomorphism and Homomorphism of graphs.	10
TOTAL		**46**

BOOKS:

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1.	J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw-Hill,	1997

	ISBN: 0070651426	
2.	C. L. Liu, Elements of Discrete Mathematics, Tata McGraw-Hill, (ISBN: 9780007043477	2000
3.	Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata McGraw-Hill ISBN**:** 9780070681880	2007
4.	Narsingh Deo, "Graph Theory with Application to Engineering and Computer Science", PHI, ISBN: 9788120301450.	2004

Course Code	DS6A-204	**Course Title**	Python Programming
Credits	4 (3-0-2)	**Pre-requisite**	Nil
Objective	The main objective is to help students to understand the fundamentals of python. Student will learn how to analysis data using Python.		

COURSE DESCRIPTION:

Unit	**Contents**	**Contact Hours**
1.	Introduction to Python: Python versus Java, Python Interpreter and it's Environment, Python installation, Python basics: variables, operators, Strings, Conditional and Control Statements, loops; Data structures: lists and dictionaries; functions: global functions, local functions, lambda functions and methods.	10
2.	**Object Oriented Programming Concepts**: Class, object, constructor, destructor and inheritance; Modules & Packages, File Input and Output, Catching exceptions to deal with bad data, Multithreading, Database Connectivity.	10
3.	**Numpy:** Creating Arrays, Arrays Operations, Multidimensional Arrays. Arrays transformation, Array Concatenation, Array Math Operations, Multidimensional Array and its Operations, Vector and Matrix. **Visualization:** Visualization with matplotlib, Figures and subplots, Labeling and arranging figures, Outputting graphics.	12
4.	**Pandas:** Manipulating data from CSV, Excel, HDF5, and SQL databases, Data analysis and modelling with Pandas, Time-series analysis with Pandas, Using Pandas, the Python data analysis library, Series and Data Frames, Grouping, aggregating and applying, Merging and joining.	12
TOTAL		**44**

BOOKS:

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1.	McKinney Wes, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly Media	2012
2.	Hauck Trent, "Instant Data Intensive Apps with Pandas How-To", Packt Publishing Ltd.	2013
3.	Beazley David M.,"Advanced Python Programming", Pearson Education	2009
4.	Chun Wesley , Core Python Programming, 3rd Edition,Prentice Hall Professional	2012
5.	Telles Matt "Python Power!: The Comprehensive Guide", Cengage Learning	2008
6.	McKinney Wes & PyData Development Team, "pandas: powerful Python data analysis toolkit", Release 0.13.1, Feb.2014	2014

1. https://docs.python.org/3.4/tutorial/
2. http://www.tutorialspoint.com/python/python_quick_guide.htm

COURSE OUTCOMES:

No.	Outcome
The students will	
1.	learn core data types of python
2.	learn conditional and looping operations in python.
3.	be able to work with Object-oriented concepts and Database connectivity in python.
4.	be able to analyze data using Pandas and Numpy
5.	be able to visualize the data using seaborn and matplotlib

Course Code	DS6A-206	Course Title	Database Management Systems
Credits	4 (3-0-2)	Pre-requisite	Nil
Objective	The purpose of this course is to provide fundamental knowledge of database management system and understanding of how to use and design a DBMS.		

COURSE DESCRIPTION:

Unit	Contents	Contact Hours

1.	DBMS Concepts, Comparison between Database approach and Traditional file accessing approach, Advantages of database systems, Schemas and instances, Data Dependency, Data Dictionary, and Meta Data. Data models, Types of Data models (Object Oriented, Record Based and Physical data models), E-R diagram, Relational Data models: Domains, Tuples, Attributes, Keys, Relational database, Schemas, Integrity constraints, Relational algebra and relational calculus.	12
2.	Database Design: Introduction to normalization, Normal forms (INF, 2NF, 3NF, BCNF), Functional dependency, Decomposition, Dependency preservation and lossless join, multi-valued dependencies. **Structured Query Language**: DDL, DML, DCL, TCL, SQL Functions, integrity constraints, various joins, sub-query, index, View, Sequence, and Clusters. PL/SQL: manipulating data using PL/SQL, Iteration, Exceptions, Cursors, Trigger.	12
3.	Transaction Processing and Concurrency Control: Transaction System, Serializability of schedules, conflict & view serializable schedule, Recovery from transaction failures, Log based recovery. Checkpoints dead lock handling, Concurrency Control, locking Techniques for concurrency control, time stamping protocols for concurrency control, validation based protocol, multiple granularity.	12
4.	Advance Concepts: Introduction to Distributed databases, data mining, data warehousing, Basic Concepts of Object Oriented Database System, Comparative study of OODBMS V/s RDBMS. Introduction to Image and Multimedia databases and data structures, Web and mobile database, Spatial and Geographic Database, Accessing Database from front-end Application. Case Study: Oracle, MySql, DB2.	10
TOTAL		**46**

BOOKS:

S. No.	Name of Books/Authors/Publisher
1.	A Silberschatz, H Korth, S Sudarshan, “Database System and Concepts”, Fifth Edition McGraw-Hill.
2.	Elmasri Ramez and Novathe Shamkant, “Fundamentals of Database Systems”, Benjamin Cummings Publishing. Company.
3.	Rob, Coronel, “Database Systems”, Seventh Edition, Cengage Learning**.**
4.	Ramakrishnan: Database Management System, McGraw-Hill

5.	Fred R.McFadden,Jeffrey A.Hoffer & Marry B.Prescott.?Modern Database Management, Fifth Edition,Pearson Education Asia,2001
6.	Gray Jim and Reuter Address, “Transaction Processing: Concepts and Techniques”, Morgan Kauffman Publishers.

COURSE OUTCOMES:

S. No.	OUTCOME
1.	The student will learn the basics of database management.
2.	The student will be able to design database using ER diagram
3.	The student will able to optimize database using normalization.
4.	The student will able to work on database software MYSQL/Oracle.
5.	The student will learn how to write SQL queries.

Course Code	DS6A-208	**Course Title**	Sampling Theory and Applications
Credits	3 (2-1-0)	**Pre-requisite**	Nil
Objective	The main objective of the sampling theory is to obtain optimum results, i.e., to construct maximum information about the characteristics of the population with the available sources at our disposal in terms of time, money and manpower by studying the sample values only.		

COURSE DESCRIPTION:

Unit	Contents	Contact Hours
1.	**Sample Survey:** Concept of population and sample, need for sampling, steps in a sample survey, principles of sample survey, sampling and non-sampling errors, complete census v/s sample survey, Limitations of sampling.	8
2.	**Simple Random Sampling:** Definition of Simple random sampling, Simple random sampling with & without replacement. Unbiasedness of the sample mean, mean square error of the sample mean; merits, demerits and limitations of simple random sampling, simple random sampling for attributes. **Stratified Random Sampling:** Definition and advantages of stratified random sampling, proportional allocation, optimum allocation, cost function. Comparison of stratified random sampling with simple random	12

	sampling without stratification, proportional allocation versus simple random sampling, Neyman allocation Versus proportional allocation, Neyman allocation versus simple random sampling.	
3.	**Systematic Sampling:** Definition, linear systematic sampling, circular systematic sampling, mean and variance of a systematic sample mean, comparison of systematic sampling to simple random sampling, systematic sampling versus stratified random sampling, stratified random sampling versus simple random sampling for a population with linear trend, merits and demerit of systematic sampling.	10
4.	**Ratio Method of Estimation:** Definition, bias of ratio estimate, expected value of ratio estimate for first order approximation under simple random sampling without replacement, variance of ratio estimate for first order approximation under simple random sampling without replacement. **Regression Method of Estimation:** Definition, simple regression estimate, determination of beta, expected value of regression estimate for first order approximation under simple random sampling without replacement, variance of regression for first order approximation under simple random sampling without replacement.	12
TOTAL		**42**

BOOKS:

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1.	Sampling Techniques, Cochran W.G., Wiley Eastern. ISBN: 978-0-471-16240-7	1977
2.	Sampling Theories of Survey with Application, Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. Asok, C., IOWA State University Press and Indian Society of Agricultural Statistics	1984
4.	Sample Survey Theory, Des Raj and Chandhok P., Narosa Publishing House.	2013
5.	Fundamentals of Applied Statistics, Gupta, S.C. and Kapoor, V.K.: Sultan Chand and Co.	2019
6.	Theory and Methods of Survey Sampling, Mukhopadhyaya, P. PHI Learning. Print Book ISBN : 9788120336766 eBook ISBN : 9789354435430	2008
7.	Goon A.M., Gupta M.K. and Dasgupta B.: Fundamentals of Statistics (Vol.2), World Press.	2001

Course Code	DS6A-210	Course Title	Automata Theory
Credits	3 (2-0-2)	Pre-requisite	Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions.
Objective	This course aims to introduce an idea of Automata, Formal languages and computability.		

COURSE DESCRIPTION:

Unit	Contents	Contact Hours
1.	Finite Automata: Basic Definition of an automaton, Description of a finite automata Deterministic finite automata (DFA), Non-deterministic finite automata (NFA), transition systems, Acceptability of a string by a finite automation, The equivalence of DFA and NFA, Construction of minimum automaton. Formal Languages: Basic definitions, Chomsky classification of languages, Languages and their relations, Operations on languages, Languages and automata.	10
2.	Regular Grammars: Identities and regular expressions, Finite automata and regular expressions, Conversion of non-deterministic systems to deterministic systems, Algebraic method using Arden's theorem, Construction of finite automata equivalent to regular expression, Pumping lemma for regular sets, Applications of pumping lemma.	8
3.	Context-free Grammer: Context-free grammars, Parse trees, Ambiguity in context-free grammars, Simplification of context-free grammars, Normal forms of context-free grammars, Pumping lemma, Decision algorithms. Pushdown Automata: Basic definitions, Acceptance by pushdown automata, Pushdown automata and context-free languages.	12
4.	Turing Machines and Linear Bounded Automata (LBA): Turing Machines Model, Representation of a Turing machine, Language acceptability by Turing machines, Design of Turing Machines, Universal Turing Machines and other modifications, Model of linear bounded Automaton, Turing machines and type- 0 Grammars, Linear bounded automata and languages, Halting problem of Turing machines, NP Completeness. Computability: Introduction and basic concepts, Primitive recursive functions, Recursive functions, Partial recursive functions and Turing machines.	14
TOTAL		**44**

BOOKS:

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1.	J. E. Hopcroft, J. Motwani and J. D. Ull man, Introduction to Automata Theory, Languages and Computation, Pearson Education, Asia	2002
2.	J. H. Martin, Introduction of Languages and the Theory of Computation, McGraw-Hill International Edition, New York	1991
3.	Z. V. I. Kohavi, Switching and Finite Automata Theory, Tata McGraw-Hill, New Delhi.	1972
4.	H. R. Lewis and C. H. Papadimitrou, Elements of the Theory of Computation, Pearson Education.	1998

COURSE OUTCOMES:

No.	Outcome
The students will be able to	
1.	Understand, design, construct, analyze and interpret Regular languages, Expression and Grammars.
2.	Design different types of Finite Automata and Machines as Acceptor, Verifier and Translator.
3.	Understand, design, analyze and interpret Context Free languages, Expression and Grammars
4.	Design different types of Push down Automata as Simple Parser.
5.	Design different types of Turing Machines as Acceptor, Verifier, Translator and Basic computing machine.
6.	Compare, understand and analyze different languages, grammars, Automata and Machines and appreciate their power and convert Automata to Programs and Functions.

Course Code	DS6A-222	**Course Title**	Digital Logic Design
Credits	3 (2-0-2)	**Pre-requisite**	Nil
Objective	To acquaint the students with the fundamental principles of Digital Logic Circuits and their design.		

COURSE DESCRIPTION:

Unit	Contents	Contact Hours

1.	Number systems and Boolean algebra: Introduction to number system and Boolean algebra; Boolean identities, basic logic functions, standard forms of logic expressions, simplification of logic expressions. Logic families: Brief overview of Transistor as a switch; Logic gate characteristics – propagation delay, speed, noise margin, fan-out and power dissipation; Standard TTL and static CMOS gates.	10
2.	Combinational logic: Arithmetic circuits, decoders, encoders, multiplexers, de-multiplexers, and their use in logic synthesis; Hazards in combinational circuits. Introduction to VHDL: Behavioral – data flow, and algorithmic and structural description, lexical elements, data objects types, attributes, operators; VHDL coding examples, combinational circuit design examples in VHDL and simulation.	12
3.	Sequential logic circuits: Latches and Flip Flops (SR,D,J K,T); Timing in sequential circuits; Shift register; Counters–synchronous, asynchronous; Sequential circuit design examples in VHDL and simulation. Finite state machines: Basic concepts and design; Moore and Mealy machines examples; State minimization/reduction, state assignment; Finite state machine design case studies and FSM circuit design examples in VHDL and simulation.	13
4.	ROM and RAM, PLA, PAL and FPGA; RTL based design projects and their implementation in FPGA using VHDL. Astable and monostable multivibrator circuits using basic logic gates; Internal structure of 555 and its applications, clock circuits.	8
TOTAL		**43**

BOOKS:

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1.	Mano M.M., Ciletti M.D., “Digital Design”, Pearson India, 4th Edition	2006
2.	Katz R.H., Borriello G., “Contemporary Logic Desing”, Prentice Hall India, 2nd Edition.	2008
3.	Kohavi Z., Jha N.K., “Switching and Finite Automata Theory”, Cambridge University Press, India, 2nd Edition	2011
4.	Wakerly J.F., “Digital Design: Principles and Practices,” Pearson India, 4th Edition.	2008

5.	Harris D., Harris S., “Digital Design and Computer Architecture”, Elsevier Publications, 2nd Edition.	2007
6.	Pedroni V.A., “Digital Circuit Design with VHDL”, Prentice Hall India, 2nd Edition	2001

COURSE OUTCOMES:

No.	Outcome

Course Code	DS6A-224	**Course Title**	Optimization Algorithms and Techniques
Credits	3 (2-1-0)	**Pre-requisite**	
Objective	This course exposes the students in mathematical modelling, solving and analysing business and industrial problems using operations research methods.		

COURSE DESCRIPTION:

Unit	Contents	Contact Hours
1.	Introduction to LPP: Formulation of LP models, Graphical procedure of solution, Convex functions and their properties, Basic feasible solution, Optimal solution.	4
2.	Simplex Algorithm: Simplex method, Big M method, Two phase Method, Degenerate LPP, Revised simplex method, Duality Theorem, Dual Simplex Method, Sensitivity analysis.	14
3.	Transportation Problems: North West Corner Method, Matrix minima Method, VAM Method, Optimality Test, Degeneracy, Unbalanced Transportation problem. Assignment problems. Integer LPP: Branch and Bound Algorithm	12
4.	Network flow: Shortest path problem, Maximal flow problem, CPM, PERT. Introduction to Game Theory: Strategy, Minimax and Maximin Criterion, Existence of saddle point, Game without saddle point, Mixed strategies, Solution of 2x2 games, Rectangular games, Concept and general rules	12

	for dominance, Two person zero sum game. Solution of a game by simplex method.	
TOTAL		**42**

BOOKS:

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1.	Hamdy A. Taha: Operations Research: An introduction, Pearson Prentice Hall	
2.	David R. Anderson, Dennis J. Sweeney, Thomas A. Williams: An Introduction to Management Science, South-Western College Publishing.	
3.	William J. Stevenson: Introduction to Management Science, IRWIN.	

COURSE OUTCOMES:

No.	Outcome
1.	Understand the verbal description of the real system and accordingly identify and development of operational research models.
2.	Understand the mathematical tools that are needed to solve optimization problems.
3.	Use of mathematical software to solve the OR models developed.
4.	Develop a technical report that describes the model, solving technique, results analysis and recommendations.

Course Code	DS6A-242	**Course Title**	Ethics in AI
Credits	3 (3-0-0)	**Pre-requisite**	
Objective			

COURSE DESCRIPTION:

Unit	Contents	Contact Hours
1.	AI Ethics: AI ethics vs Ethics of AI. AI ethics theories, Benefits & risks of artificial intelligence, ethical issues in artificial intelligence, artificial intelligence: positive and negative factor, Risks, AI vs Humans, Robust and	4

	beneficial artificial intelligence, Ethics vs Law.	
2.	AI ethics: data control AI control vs ethical control, Superintelligence: Paths, Dangers, The value alignment problem, Principles of Safe AI, Data Collection, Fairness and Bias.	14
3.	Racist AI Algorithmic Accountability, Racist Algorithm, Right to explanation, Fair machine learning, Algorithms Ethics, algorithmic decision making, AI led Inequality and threatens democracy, Transparency and Interpretability, Algorithmic bias, discrimination discovery, Data fairness.	12
4.	Autonomy and Morality Robo ethics, Ariel weapons Morality, Ethical Autonomy, AI automation ethics, Artificial morality, artificial moral advisor, Moral Cognition, Moral Machines, Autonomous vehicles and Ethics, Robo rights.	12
TOTAL		**42**

BOOKS:

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1.		
2.		
3.		

COURSE OUTCOMES:

No.	Outcome
1.	
2.	
3.	
4.	