CENTRAL UNIVERSITY OF HARYANA
(*Established under the Central Universities Act, 2009*)
(NAAC Accredited 'A' Grade)

CBCS Based
Curriculum and Syllabi
of
M.Sc. Data Science
(Two-Year Post-Graduate Program)
(w.e.f. August, 2022)

DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

SCHOOL OF BASIC SCIENCES

CENTRAL UNIVERSITY OF HARYANA

SCHOOL OF BASIC SCIENCES

DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

Scheme & Syllabi of M.Sc. Data Science (Two-Year PG Programme)

Total Credit = 100

Semester Wise Distribution of Credits: 26 + 26 + 24 +24

Eligibility for Admission:

Passed B.C.A/ B.Sc. (Computer Science)/ B.Sc. (IT) / B.E. (CSE)/ B.Tech. (CSE) / B.E. (IT) / B.Tech. (IT) or equivalent Degree.

OR

Passed any graduation degree (e.g.: B.E. / B.Tech. / B.Sc / B.Com. / B.A./ B. Voc./ etc.,) with Mathematics at 10+2 level or at Graduation Level Obtained at least 50% marks (45% marks in case of candidates belonging to reserved category) in the qualifying examination. (The students admitted with this eligibility will have to simultaneously undertake additional Bridge Course(s) as prescribed by the University during the first year).

* *Reservation policy, Fee etc as per CU Haryana rules.*

Intake: 30

Category-wise Credit distribution

Category	Credits
• Programme core	80
• Departmental elective	12
• General elective	08

Bridge Course (0-credit)

Sr. No	Course No	Course Name	Course Code	Course Type	Credit
1.	CSP-BC01	Fundamentals of Computer Science	SBS CS 030120 C 3014	Bridge Course	0
2.	CSP-BC02	C Programming	SBS CS 030121 C 3014	Bridge Course	0
3.	CSP-BC03	C Programming Lab	SBS CS 030122 C 0042	Bridge Course	0

Note: It is compulsory for each student of **non-computer background** to pass out Bridge Course(s) during the first year only (Two additional theory papers and one practical as prescribed in the scheme of Bridge Course). Papers under Bridge Course will be taught only in the 1st semester.

Semester: Ist

						Total 100	
Sr. No	**Course No**	**Course Name**	**Course Code**	**Course Type**	**Credit**	**Internal Marks**	**External Marks**
1.	CSP-01	Linear Algebra and Statistical Techniques	SBS CS 030101 C 3014	Core	**4**	30	70
2.	CSP-02	Data Structures and Algorithms	SBS CS 030102 C 3014	Core	**4**	30	70
3.	CSP-03	Programming for Data Science using Python	SBS CS 030103 C 3014	Core	**4**	30	70
4.		General Elective Course-II (To be taken from another department)		Elective	**4**		
5.		Departmental Elective		Elective	**4**	30	70
6.	CSP-04	Inferential Statistics Lab	SBS CS 030104 C 0042	Core	**2**	15	35
7.	CSP-05	Data Structures and Algorithms Lab	SBS CS 030105 C 0042	Core	**2**	15	35
8.	CSP-06	Programming for Data Science using Python Lab	SBS CS 030106 C 0042	Core	**2**	15	35
					Total Credit = 26		

List of Departmental Elective Courses of Ist semester:					
S.No	**Course Name**	**Course Code**	**Credit**	**Internal Marks**	**External Marks**
1.	Queuing Theory and Network Analysis	SBS CS 030101 E 3014	**4**	**30**	**70**
2.	Graph Theory & Stochastic Processes	SBS CS 030102 E 3014	**4**	**30**	**70**
3.	Artificial Intelligence	SBS CS 030103 E 3014	**4**	**30**	**70**
4.	Software Engineering	SBS CS 030104 E 3014	**4**	**30**	**70**

Bridge course

<table>
<tr><td rowspan="2">Scheme Version:

2022-2023</td><td rowspan="2">Name of the Subject:

Fundamental of Computer Science (Bridge course)</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:

I(1st Year)</td><td>Contact hours per week: 4</td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>0</td><td>Total Hours:46</td></tr>
<tr><td rowspan="2">Subject Code: SBS CS 030120 C 3014</td><td rowspan="2">Applicable to Programs:

M.Sc. Data Science</td><td rowspan="2">Evaluation (Total Marks): 100</td><td>CIE</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>TEE</td><td>70 Marks</td><td colspan="3">Pre-requisite of course:Basic Fundamentals of Computer Science.</td></tr>
<tr><td>Course Description</td><td colspan="7">To introduce knowledge on basics of fundamental of computer science and various aspects of computational theory, programming, algorithm design, andoptimization, network and database management, mobile technologies, electronics and mathematics.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">This course aims to give students an in-depth understanding of why computers are essential components in business, education and society. This course will provide hands-on use of Microsoft Office applications Word, Excel, Access and PowerPoint.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">Upon successful completion of the course students will be able to:

COB010101.1 Learn about the fundamental concepts of computer.</td></tr>
</table>

	COB010101.2 To understand the role of Internet and IPV4 and IPV6. COB010101.3 Apply the binary logics to solve the problems. COB010101.4 Analyse Boolean logics and truth table. COB010101.5 Evaluate tasks like compose, format and edit a word document and other office software	
	COURSE SYLLABUS	
Unit No.	Content of Each Unit	Hours of Each Unit
1.	Overview of Computer System: [Course Outcome (s): COB010101.1] Evolution of Computer Systems, Generations of Computers, Parts of Computer System, Categories of Computers, Computer System Characteristics, Computer Hardware. Working of input & output devices: keyboard, mouse, trackball, pen, touch screens, scanner, digital camera, monitor, and printer. Working of storage devices: magnetic tape, magneticdisk, CD, DVD. Software- System & Application.	11
2.	The Internet: [Course Outcome (s): COB010101.2] Introduction to networks and internet, history, Working of Internet, Internet Congestion, Modes of Connecting to Internet, Internet Service Providers (ISPs), Internet addressing, comparison of IPv4 and IPv6.	10
3.	Information Representation: [Course Outcome (s): COB010101.3 & COB010101.4] Number systems,BCD codes, character codes, error detecting and correcting codes, fixed-point and floating-point representation of information. Binary arithmetic operations, Booths multiplication. Binary Logic: Boolean algebra, Boolean functions, Truth Tables, Canonical and Standard forms, Simplification of Boolean functions, Digital logic gates.	12

4.	Office Automation Tools Word Processing: [Course Outcome (s): COB010101.5] Editing features, formatting features, saving, printing, table handling, page settings, spell-checking, macros, mail-merge, and equation editors. Excel/Access Power Point Slides: Templates, views, formatting slide, slides with graphs, animation, using special features, presenting slide shows.	13

REFERENCE BOOKS

1. Norton, P., *Introduction to Computers*, Mc-Graw-Hill, 2017.

2. Raja, Raman V., *Fundamental of Computers*, Prentice Hall of India, 2014.

3. Sanders, D. H., *Computer Today*, Mc-Graw Hill, 1988.

4. Sinha, P.K. and Sinha, P., *Computer fundamentals*, BPB Publications, 2010.

5. Vermaat, M.E., *Discovering Computers & Microsoft Office 2013: A Fundamental Combined Approach*, Cengage Learning, 2013.

<table>
<tr><td rowspan="2">Scheme Version:

2022-2023</td><td rowspan="2">Name of the Subject:

Programming using C

(Bridge Course)</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:

I(1st Year)</td><td>Contact hours per week: 4</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>0</td><td>Total Hours:46</td></tr>
<tr><td rowspan="2">Subject Code: SBS CS 030121 C 3014</td><td rowspan="2">Applicable to Programs:

M.Sc Data Science</td><td rowspan="2">Evaluation (Total Marks): 100</td><td>CIE</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>TEE</td><td>70 Marks</td><td colspan="3">Pre-requisite of course:Basic Operating System and Shell Programming.</td></tr>
<tr><td>Course Description</td><td colspan="7">To introduce knowledge on basics of fundamental of computer science and various aspects of computational theory, programming, algorithm design, andoptimization, network and database management, mobile technologies, electronics and mathematics</td></tr>
<tr><td>Course Objectives</td><td colspan="7">The course is designed to provide knowledge of C language. Students will be able to develop logics which will help them to create programs, applications in C. Also by learning the basic programming constructs they can easily switch over to any other language in future. Student will learn the fundamental programming concepts and methodologies.</td></tr>
</table>

Course Outcomes:	Upon successful completion of the course students will be able to: COB010103.1 Learn the basic concepts of programs connecting decision structures, loops and functions. COB010103.2 Understand the difference between call by value and call by address. COB010103.3 Apply the dynamic behaviour of memory by the use of pointers. COB010103.4 Analyse the arrays and difference between structure and union. COB010103.5 Evaluate the result based on array, structure and union.	
	COURSE SYLLABUS	
Unit No.	Content of Each Unit	Hours of Each Unit
1.	Elements of C: [Course Outcome (s): COB010103.1] character set identifier and keywords, data type, declaration and definition. Operators: arithmetic, relational, logical, bit wise, unary, assignment and conditional operators their hierarchy arid associativity.	10
2.	Control statements: [Course Outcome (s):COB010103.2] sequencing, selection, if and switch statement; repetition / loop statements: for, while, and dowhile loops; break, continue and goto statements.	12
3.	Function: [Course Outcome (s): COB010103.2] definition, declaration, and calling, call by value, call by reference prototype, passing parameters, actual and formal parameters, recursion.	10

4.	Data Structures: [Course Outcome (s): COB010103.4 & COB010103.5] arrays, structure, structure members, access to structure members union, string, data files. Pointer: declaration, operation of pointers, array to pointers, pointers to arrays.	14

REFERENCE BOOKS

1. *E. Balagurusamy, "Programming with ANSI-C", Fourth Edition,2008, Tata McGraw Hill.*

2. Gottfried, B.S., *Programming with C*., McGraw Hill Education, 2018.

3. Hanly, J. R., Koffman, E.B. , *Problem Solving and Program Design in C*, 8th edition., Pearson Publications, 2015.

4. Kanetkar, Y., *Let Us C*, 16th Edition, BPB Publication, 2017.

5. Kelley, A., Pohl, I., *A Book on C: Programming in C*, Addison Wesley, 2000.

6. Kernighan, B.W. and Ritchie D., *The C Programming Language,* Pearson Publications, 2015.

Semester: Ist

Scheme Version: 2022-2023	Name of the Subject: Linear Algebra and Statistical Techniques	L	T	P	C	Semester: (Year)	Contact hours per week: 4 / Total Hours:46
		4	0	-	0		
SBS CS 030101 C 3014	Applicable to Programs: M.Sc Data Science	Evaluation (Total Marks): 100	CIE	30 Marks	Examination Duration: 3hours		
			TEE	70 Marks	Pre-requisite of course:		

	COURSE SYLLABUS	
Unit No.	Content of Each Unit	Hours of Each Unit
1.	Vector Spaces and Subspaces, Basis and dimension of a vector space, Determinants, Properties of the Determinant. Eigenvalues and eigenvectors, Diagonalization of a Matrix, Complex Matrices, Similarity Transformation, Test for positive definiteness, Singular Value Decomposition.	10
2.	Errors in Computations, Computing Norm, Inner product and solution of Triangular System, Efficiency and stability of an Algorithm, Conditioning, Perturbation Analysis. LU Factorization Methods, Effects of the condition number on accuracy, computing and estimating the condition number QR factorization.	10
3	Axioms of Probability, Conditional Probability & Independence, Random Variables, Continuous Random Variables, Survey Sampling.	10

4	Estimation of Parameters & Fitting of Probability Distributions, measures of central tendency and dispersion. Covariance, correlation, regression etc. Testing Hypotheses & Assessing Goodness of Fit, The Analysis of Variance using F test, The Analysis of Categorical Data using Fisher's exact test and the Chi-square test of homogeneity and independence.	10

REFERENCE BOOKS

1. Gilbert Strang, Introduction to linear algebra, 5/e., Wellesley-Cambridge, 2016.
2. David C. Lay, Linear Algebra and Its Applications, Pearson, 5/e 2019.
3. Nick Fieller, "Basics of Matrix Algebra for Statistics with R", published in 2015, CRC Press
4. S. Ross, A First Course in Probability, 8th Edition, Pearson Education, 2010.
5. J. A. Rice, Mathematical Statistics and Data Analytics, 3rd Edition, Cengage Learning, 2013.
6. Nabil Nassif, Jocelyne Erhel, Bernard Philippe, Introduction to Computational Linear Algebra, CRC press, 2015.

<table>
<tr><td rowspan="2">Scheme Version:

2022-2023</td><td rowspan="2">Name of the Subject:

Data Structures & Algorithms</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:

I(1st Year)</td><td>Contact hours per week: 4</td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>0</td><td>Total Hours:46</td></tr>
<tr><td rowspan="2">SBS CS 030102 C 3014</td><td rowspan="2">Applicable to Programs:

M.Sc. (Data Science)</td><td rowspan="2">Evaluation (Total Marks): 100</td><td>CIE</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>TEE</td><td>70 Marks</td><td colspan="3">Pre-requisite of course: knowledge of programming languages and basics of mathematics</td></tr>
<tr><td></td><td colspan="7">COURSE SYLLABUS</td></tr>
<tr><td>Unit No.</td><td colspan="5">Content of Each Unit</td><td>Hours of Each Unit</td></tr>
<tr><td>1.</td><td colspan="5">Basics and Introduction To Data Structure: [Course Outcome (s): COB030102.1]
Basics: Algorithm Specifications: Performance Analysis and Measurement (Time and space analysis of algorithms-Average, best and worst case analysis).
Introduction: Basic Terminology, Data structures and its classification, Representation and Analysis of Arrays, Single and Multidimensional Arrays, Address calculation, Linear Search, Binary Search of Array, Traversing, Insertion & deletion in array, Sparse Matrices, Sorting.</td><td>10</td></tr>
<tr><td>2.</td><td colspan="5">Linear Data Structure: [Course Outcome (s): COB030102.2]
Linked List Introduction, Representation of linked list in to memory, Memory allocation -Garbage
Collection, Traversing & Searching in Linked List, Insertion into linked list- at beginning of list &</td><td>10</td></tr>
</table>

	at given location, Deletion in linked list- from starting of list & given location of node, Header Linked List, two way List, Input & output restricted liked list, Circular Header Linked List, Representation of Polynomials using linked List.	
3	Nonlinear Data Structure [Course Outcome (s): COB030102.3] Stack, Array Implementation of stack, Linked Representation of Stack, Application of stack: Conversion of Infix to Prefix and Postfix Expressions and Expression evaluation. Queue, Array and linked implementation of queues, Circular queues, D-queues and Priority Queues.	08
4	Sorting, Searching, Hashing and File Structures [Course Outcome (s): COB030102.4] Trees: Basic terminology, Binary Trees, algebraic Expressions, Complete Binary Tree, Extended Binary Trees, Array and Linked Representation of Binary trees, Traversing Binary trees, Threaded Binary trees, Binary Search Tree (BST), AVL Trees, B-trees. Graphs: Introduction, Sequential Representations of Graphs, Adjacency Matrices, Traversal, Connected Component and Spanning Trees, Minimum Cost Spanning Trees. Searching & Hashing: Sequential search, binary search, Hash Table, Hash Functions, Collision Resolution Strategies.	12

REFERENCE BOOKS

1. Lipschutz: Data Structures (Schaum's Outline Series), Tata McGraw-Hill.
2. Horowitz and Sahani, ″Fundamentals of data Structures″, Galgotia Publication Pvt. Ltd., N Delhi.
3. A.M. Tenenbaum, ″Data Structures using C & C++″, Prentice-Hall of India Pvt. Ltd., New Delhi.
4. Trembley and Sorenson, ″Data Structures″, TMH Publications

Scheme Version: 2022-2023	Name of the Subject: Programming for Data Science	L	T	P	C	Semester: I(1st Year)	Contact hours per week: 4
		3	1	-	0		Total Hours:46
SBS CS 030103 C 3014	Applicable to Programs: M.Sc. (Data Science)	Evaluation (Total Marks): 100	CIE	30 Marks	Examination Duration: 3 hours		
			TEE	70 Marks	Pre-requisite of course: Understanding of Data, Algorithms, Programming Language		

	COURSE SYLLABUS	
Unit No.	Content of Each Unit	Hours of Each Unit
1.	Getting Started with Python: Introduction, Basic data types, Variables, Integers, Floating Points, Boolean types and Strings; Control Structures: if, if-elif-else, for, while, break, continue. Data Structures: Lists, Tuples, Sets, and Dictionaries; Functions: Defining functions, Calling functions, Passing arguments, Keyword arguments, Default arguments, Variable-length arguments, Anonymous functions, Function returning values, Scope of the variables in a function, User defined functions.	12 Hours
2.	Object Oriented Programming: Features, classes and objects, creating class and object, Using a class & its methods; Exception Handling: Errors, Types of exception, try, except and finally, assertion.	8 Hours
3	Modules & Packages: Creating modules, Import statement, from ... import statement, name spacing; Creating user defined packages; Numpy: Introduction, Creating of arrays and matrices; File Handling: Handling of csv file.	10 Hours

4	Introduction to Panda: Creating a data frame, Dealing with row & columns, Indexing & selection data, Working with missing data, Iterating over rows and columns; Merging and joining DataFrame objects, Concatenation, Reshaping DataFrame objects, Pivoting, Data transformation, permutation & sampling, Data aggregation and GroupBy operations; Creating data frame from CSV file; Introduction to scikit-learn: Fundamental of scikit-learn; Loading data set, Splitting of data set; Matplotlib: Creating effective visual representations of your data, Avoiding common pitfalls.	10 Hours

REFERENCE BOOKS

1. J. V. Guttag, Introduction to CoMputation and PrograMMing Using Python, with Application to Understanding Data, 2nd Edition, PHI Learning, 2016.
2. W. McKinney, Python for Data Analysis: Data Wrangling with Pandas, NuMPy, and Ipython, 2nd Edition, O'Reilly Media, 2017.
3. R. N. Rao, Core Python PrograMMing, 2nd Edition, Dreamtech Press, 2018.

Departmental Elective Courses: Semester Ist

Scheme Version: 2022-2023	**Name of the Subject:** Queuing Theory and Network Analysis	**L**	**T**	**P**	**C**	**Semester: Ist**(1st Year)	**Contact hours per week:** 4
		3	**1**	**-**	**0**		**Total Hours:**46
Subject Code: SBS CS 030101 E 3014	**Applicable to Programs:** M.Sc. Data Science	**Evaluation (Total Marks):** 100	**CIE**	**30 Marks**	**Examination Duration: 3 hours**		
			TEE	**70 Marks**	**Pre-requisite of course:** Calculus-based Probability Theory		

COURSE SYLLABUS

Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1.	Introduction to queues, measures of system performance, characteristics of queueing systems, Little's law and other general results; Transforms and generating functions, Stochastic processes overview, discrete-time Markov chains, classification and long-term behavior, Continuous-time Markov chain, birth-death processes, Poisson process and exponential distribution.	**10**
2.	Birth-death queueing systems: Single-server queues, multiserver queues, finite-capacity queues, Birth-death queueing systems: Loss systems, infinite-server queues, finite-source queues, state-dependent queues, queues with impatience, overview of transient analysis and busy period analysis, Non-birth-death Markovian queueing systems: Bulk input queues, bulk service queues, Erlangian models	10
3.	Priority queues, retrial queues, discrete-time queues, Queueing networks: Series, open Jackson networks, Queueing networks: Closed Jackson networks, cyclic queues, extensions of Jackson networks.	10

4.	Renewal and semi-Markov processes; Semi-Markovian queues, Semi-Markovian queues: Single server and multiserver general service and general input models, General queueing models, queues with vacations	10

REFERENCE BOOKS

1. 1. D. Gross and C. Harris, Fundamentals of Queueing Theory, 3rd Edition, Wiley.

2. B. Cooper, Introduction to Queueing Theory, 2nd Edition, North-Holland.

3. L. Kleinrock, Queueing Systems, Vol. 1: Theory, Wiley & Vol. 2: Computer Applications, Wiley.

4. R. Nelson, Probability, Stochastic Processes, and Queueing Theory: The Mathematics of Computer Performance Modelling, Springer.

5. J. Medhi, Stochastic Models in Queueing Theory, 2nd Edition, Academic Press.

Scheme Version: 2022-2023	**Name of the Subject:** Graph Theory & Stochastic Processes	**L**	**T**	**P**	**C**	**Semester:** Ist Semester (Ist year)	**Contact hours per week:** 4
		4	**0**	**-**	**0**		**Total Hours:**46
Subject Code: SBS CS 030109 E 3014	**Applicable to Programs:** M.Sc Data Science	**Evaluation (Total Marks):** 100	**CIE**	**30 Marks**	**Examination Duration: 3 hours**		
			TEE	**70 Marks**	**Pre-requisite of course:**		

	COURSE SYLLABUS	
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1.	Graphs, Degrees, Graph Isomorphism, Trees, Cut-Vertices. Eulerian graphs and Hamiltonian graphs, Matchings, Planar graphs, Vertex coloring.	**10**
2.	Joint distribution, Independent random variables, Covariance and Correlation coefficient, Variance-Covariance matrix, Conditional distribution and conditional expectation.	**10**
3	Multivariate normal distribution, The weak law of large numbers, The strong law of large numbers, Central limit theorem, Stochastic processes - definitions and properties.	**10**

4	Discrete-Time Markov Chain, Classification of states, Measure of stationary probability, Continuous-Time Markov Chains, Poisson Process.	**10**

Reference Books:

1. Narsingh Deo, Graph Theory and its application to Science and Engineering, PHI
2. Castan˜eda, V. Arunachalam, and S. Dharmaraja, Introduction to Probability and Stochastic Processes with Applications, 1st Edition, Wiley-Blackwell, 2012.
3. Chartrand G., Zhang Ping, Introduction to Graph Theory, Tata McGraw-Hill
4. Douglas B. West, Introduction to Graph Theory 2nd Ed., Pearson Education
5. Ross, S., Stochastic Processes, second edition, John Wiley, 1996.
6. Goswami, A. and Rao, B. V., A Course in Applied Stochastic, Processes, Hindustan Book Agency, 2006.

<table>
<tr><td rowspan="2">Scheme Version:

2022-2023</td><td rowspan="2">Name of the Subject:

Artificial Intelligence and Expert System</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:

Ist

(Ist Year)</td><td>Contact hours per week: 4</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours:48</td></tr>
<tr><td rowspan="2">Subject Code:
SBS CS 030103 E 3014</td><td rowspan="2">Applicable to Programs:

M.Sc. Data Science</td><td rowspan="2">Evaluation (Total Marks):
100</td><td>CIE</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>TEE</td><td>70 Marks</td><td colspan="3">Pre-requisite of course:</td></tr>
<tr><td>Course Description</td><td colspan="7">To introduce knowledge on basics of fundamental of computer science and various aspects of computational theory, programming, algorithm design, andoptimization, network and database management, mobile technologies, electronics and mathematics</td></tr>
</table>

Course Objectives	The primary objective of this course is to introduce the basic principles, techniques, and applications of Artificial Intelligence. Emphasis will be placed on the teaching of these fundamentals and labs for the hands-on approach for understanding, as well as a challenging avenue for exploration and creativity.	
Course Outcomes:	Upon successful completion of the course students will be able to: **CO010319.1** Choose problems that are amenable to solution by AI methods, and which AI methods may be suited to solving a given problem. **CO010319.2** Examine a given problem in the language/framework of different AI methods **CO010319.3** Apply basic AI algorithms (e.g., standard search algorithms or resolution) and solve problems. **CO010319.4** Analyse and carry out an empirical evaluation of different algorithms on a problem formalization.	
	COURSE SYLLABUS	
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1.	**Basic Concepts: [Course Outcome CO010319.1]** AI and its importance, history of AI, applications areas, AI approach for solving problems. Problem representation: State space representation, problem reduction representation, bounding functions. Propositional logic: syntax and semantics. First order predicate logic (FOPL): syntax and semantics, conversion to clausal form, inference rules, unification, resolution principle, proof procedure, refutation.	**10**

2.	**Search and Control Strategies: [Course Outcome CO010319.2]** Strategies for state space search, data driven and goal driven search; Search algorithms- uninformed search (depth first, breadth first, depthfirst with iterative deepening) and informed search (Hill climbing, best first, A, A*, AO algorithm, mini- max etc.), computational complexity, Properties ofsearch algorithms Admissibility, Monotonicity, Optimality, Dominance, etc., genetic algorithms.	**10**
3.	**Expert System Architecture: [Course Outcome CO010319.3]** Rule based architecture, non-production system architecture. Components of Expert Systems, Stages of expert system development, Expert systems applications, Building Expert System and Shell. Knowledge acquisition and validation.	**12**
4.	**Managing uncertainty in expert systems: [Course Outcome CO010319.4]** Bayesian probability theory, Stanford certainty factor algebra, No monotonic logic and reasoning with beliefs, Fuzzy logic, Dempster/Shaffer theory.	**8**

REFERENCE BOOKS

1. Patterson, D.W., Introduction to Artificial Intelligence and Expert Systems, Prentice-hall of India, 2007.
2. Nilsson, N.J., Principles of Artificial Intelligence, Morgan Kaufmann, 2014.
3. Luger, G.F. and Stubblefield, W.A., Artificial Intelligence and The Design of Expert Systems, Benjamin-Cummings Publishing Co. Inc., 2008.

4. Rich, E.K. and Nair, S.B., Artificial Intelligence, New Delhi, 2009.

5. Russell, S., and Norvig, P., Artificial Intelligence: A Modern Approach, Prentice Hall, 2015.

Scheme Version: 2022-2023	**Name of the Subject:** Software Engineering	**L**	**T**	**P**	**C**	**Semester:** Ist Semester	**Contact hours per week:** 4
		3	**1**	**0**	**4**		**Total Hours: 46**
Subject Code: SBS CS 030104 E 3014	**Applicable to Programs:** M.Sc. Data Science	**Evaluation (Total Marks):** 100	**CIE**	**30 Marks**	**Examination Duration: 3 hours**		
			TEE	**70 Marks**	**Pre-requisite of course:**		
Course Description	To introduce knowledge on basics of fundamental of computer science and various aspects of computational theory, programming, algorithm design, and optimization, network and database management, mobile technologies, electronics						

	and mathematics	
Course Objectives	The objective of this course is to provide a solid fundamental knowledge of software engineering. This course will help the students to utilize and exhibit strong communication and interpersonal skills, as well as professional and ethical principles when functioning as members and leaders of multi- disciplinary teams.	
Course Outcomes:	Upon successful completion of the course students will be able to: **CO010212.1** To interpret the problem statement for the software design. **CO010212.2** To understand the requirements of the software efficiently. **CO010212.3** Translate the requirements into the design model with modern tools and apply to solve problems. **CO010212.4** Write the test cases and analyse the software modules. **CO010212.5** Evaluation of software module test cases.	
	COURSE SYLLABUS	
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1	**Software and Software Engineering: [Course Outcome (s): CO010212.1]** software characteristics, software crisis, software engineering paradigms. Planning a Software Project: software cost estimation, project scheduling, personal planning, team structure	10
2	**Software Configuration Management: [Course Outcome (s): CO010212.2]** quality assurance, project monitoring, risk management. Software Requirement Analysis: structured analysis, object-oriented analysis and data modeling, software requirement specification, validation.	10

3	**Design and Implementation of Software: [Course Outcome (s): CO010212.3]** software design fundamentals, design methodology (structured design and object-oriented design), design verification, monitoring and control, coding. **Software Reliability:** metric and specification, fault avoidance and tolerance, exception handling, defensive programming.	10
4	**Testing: [Course Outcome (s): CO010212.4]** testing fundamentals, white box and black box testing,software testing strategies; unit testing, integration testing, validation testing, system testing, debugging Software **Maintenance:** maintenance characteristics, maintainability, maintenance side effects, CASE tools	10

REFERENCE BOOKS

1. Software Engineering, "K. K. Aggarwal&Yogesh Singh", 2E, New Age International, 2005
2. PankajJalote's, "Software Engineering", Wiley India
3. Roger S. Pressman, "Software Engineering- A Practitioner's Approach", Tata McGraw Hill
4. Rajib Mall, "Fundamentals of Software Engineering", PHI Learning Pvt. Ltd.