SIKKIM UNIVERSITY

(A Central University Established by an Act of Parliament of India, 2007)

LEARNING OUTCOME - BASED CURRICULUM

MASTER IN COMPUTER APPLICATIONS

(2 Years)

(With effect from Academic Session 2023-24)

DEPARTMENT OF COMPUTER APPLICATION

SIKKIM UNIVERISTY

6TH MILE, TADONG - 737102

GANGTOK, SIKKIM, INDIA

VICE-CHANCELLOR'S MESSAGE

Sikkim University stands at the forefront of embracing the transformative National Education Policy (NEP) 2020. In alignment with NEP 2020's vision and the guidelines of the Learning Outcomes-based Curriculum Framework (LOCF) mandated by the UGC, we have undertaken a comprehensive revision of our curriculum across all departments. This initiative ensures a holistic educational experience that transcends traditional knowledge delivery, emphasizing the practical application of knowledge in real-world scenarios.The shift towards LOCF marks a pivotal change from teacher-centric to learner-centric education, fostering a more active and participatory approach to learning. Our updated curriculum clearly defines Graduate Attributes, Programme Learning Outcomes (PLOs), and Course Learning Outcomes (CLOs), setting clear objectives for our students to achieve. This revision is designed to enable a teaching-learning environment that supports the attainment of these outcomes, with integrated assessment methods to monitor and encourage student progress comprehensively.

A key innovation in our curriculum is the mandatory integration of Massive Open Online Courses (MOOCs) through the SWAYAM platform, enhancing accessibility and the breadth of learning opportunities for students. Our approach encourages multidisciplinary studies through the curriculum while allowing for specialization. The curriculum embodies the policy's core principle of flexibility by enabling mobility for students, thereby allowing the exit and entry of students in the program.

I extend my heartfelt gratitude to our faculty, the Head of the Department, the Curriculum Development Committee members, the NEP coordinators, and the dedicated NEP Committee of Sikkim University for their relentless dedication to updating our curriculum. I appreciate Prof. Yodida Bhutia, the Chairperson, and all dedicated NEP Committee members for their thorough review and integration of LOCF and NEP components into our curriculum.

To our students, I convey my best wishes as we embark on this journey with our updated and inclusive curriculum, aiming not only to enrich their academic knowledge but also to nurture their personal growth, critical thinking, and ability to adapt and innovate in an ever-changing world.

Best wishes,

Prof. Avinash Khare
Vice Chancellor
Sikkim University

Acknowledgement

The undersigned would like to thank all the following experts for their valuable contributions and suggestions in developing MCA two years curriculum.

1.	Prof Sukumar Nandi	Department of Computer Sc. & Engg., Indian Institute of Technology, Guwahati
2.	Prof Dhruba K Bhattacharyya	Department of Computer Sc. & Engg., Tezpur University, Assam
3.	Prof Sudip Misra	Department of Computer Sc. & Engg., Indian Institute of Technology, Kharagpur
4.	Prof Sandar Ahmed	School of Computational and Integrative Sciences, Jawaharlal Nehru University (JNU), New Delhi
5.	Prof R K Agrawal	School of Computer & Systems Sciences, Jawaharlal Nehru University (JNU), New Delhi
6.	Mr Parameswar Das	Senior Consultant, Tata Consultancy Services Limited (TCS), Kolkata
7.	Mr Deepak Pal	Associate Vice President, JP Morgan
8.	Mr Dibakar Bhattacharjee	Associate Director, Ernst and Young (EY) LLP
9.	Prof Dinabandhu Bhandari	Ex. Senior Delivery Manager, Cognizant & Department of Comp. Sc. Engg., Heritage Institute of Technology, Kolkata
10.	Dr Jayanta K Das	School of Medicine, Johns Hopkins University, Baltimore, Maryland, USA
11.	Prof. Swarup Roy	Department of Computer Applications, Sikkim University
12.	Prof. Rosy Chamling	Department of English, Sikkim University
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16.	Dr Somnath Mukhopadhyay	Department of Computer Applications, Sikkim University
17.	Mrs Chunnu Khawas	Department of Computer Applications, Sikkim University
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19.	Mr Partha P Ray	Department of Computer Applications, Sikkim University
20.	Mrs Lekhika Chettri	Department of Computer Applications, Sikkim University

1. Preamble

The two-year master's programme aims to prepare professionals for the I.T. industry and academic researchers. The design of the curriculum supports the vision of the National Education Policy-2020 (NEP-2020) of India. It emphasizes on the reduced curriculum content to enhance essential learning, promote critical thinking and self-learning. Reduced examination burden and rigorous evaluation through self-learning based critical problem solving are the key features that support the above objectives. While designing, the curriculum, attention also has been given to prepare the students for various competitive examinations.

The programme allows the students flexibility to opt for their preferred elective courses on the advanced topic and latest technologies through Massive Open Online Course (MOOC) offered by SWAYAM and NPTEL.

The core part of the curriculum embodies scientific and engineering knowledge, essential to the profession. Besides the core subjects, the other professional knowledge ingredients, such as professional communications and corporate management basics, has also been added to enrich the curriculum. The syllabus has balanced the core, specialized and elective subjects to provide the students relevant professional knowledge and develop their capacity to tackle new engineering problems, integrating practical and field exercises with challenging project activities. Subjects related to industrial applications such as Database technologies and Web programming are designed in consultation with industry experts to make it more relevant in order to prepare the students industry ready.

2. Programme Outcomes (POs) for MCA

Programme Outcomes (POs)	
PO1	**Inclusive Computational Knowledge:** Students will be able to acquire the complete exposure and full understanding to the theories and practices of Computing, Mathematics, Accounting, Professional Communications, Management and Engineering suitable to the discipline.
PO2	**Problem Identification and Analysis:** Through assignments, presentations, group discussions, Brainstorming activities, Collaborative concept mapping, and critical thinking, students will be able to identify and analyze problems and in so doing articulate the key requirements based on their rational thinking ability and by reviewing different available literatures.
PO3	**Design and Development of Solutions:** Through assignments and projects, students will be able to design innovative methodologies and applications by applying the knowledge of mathematics and computing fundamentals for any given requirement considering the societal as well as environmental aspects.
PO4	**Investigations of Complex Computing Problems:** Through laboratory experiments and projects, students will be able to accomplish investigations and experiments to examine and construe data of complex applications to determine valid solutions.
PO5	**Usage of Contemporary Tool and Models:** Students will be able to identify, choose and apply current techniques and modern tools that suit the computing requirements.
PO6	**Research skills and Professional ethics:** Students through this program will be able to enhance their research skills essential to function competently as an individual and as a leader in multidisciplinary projects thereby fulfilling the given task. Further, students will be capable of understanding the professional, security, social, ethical issues that are mandatory to survive in a society.
PO7	**Communication Efficacy:** Through individual / group presentations, class discussions, Brainstorming activities and collaborative concept mapping, Students with their sturdy communication skills will be able to communicate effectively across multidisciplinary teams to achieve a common goal.
PO8	**Innovations and Employments:** Students will be able to establish a culture that focus on Innovation thereby paving a way for employment opportunities in future by inculcating the knowledge of Computing, Engineering, Accounting, Communication skills, Research skills and Management principles.

3. Course Coding Scheme

3.1 Adopted Course Code

CA-A-BCD

3.2 Acronym used in Course Code

CA – Computer Applications

3.3 Coding for the Papers

Four characters Alpha-Numeric code is used as Paper Code:

A	B	CD
C-Core Subject **S-** Ability/Skill enhancements **P-** Practical / Laboratory **R-**Dissertation **E-**Elective **I-**Internship **V-**Valued-Added Course	**Level:** 5-6	**Paper Code:** Odd Sem: 01-49 Even Sem: 51-99

Example: CA-I-653 is an internship to be pursued in the fourth semester and the third paper in that semester.

4. Programme Structure

4.1 Total Credits: 96

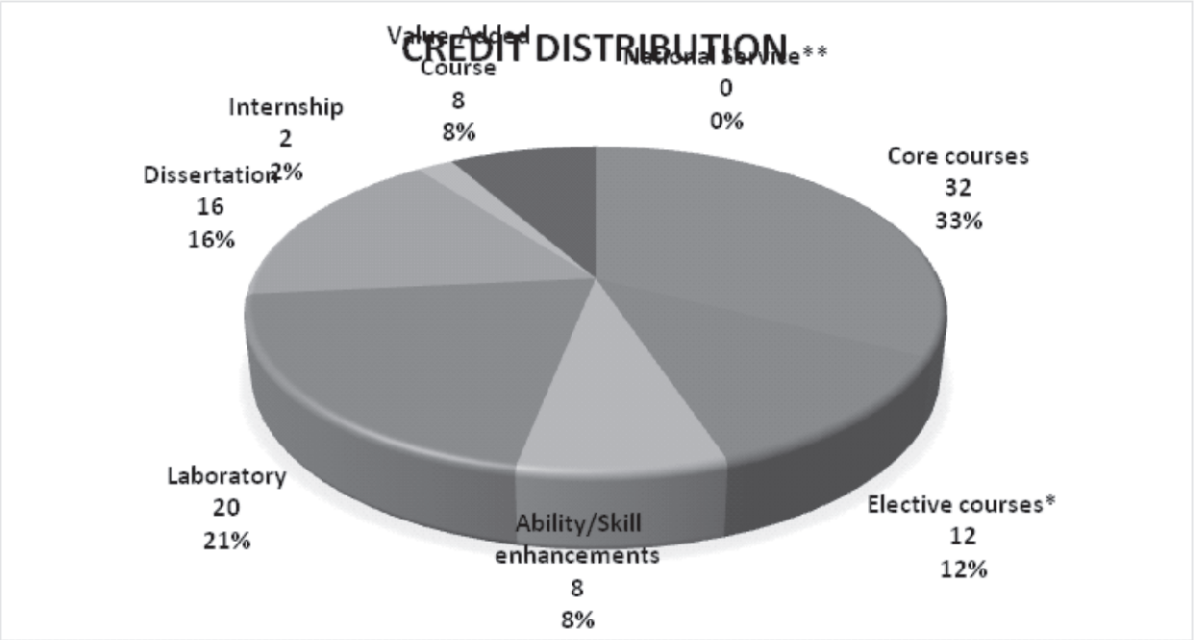
4.2 Structure of the curriculum

Sl	Course category	Number of courses	Credits per course	Total credits	Marks
1	Core courses	8	4	32	800
2	Elective courses*	3	4	12	300
3	Ability/Skill enhancements	2	4	8	200
4	Laboratory	5	4	20	500
5	Dissertation	1	16	16	350
6	Internship	1	2	2	50
7	Value-Added Course	2	4	8	200
8	National Service**			0	
		22		**96**	**2400**

***** Two out of three elective courses will be offered from SWAYAM platform depending on student's interest and departmental recommendations and these courses can be completed in any semester during the MCA programme.

****** The students shall complete the requirements of "National Service" by doing some service in their own village, towns, etc. for a period of 30 days during the winter vacation between I and II semesters. The reports of such service shall be evaluated by the departments concerned and adjudged "Satisfactory" or "Not Satisfactory". If the report is "Not Satisfactory", they will not be eligible for the degree. It is exempted only for NSS volunteers who have completed 120 hours of service.

4.1 Total Credit Share



4.3 Course Layout for MCA Programme (Year 2023 Onwards)

SEMESTER I								
SC	**Subject Name**	**L**	**T**	**P**	**IS**	**ES**	**TM**	**C**
CA-V-501	Indian Contributions to Computer Science	3	1	0	50	50	100	4
CA-C-502	Discrete Mathematics	3	1	0	50	50	100	4
CA-C-503	Programming using C and Python	3	1	0	50	50	100	4
CA-S-504	Professional Communications	3	1	0	50	50	100	4
CA-S-505	Management Concepts & Practices	3	1	0	50	50	100	4
CA-P-506	C and Python Programming Laboratory	0	0	4	50	50	100	4
Total:							**600**	**24**

SEMESTER II								
SC	**Subject Name**	**L**	**T**	**P**	**IS**	**ES**	**TM**	**C**
CA-C-551	Data Structure and Algorithm	3	1	0	50	50	100	4
CA-C-552	Object Oriented Programming in C++ & Java	3	1	0	50	50	100	4
CA-C-553	Operating System	3	1	0	50	50	100	4
CA-C-554	Formal Language and Automata Theory	3	1	0	50	50	100	4
CA-P-555	Object Oriented Programming Laboratory	0	0	4	50	50	100	4
CA-P-556	Data Structure Laboratory	0	0	4	50	50	100	4
Total:							**600**	**24**

SEMESTER III								
SC	**Subject Name**	**L**	**T**	**P**	**IS**	**ES**	**TM**	**C**
CA-V-601	Cyber Security	3	1	0	50	50	100	4
CA-C-602	Database Management System	3	1	0	50	50	100	4
CA-C-603	Software Engineering	3	1	0	50	50	100	4
Elective-I – Student can choose any one Elective From E-604 to E-614		**3**	**1**	**0**	**30**	**50**	**50**	**4**
CA-E-604	Data Science	3	1	0	50	50	100	4
CA-E-605	Machine Learning	3	1	0	50	50	100	4
CA-E-606	Artificial Intelligence	3	1	0	50	50	100	4
CA-E-607	Data Mining	3	1	0	50	50	100	4
CA-E-608	Cryptography & Network Security	3	1	0	50	50	100	4
CA-E-609	Cloud Computing	3	1	0	50	50	100	4
CA-E-610	Internet of Things	3	1	0	50	50	100	4
CA-E-611	Bioinformatics	3	1	0	50	50	100	4
CA-E-612	Operation Research	3	1	0	50	50	100	4
CA-E-613	Digital Image Processing	3	1	0	50	50	100	4
CA-E-614	Introduction to Computer Networks	3	1	0	50	50	100	4
CA-P-615	Web Programming Laboratory	0	0	4	50	50	100	4
CA-P-616	Database Laboratory	0	0	4	50	50	100	4
Total:							**600**	**24**

SEMESTER IV								
SC	**Subject Name**	**L**	**T**	**P**	**IS**	**ES**	**TM**	**C**
CA-E-651	Elective-I (MOOC)	3	-	-	50	50	100	3
CA-E-652	Elective-II (MOOC)	3	-	-	50	50	100	3
CA-I-653	Internship	-	-	10	0	50	50	2
CA-R-654	Dissertation	0	0	12	150	200	350	16
Total:							**600**	**24**

Abbreviations:

MOOC	Massive Open Online Course	**TM**	Total Marks
SC	Subject Code	**C**	Credits
IS	In-Semester Marks		
ES	End-Semester Marks		

4.4 Mapping of Courses with Program Outcomes (POs)

Semester	Course Code	Course Name	Program Outcomes (POs)							
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
I	CA-V-501	Indian Contributions to Computer Science	✓						✓	✓
	CA-C-502	Discrete Mathematics	✓			✓			✓	✓
	CA-C-503	Programming using C and Python	✓			✓	✓		✓	✓
	CA-S-504	Professional Communications	✓					✓	✓	✓
	CA-S-505	Management Concepts & Practices	✓				✓		✓	✓
	CA-P-506	C and Python Programming Laboratory		✓	✓	✓	✓		✓	✓
II	CA-C-551	Data Structure and Algorithm	✓			✓			✓	✓
	CA-C-552	Object Oriented Programming in C++ & Java	✓			✓	✓		✓	✓
	CA-C-553	Operating System	✓			✓			✓	✓
	CA-C-554	Formal Language and Automata Theory	✓			✓			✓	✓
	CA-P-555	Object Oriented Programming Laboratory		✓	✓	✓	✓		✓	✓
	CA-P-556	Data Structure Laboratory		✓	✓	✓	✓		✓	✓
III	CA-V-601	Cyber Security	✓				✓		✓	✓
	CA-C-602	Database Management System	✓		✓		✓		✓	✓
	CA-C-603	Software Engineering	✓		✓		✓		✓	✓
	CA-E-6XX	Elective-I	✓		✓				✓	✓
	CA-P-615	Web Programming Laboratory		✓	✓	✓	✓		✓	✓
	CA-P-616	Database Laboratory		✓	✓	✓	✓		✓	✓
IV	CA-E-651	Elective-I (MOOC)	✓					✓	✓	✓
	CA-E-652	Elective-II (MOOC)	✓					✓	✓	✓
	CA-I-653	Internship		✓	✓	✓	✓	✓	✓	✓
	CA-R-654	Dissertation		✓	✓	✓	✓	✓	✓	✓
XX: Elective Subjects										

5. Assessment

The performance of the student will be assessed through continuous evaluation and end-semester examination. However, the internship performance will be evaluated once as a part of the end semester examination.

5.1 Continuous Evaluation

Except for dissertation, performance in all the core course subjects to be evaluated in continuous evaluation mode that involves grading through three assignments and two sessional examinations. To make the course more outcome-based, emphasis has been given on unit-wise assignment works. Students need to submit three assignments, which may be report type or coding based (supplemented with report).

Assignment (A)	Sessional-I (B)	Sessional-II (C)	Internal Mark
Average of best two scores out of three assignment scores (Assignment-I, II, III).	Preferably through written test.	Preferably through written test.	Average of best two scores out of three scores from A, B, C.

In the case of laboratory subjects, the internal marks may be assigned through the students' continuous performance in the laboratory works, regular report book submission and/or through sessional examinations. However, the concerned teacher may adopt any suitable way to evaluate the same.

5.2 End Semester Examination

Aligning with the prevailing question paper patterns adopted by the University, the marks distribution for the ***theory paper*** will be as follows.

Part No.	Question Type	Number of questions	Total Questions to attempt	Unit Coverage	Marks for each question	Total Marks	Duration
I	Very Short (Multi-Option, Single Word-Answer, fill-up the blanks, True/False etc.)	10	10	All the four units.	1	10	2.5 hrs
II	Short	5	4	Four questions from each unit. Rest	5	20	

				one from any or combination of units			
III	Descriptive	4	2	Four questions from each unit.	10	20	
	Grand Total	**19**	**16**			**50**	

5.3 Dissertation

In dissertation, the internal marks will be assigned based on the overall understanding and involvement in the project work assigned and will be evaluated through three seminars and viva voce. The distribution of marks may be as follows.

Supervisor (S) Assessment	Department Assessment (Other than supervisor (s))	Internal Marks	External	Total
75 (50% of total internal marks)	75 (50% of total internal marks) (Cumulative assessment score based on continuous performances)	150	200	350

The dissertation work will be evaluated by the external expert or internal committee (in the absence of expert) based on the dissertation report, seminar and viva voce.

5.4 Internship Evaluation

The internship may be pursued during summer break or winter vacation (after 2nd Sem or 3rd Sem). A student may continue Internship program with Dissertation (if undergoing in the same company/organization). In the case where the external internship is not available, the student may undergo an in-house internship programme within the department or any other departments. However, it will be evaluated during the fourth semester. Marks will be assigned as follows.

Supervisor from Hosting institute	Department Assessment	Total
25 (50% of total marks)	25 (50% of total marks) (Cumulative assessment score based on single seminar)	50

5.5 Elective Subjects though MOOC

- There are three elective courses. One in the third semester with 04 credits and two in the fourth semester with 03 credits each.
- Two of them are proposed to be pursued through SWAYAM/NPTEL to get more advanced or latest knowledge. A total of 06 credits to be earned through MOOC, which is approximately 6.25% of the total credit.

- Students are free to select the courses in consultation with department faculty coordinator designated for the MOOC, subject to approval by the department.
- A student may register and complete the necessary credits through SWAYAM/NPTEL at any point of time within two years. The final marks earned through MOOC to be submitted by the coordinator, based on the mark sheet by the end of the respective semester.
- The internal and external marks awarded by the MOOC course hosting institutes will be scaled down to **30/70** to match the Sikkim University marking system (if necessary).

6 Post Graduate Attributes

Attribute 1: Attainment of deep, comprehensive, and cohesive knowledge of computer science.

Graduates shall attain in-depth, comprehensive knowledge and understanding of various aspects of computer science and apply the same in multi-disciplinary or multi-professional intellectual practices.

Attribute 2: Creative solutions through critical thinking for solving programming problem leading to value addition and positive changes.

Graduates shall evolve as effective problems-solvers and shall able to apply critical, creative and evidence-based thinking to conceive innovative computational solutions for meeting the expectations of challenges and respond amicably.

Attribute 3: Promote Efficient Communication and Teamwork.

Graduates shall attain the ability to conceive and effectively communicate ideas and information influentially to a range of audiences and convince them to contribute and collaborate towards the attainment of common goals.

Attribute 4: Promote professionalism and leadership readiness.

Graduates shall attain the ability and attributes of an able entrepreneur and shall efficiently take a lead in their profession for organisational prosperity.

Attribute 5: Adopt a culture of fair, honest and integrity in creation and communications of knowledge and promote Ethical competency.

Graduates shall attain the ability to exhibit high ethical competency in the creation and communication of knowledge related to academics and research.

Attribute 6: Embrace Digital capabilities and effectively harness digital competencies.

Graduates shall prepare for living, learning, and working by harnessing digital competencies for building optimal solutions to problems in the real world.

Attribute 7: Self-awareness and emotional intelligence

Graduates shall provide constructive, resilient, and intellectually reflective feedback, exhibiting high integrity and fulfilling their responsibilities.

Detailed Syllabus First Semester

MCA
CA-V-501
INDIAN CONTRIBUTIONS TO COMPUTER SCIENCE

Semester: First Semester **Course Level: 500** **Total Marks: 100**
L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+ Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:
CLO1: Learn about Indian ancient contributions to Computer Science
CLO2: Learn about contribution of Computer Scientists and Technologists.
CLO3: Revisit evolution of Indian Computers.
CLO4: Learn about Information Technology Revolutions.
CLO5: Learn about Future perspectives of Computer Science in India.

Unit-I: Historical Perspectives

- The Idea of Zero, The Decimal System, Numeral Notations, Fibonacci Numbers, Binary Numbers, National Centre for Software Technology- Origin, Activities and Contribution, National Informatics Centre: Evolution and its Impact, Impact of Computer Science Education in India.
- Computer Scientists and Technologists from India and their contribution.

Unit-II: Towards Indigenous Computer and Supercomputers

- India's First Computer - TIFRAC, ISIJU- technical specifications, Indigenous Computer: Role of ECIL, Supercomputers - History, Challenges, PARAM, Pratyush, Mihir.

Unit-III: Innovation and prospects in the Indian IT industry

- The Indian Software Industry-Past, Present, and Future, Evolution of Information Technology in India, The Potential of the Unique Identity Number in India.

Unit-IV: Future perspectives

- Computer Architecture from 1970-2030, Software Engineering, Wireless Technology and Services in India, Quantum Computation, Computational Biology, System-wide Computerization of India's Grid Operations.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the faculty member can innovate any)

- Facts findings.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Any current literature (online & offline), Research Papers, web articles, blogs, online& offline lecture notes/slides.
- Homi Bhabha and The Computer Revolution, Oxford Publications.

Semester I
CA-C-502
DISCRETE MATHEMATICS

Semester: First Semester **Course Level: 500** **Total Marks: 100**

L+T+P:3+1+0 = 4 Credits **Lecture: 45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Construct mathematical arguments using logical connectives and quantifiers.

CLO2: Perform operations on discrete structures such as sets, functions, relations or sequences.

CLO3: Solve problems using counting techniques and combinatorics.

CLO4: Construct proofs using direct proof, proof by contradiction, and proof by cases, or mathematical induction.

CLO5: Verify the correctness of an argument using symbolic logic and truth tables.

CLO6: Solve problems involving recurrence relations and generating functions.

CLO7: Apply algorithms and use definitions to solve problems to proof statements in elementary number theory.

UNIT-I: SET AND RELATION THEORY

- Sets: Operations on Sets, De Morgan's Laws, Power Set, Cartesian Product, Equivalence relation, Partition of a Set, Partial order on a set.Relations, Ordered Pairs, Cartesian product of Sets,
- Relations: Types of relations, equivalence relations, Partial Ordering, Equivalence Class, Properties of Equivalence Class.

UNIT-II: FUNCTION & COMBINATORICS

- Function: Definition of function, Injective, Surjective function, Bijective function, Composition of two functions, Inverse Function
- Combinatorics: Review of Permutation and Combination, Pigeon Hole Principle, Cardinality and Countability, Principle of Inclusion and Exclusion, Generating Function, Recurrence Relations.

UNIT-III: PROPOSITIONAL LOGIC AND PREDICATE CALCULUS

- Propositional logic: Prepositions, Logical Operations, Tautologies, Negation, Contradiction, Contraposition, Mathematical Induction, Logical Implication, Logical Equivalence, Normal Forms, Theory of Inference and Deduction,
- Predicate calculus: Predicates and Quantifiers.

UNIT-IV: BASICS OF GRAPH THEORY & LATTICES AND BOOLEAN ALGEBRA

- Graph theory: Graph as a Discrete Structure, Terminologies and Properties, graph Traversal, and Spanning Trees.Introduction, POSET, Hasse Diagram, Well Ordered Set,
- Lattices: Properties of Lattices, Bounded Lattices, Complemented and Distributive Lattices, Boolean Algebra.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.
- Solving case studies.
- Discussing competitive examinations questionnaires.
- Individual and group presentations by students on selected topics.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Lipschutz, Seymour (2017). Discrete Mathematics, Schaum's Series.
- Gersting (2014). Mathematical Structure for Computer Science, WH Freeman & Macmillan.
- Tucker, A. (2012). Applied Combinatorics, 6/e, Wiley.
- Liu, C. &Mohapatra, D. P. (2008). Elements of Discrete Mathematics, 3/e, Tata-McGraw Hill.
- Koshy, T. (2003). Discrete Mathematics with Applications, Academic Press.
- Hein, J. (2009). Discrete Structures, Logic, and Computability, 3/e, Jones and Barlett.

SEMESTER I
CA-C-503
PROGRAMMING USING C AND PYTHON

Semester: First Semester **Course Level: 500** **Total Marks: 100**

L+T+P:3+1+0= 4 Credits **Lecture: 45 Hrs+Tutorial:15 Hrs+ Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Analyze, design and build logical solutions for problems.

CLO2: Use appropriate programming constructs to realize computational algorithms.

CLO3: Choose appropriate data structures to represent data items in the real world.

CLO4: Manage I/O operations through C and Python program.

CLO5: Apply code reusability with functions and pointers.

UNIT-I: IMPERATIVE PROGRAMMING & CONTROL FLOW

- Overview of C and Python, Execution, Debugging, Constants, Variables and Data Types,
- Input and Output Operations, Operators and Expressions, Operator Precedence.
- Conditional Statements, Looping, Control statements

UNIT-II: ARRAYS,STRINGS AND COLLECTIONS

- Array declaration, Initialization of Single and Multi-dimensional array.
- String Initialization, Display, String manipulation functions, array of strings in C. Searching, Looping and Counting, String Methods, in Operator, String Comparison, and String Operations in Python.
- List, Tuples, Set, Dictionaries in Python.

UNIT-III: FUNCTIONS & POINTER IN C

- Defining a function, accessing a function, passing arguments to a function, specifying argument data types, function prototypes and recursion, passing arrays to a function. Argument types, Anonymous functions, Importing module, Math module, Random module, Packages in Python (NumPy and Pandas).
- Introduction to pointers, declaration, Call-by-value and reference, pointer and arrays, and pointer as function arguments, Dynamic memory allocation.

UNIT-IV: STRUCTURES AND UNIONS IN C, CLASSES AND OBJECTS IN PYTHON AND FILE MANAGEMENT

- Defining and processing of structure and union, Array of structure, array within structure, and passing of structure as argument.
- Class Definition, Creating Objects.
- Introduction to files, Defining and Opening a File, Closing & Deleting a File, Input/Output Operations on Files.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.
- Solving case studies.
- Discussing competitive examinations questionnaires.
- Individual and group presentations by students on selected topics.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Y. Kanetkar (2004). Let us C, BPB Publication.
- E. Balaguruswami (2004). Programming in ANSI C 2nd Edition, Tata Mcgraw Hill.
- Y. Kanetkar (2017). Let us Python 2nd Ed, BPB Publication.
- E. Balagurusamy (2017). Introduction to Problem Solving with Python Tata Mcgraw Hill.
- Dierbach, Charles (2012). Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley Publishing.

SEMESTER I
CA-S-504
PROFESSIONAL COMMUNICATIONS

Semester: First Semester **Course Level: 500** **Total Marks: 100**

L+T+P:3+1+0=4 Credits **Lecture: 45 Hrs+Tutorial:15 Hrs+ Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Understand the prevailing hurdles, necessary corrective measures and improvisation for meeting the demand of the nature of communication.
CLO2: Communicate fluently with confidence abiding by the grammatical rules.
CLO3: Demonstrate Cohesion and Competence in Oral Discourse.
CLO4: Write contextual correspondence through sound writing practices.
CLO5: Design and deliver effective presentations.

UNIT-I: BASICS OF COMMUNICATION

- Introduction to Professional Communication Essentials of grammar and vocabulary, Parts of Speech, Punctuation, Articles, Tenses, Voices, Degrees of comparison, Synonyms and Antonyms, Confusable, Homonyms, Homophones, Homographs, Word formation, Root Words, Use of Prefixes and Suffixes, Collocations.

UNIT-II: PROFESSIONAL READING SKILLS

- Reading and its importance, Techniques for effective reading, improving comprehension skills, Skimming and Scanning, understanding messages and factual information; Non-verbal signals, reading and information transfer, Inference, Reader Anticipation, Determining the meaning of words, Summarizing.

UNIT-III: PROFESSIONAL WRITING SKILLS

- Letter Writing (Format and Styles), Letter of apology, Letter of Complaint, Letter of Inquiry and Letter of Requisition with reply, Professional Report Writing, Note Making, Technical Report, Types of Report, Business Correspondence, Official Communication and other business writing, memos, circulars, notices, agenda, minutes, advertising, E-mail etiquette.

UNIT-IV: PROFESSIONAL ORAL COMMUNICATION SKILLS

- Professional Communication barriers, Speaking for Professional Purposes, Starting discussion, Public speaking and Group Discussion, Interview Strategies, Corporate etiquette, Leadership function, voice modulation, body language, Presentation and Meeting skills, disagreeing and stress management.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

- Solving case studies.
- Discussing competitive examinations questionnaires.
- Individual and group presentations by students on selected topics.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Michael Swan (2017). Practical English Usage, Oxford University Press.
- Board of Editors (2016). Fluency in English- A Course book for Engineering Students, Hyderabad: Orient Blackswan Pvt. Ltd.
- Meenakshi Raman & Sangeeta Sharma (2015). Technical Communication _ Principles and Practice,. 3rd Ed, Oxford University Press.
- David Green (2014). Contemporary English Grammar - Structures and Composition: Macmillan India.
- M. Ashraf Rizvi (2015). Effective Technical Communication, Tata McGraw Hill.
- Sanjay Kumar &PushpLata (2013). Communication Skills, Oxford University Press.
- Kelly M. Quintanilla, & Sharon T. Wahl (2011). Business and Professional Communication: for workplace excellence, Sage Publication, India.

SEMESTER I
CA-S-505
MANAGEMENT CONCEPTS & PRACTICES

Semester: First Semester **Course Level: 500** **Total Marks: 100**

L+T+P:3+1+0=4 Credits **Lecture: 45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Understand and implement basic concepts of management in the workplace

CLO2: Discuss organization and the roles of managers.

CLO3: Understand the concepts related to management, managerial functions and skills

CLO4: Understand the complexities in decision making, the need for Decision making environment, models and associated tools

CLO5: Understand the need and importance of various Disciplines in Management

CLO6: Use ICT tools for performing various managerial operations.

UNIT-I: Introduction to Management, Managerial Functions, Managerial Skills And Types Of Managers

- The need for management, scope, meaning and definition, The process of Management, Managerial levels/Hierarchy, Managerial functions including Planning, Organizing, Staffing, Directing, Controlling; Managerial skills including Technical, Conceptual, Human Resource, Manger types including Functional, Specialize, Generalize, Line and staff managers

UNIT-II: Decision making environment, Decision Types /models and Decision-making tool

- Decision making environment: Open Systems, Closed system, Decision making under certainty, Decision making under uncertainty, Decision making under risk Decision Types /models: Structured decisions, Unstructured decisions, Programmable decisions, Non programmable Decisions, Classical Model, Administrative model Decision making tools: Autocratic, Participative, Consultative, Herbert Simon's Model Principle of Rationality / Bounded Rationality

UNIT-III: Management Disciplines

- Basics of Marketing Management: Marketing and concepts of Marketing, Marketing Management, Marketing environment, Marketing Research, Market Segmentation, Marketing Planning. Basics of Human Resource Management: Human resource planning, Analyzing work and Designing Job, Performance appraisal and Incentive-Based Payments, Work Stress. Basics of Financial Management: Meaning and nature of financial management, Financial Statements.

UNIT-IV: Use of computers for managerial applications

- Technology issues and data and information processing in organisations, Introduction to Information Systems, shift in Information system thinking, latest trends in Information Technology, Computer Based Information Systems, office automation systems, decision making and MIS, transaction

processing systems, decision support system, Group Decision Support, Executive Information systems, DSS generator.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.
- Solving case studies.
- Discussing competitive examinations questionnaires.
- Individual and group presentations by students on selected topics.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Shejwalkar P.C (2005). Principles and Practices of Management, Everest Publishing House.
- Koontz H & Weitrich H (2015). Essential of management, Tata McGraw-Hill Publication.
- Burton & Thakur (1998). Management Today Principles and Practices, Tata McGraw-Hill Publication.
- Ivancevich & Gibson, Donnelly (1989). Management Principles and Functions, BPI/Irwin.
- Anil Kumar, Pardeep Gupta, Pardeep Ahlawat (2018). Computer Application in Business. Free Book centre, Net.
- Parameswaran (2008). Computer Applications in Business, R. S. Chand Publishing House

SEMESTER I
CA-P-506
C AND PYTHON PROGRAMMING LABORATORY

Semester: First Semester **Course Level: 500** **Total Marks: 100**

L+T+P:0+0+4 = 4 Credits **Lecture: 45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

- Apply Branching and Looping for solving computational problems.
- Design and implement algorithms using arrays and strings.
- Solve problems using multi-dimensional arrays.
- Apply the concepts of functions and pointers to arrays and strings.
- Experiment with Structure, Union and Files.
- Execute programs using command line argument.

UNIT-I: OPERATORS AND EXPRESSIONS AND BRANCHING AND LOOPING

1. Program (and draw a flowchart) that reads three numbers, calculates and prints their sum and average.
2. Program that calculates and outputs the area, perimeter of a rectangle whose length is L cm, width is W cm.
3. Program to calculate the area of a circle where radius R is given.
4. Program to read the temperature in centigrade degree (C) and change it into Fahrenheit (F) and vice versa, where,
   a) F = (9 * C + 160)/5;
   b) C = (5 * F- 160)/9

c) Program to read the coefficients a, b, c of a quadratic equation and find the roots of the equation.

d) Program to read two numbers that represent the length of two sides of a right triangle; compute and print the length of the hypotenuse (which is the square root of the sum of the squares of the lengths of the two sides).

e) Program that converts angles from degrees to radians. To convert an angle from degree to radians, you multiply the angle by / 180.

f) Program to swap two numbers (Using and without using third variable).

g) Program to find the largest among three numbers.

h) Program to reverse a given number. Ex: 325 -> 523

i) Program to accept an integer and find the sum and product of all the digits. Ex: 325 -> 3+2+5 = 10

j) Program to compute Power of XY.

k) Program to generate all prime numbers within range 1 – 100.

l) Program to generate all odd/even numbers within range 1 – 100.

m) Program to generate Fibonacci Series up to N terms. (1 1 2 3 5 8 13.....)

n) Program to find GCD of two numbers.

o) Program to check whether a number is a Armstrong no. of the following form or not: 371 = 33 +73+13 .

p) Program to compute the summation of following series:
   a. 1+2+3+.....+n
   b. 1+x+x2+x3+.....+xn
   c. 1 + x + x2/2! + x3/3! +.....+ xn /n!
   d. 1 – x + x2/2! - x3/3! +.....+ xn /n!

UNIT-II: ARRAY AND STRING

q) Program to find Sum and Average of numbers in an array.
r) Program to find an element in an array using:
   a. Linear Search b. Binary Search.
s) Program to insert and delete elements in an array.
t) Program to sort a set of numbers using:
   a. Bubble Sort b. Selection Sort c. Insertion Sort.
u) Program to convert a decimal number into binary number and visa versa.
v) Program to add and subtract two Matrix.
w) Program to Multiply two Matrix.
x) Program to implement Stack data structure.
y) Program to check whether a square matrix is magic square or not.
z) Program to compute: D = (A * B) – (C+D) [A, B, C, D are matrices]
aa) Program to check whether a string is Palindrome or not.
bb) Program to find length of a string.
cc) Program to implement string copy, compare, sub-string, etc.

UNIT-III: FUNCTION AND POINTER

dd) Program to find Factorial of a number using Recursive function.
ee) Program to find GCD of two numbers using Recursive function.
ff) Program to generate Fibonacci Series using Recursive function.
gg) Program to implement above problem (30, 31, 32) using user-defined function.
hh) Program to reverse an entire array using function.
ii) Write C Program to demonstrate Call by value and Call by address.
jj) Write C Program to find Sum and Average of numbers in an array by passing array to a function using Pointer.
kk) Write C Program to find length of string using Pointer.
ll) Write C Program to multiply two matrices using pointer.

UNIT-IV: Structure-Union, Class-Objects, File handling and Commands line Arguments

mm) Program to manipulate employee records.
nn) Program to add and subtract two complex numbers using structure.
oo) Program to implement Link List using Self-referential structure.
pp) Program to Open and Close a file.
qq) Program to Copy one file to another file.
rr) Program to merge two files.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.
- Solving case studies.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of	

summative assessment.

SUGGESTED READINGS:

- Y. Kanetkar (2004). Let us C, BPB Publication.
- E. Balaguruswami (2004). Programming in ANSI C 2nd Edition, Tata Mcgraw Hill.
- Y. Kanetkar (2017). Let us Python 2nd Ed., BPB Publication.
- E. Balagurusamy (2017). Introduction to Problem Solving with Python, Tata Mcgraw Hill.
- Dierbach, Charles (2012). Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley Publishing, 2012.

Detailed Syllabus Second Semester

SEMESTER-II
CA-C-551
DATA STRUCTURE AND ALGORITHM

Semester: Second Semester **Course Level: 500** **Total Marks: 100**

L+T+P:3+1+0 = 4 Credits **Lecture: 45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Understand data structures: Introduction, types, and ADTs.
CLO2: Implement linear data structures: Linked lists, arrays, stacks, queues, and deques.
CLO3: Apply searching and sorting techniques for linear data structures.
CLO4: Explore non-linear data structures: Trees, graphs, binary search trees, AVL trees, and B-trees.
CLO5: Understand hashing: Hash functions, collision resolution, and rehashing.
CLO6: Traverse graphs and apply minimum spanning tree and shortest path algorithms.
CLO7: Analyze algorithms: Time and space complexity, asymptotic notations.
CLO8: Understand greedy and dynamic algorithms together with NP problems.

UNIT-I: LINEAR DATA STRUCTURE

- Introduction to Data Structure: Definition, Types, Abstract Data Type (ADT), Array and List Representation.
- Linear Data Structure: Linked list, Array and List representation of Stack, Queue, Dequeues, and Circular queue, Expression evaluation, Searching & Sorting techniques

UNIT-II: NON-LINEAR DATA STRUCTURE

- Introduction to Non-Linear Data Structure: Terminologies of Tree and Graph, Representation of Tree & Graph, Binary Trees, Tree traversals, Searching, insertion and deletion operation in a Binary Search Tree, AVL tree, and B tree.
- Introduction to Graph and its terminologies: Breadth-first and Depth-first Search. Minimum Spanning tree, Kruskal's & Prim's algorithms, Shortest path algorithms.

UNIT-III: HASHING AND ANALYSIS OF ALGORITHM-I

- Hashing, Hash function, Address calculation techniques, Common hashing functions, Collision resolution, Linear probing, Quadratic, Double hashing, Bucket hashing, Deletion and rehashing.
- Time and Space Complexity, Asymptotic notations, Growth of function, Recurrences and their solution methods, Calculating complexity of Insertion, Merge and Heap sort algorithms.

UNIT-IV: ANALYSIS OF ALGORITHMS-II

- Greedy Algorithm: Theoretical foundations for greedy methods, Huffman codes
- Dynamic Programming: Elements of dynamic programming, Matrix-chain multiplication, Longest Common Subsequence.
- NP- Problems: The classes P and NP problems, NP-completeness of the satisfiability problem.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.
- Solving case studies.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Cormen, Leiserson, Rivest & Stein (2022), Introduction to Algorithms, Prentice Hall of India.
- Y Kanetkar (2022), Data Structures Through C, BPB Publication.
- E. Horowitz & S. Sahani (2008), Fundamentals of Algorithms, University Press.
- AM Tanenbaum, Y Langsam and MJ Augustein (2019), Data structure using C, Prentice Hall India.
- S Lipschutz (2006), Data Structures, TMH.

SEMESTER-II
CA-C-552
OBJECT ORIENTED PROGRAMMING IN C++ & JAVA

Semester: Second Semester **Course Level: 500** **Total Marks: 100**

L+T+P:3+1+0 = 4 Credits **Lecture: 45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Understand Object-Oriented Programming and Basics of C++ and Java.

CLO2: Comprehend and Implement Inheritance and Polymorphism in C++ and Java.

CLO3: Understand and Implement Threads, Array & String Handling in Java.

CLO4: Handle Exceptions, Develop GUI Programs, and Implement Networking in Java.

CLO5: Understand and Use Constructors, Destructors, and Method Overloading in C++ and Java.

CLO6: Implement Advanced Features like Virtual Functions and Abstract Classes.

CLO7: Utilize Java Utilities Package and Implement Synchronization in Java Threads.

UNIT-I: OBJECT ORIENTED PROGRAMMING, INTRODUCTION TO C++ AND JAVA, CLASS AND OBJECTS

- Basic concepts of OOP (Abstraction, Encapsulation, Inheritance, Polymorphism), procedural programming vs. OOP. Features, Lexical Issues, Data Types, Variables, Arrays, Operators, Control Statements
- Concept of class and objects, Constructors, Destructor, Method overloading, Static methods.

UNIT-II: INHERITANCE, POLYMORPHISM

- Types of inheritance, Defining derived class, Abstract class, Access specifiers-public, private and protected; public and private inheritance, accessing base class members, ambiguity in multiple inheritance in C++, virtual base classes.
- Interface in Java. Compile time polymorphism-operator overloading, function overloading, Run-time polymorphism- Virtual function, and pure virtual function in C++.

UNIT-III: THREADS IN JAVA, ARRAY & STRING HANDLING IN JAVA

- Creation, Synchronization, Runnable Interface, Deadlock, Suspending, Resuming and stopping threads, Multithreading.
- Operation on String, Mutable & Immutable String, Using Collection Bases Loop for String, Tokenizing a String, Creating Strings using StringBuffer, Use of ArrayList & Vector.

UNIT-IV: EXCEPTION HANDLING, GUI PROGRAMMING IN JAVA, NETWORKING IN JAVA

- Exceptions & Errors, Types of Exception, Control Flow, Use of try, catch, finally, throw, throws.
- Working with Windows, Graphics, and Text, AWT Controls, Layout Managers, and Menus, Images, Java Utilities (java.util Package).
- Connecting and communicating using socket.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Programming practice
- Group discussion

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Balaguruswamy, E. (2017). Object oriented programming with C++, 7th Ed., McGraw Hill.
- Stroustrup, Bjarne (2002). The C++ Programming Language, 3rd Ed., Pearson.
- Schildt, Herbert (2017). Java-The Complete Reference, 10th Ed., Oracle Press.
- Balagurusamy, E. (2006). Programming with Java: A Primer, 3rd Ed., McGraw Hill.
- Eckel, Bruce (2006). Thinking in Java, 4th Ed., Prentice Hall.
- Liang, Y. Daniel (2018). Intro to Java Programming, 10th Ed., Pearson.

SEMESTER-II
CA-C-553
OPERATING SYSTEM

Semester: Second Semester **Course Level: 500** **Total Marks: 100**

L+T+P:3+1+0 = 4 Credits **Lecture: 45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Comprehend the roles, functions, structures and services provided by the operating system Operating Systems.

CLO2: Understand processes and their states, threads, schedulers and CPU scheduling.

CLO3: Understand and analyze issues related to Process Synchronization.

CLO4: Anticipate situations of deadlock and deploy preventive and avoidance mechanisms.

CLO5: Comprehend the mechanisms used in Memory Management, Virtual Memory and associated challenges.

CLO6: Comprehend the concepts of File Systems, secondary storage management and Disk.

CLO7: Synthesize the concepts of I/O management, file system implementation and problems related to security and protection.

UNIT-I: OVERVIEW OF OPERATING SYSTEM AND PROCESS MANAGEMENT

- Introduction to Operating System: Basic Concepts and Terminology, Logical View, User View, Concept of Virtual Machine, Interrupt Concept. Role of Operating System Resource Manager in Memory Management, Device Management.
- Process Concepts, Process Control Block, Process Scheduling, Criteria, algorithms and Evaluation, Job Scheduling, Inter-Process Communication, Communication in Client-Server.

UNIT-II: PROCESS SYNCHRONIZATION & DEADLOCK AND MEMORY MANAGEMENT

- Concept of Synchronization: Requirements, Mechanisms, Critical Section Problem and Monitors. Deadlock, prevention & avoidance, Deadlock Detection, Deadlock Recovery.
- Memory Management: Concept &Techniques, Contiguous & Non-Contiguous allocation, Logical & Physical Memory Conversion of Logical to Physical address, Paging, Segmentation, Segment with paging, Virtual Memory Concept, Demand paging: Page Replacement Algorithms, Allocation of Frames, Page fault.

UNIT-III: FILE MANAGEMENT AND DISK MANAGEMENT

- File Structure: Protection, FILE system Implementation, Directory structure, Free Space Management, Allocation Methods, Efficiency & Performance, Recovery.
- Disk Structure: Disk scheduling algorithm, Disk management, Swap Space concept and Management, RAID structure, Disk performance issues.

UNIT-IV: OPERATING SYSTEM TYPES

- Distributed Operating System: Difference Between Distributed & Centralized OS, Advantages of Distributed OS, Types of Distributed OS, Concept of Global OS, NOS Architecture.
- Linux Operating System: Introduction, Terminal V/s File Manager, File Permissions in Linux/Unix, Linux - Environment Variables, Communication in Linux, Managing Processes in Linux, Introduction to Shell Scripting, System calls, Fork-Join, Shared memory.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Andrew Tanenbaum (2015). Modern Operating Systems4th Edition, Pearson.
- Silberschatz, Galvin, Gagne (2008). Operating System Concepts, 8th Edition,Wiley,
- Dhananjay Dhamdherem (1999). Systems Programming & Operating Systems, 2nd Edition, Tata McGraw-Hill,
- Daniel P. Bovet and Marco Cesati (2006). Understanding the LINUX KERNEL, 3rd Edition, O'Reilly.
- Robert Love (2013). Linux System Programming: Talking Directly to the Kernel and C Library, 2nd Edition, O'Reilly,

SEMESTER-II
CA-C-554
FORMAL LANGUAGE AND AUTOMATA THEORY

Semester: Second Semester **Course Level: 500** **Total Marks: 100**

L+T+P:3+1+0 = 4 Credits **Lecture: 45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Acquire the full understanding of the Automata theory as a basis for all computer science language design.

CLO2: Classify the types of Automata's namely FA, PDA, TM based on the storage mechanism employed by each automaton. Further, carry out the conversion of NFA to DFA and as well perform minimization of Finite Automatons using the minimization strategies.

CLO3: Differentiate the different variants of Automata and its computational power to recognize languages.

CLO4: Analyze variants of grammars namely Regular, Context-Free, Context-Sensitive etc., and thereby generate different languages accepted by variants of automata using the given production rules of grammar.

CLO5: Verify the correctness of an argument, identify limitations of some computational models and determine problems namely Halting Problem, Post Correspondence Problem and Undecidable problems about Languages.

CLO6: Design Finite Automata, Push Down Automata, Turing Machine using the transition functions and graphs; further, design various parser (Top Down and Bottom Up) by constructing parsing table

UNIT-I: THEORY OF COMPUTATION AND FINITE AUTOMATA

- Mathematical Preliminaries, Formal Language, Automata, Types of automata, Application of Automata Theory, Chomsky Hierarchy of Languages and Grammar, Formal definition of Grammar.
- Finite Automata and its types, Non-Deterministic Finite Automata (NFA / NDFA) and its equivalent Deterministic Finite Automata (DFA), Minimization of FA.

UNIT-II: REGULAR EXPRESSION, GRAMMAR AND LANGUAGES

- Regular Set (RS), Regular Expression (RE), Regular Grammar (RG), Regular Language (RL), FA and its equivalence with RE, Context Free Grammar (CFG).
- Context Free Language (CFL), Simplification of CFG, Normal formals in regard to CFG (Chomsky and Greibach Normal Forms (CNF and GNF)), Context Sensitive Grammar (CSG), Context Sensitive Language (CSL), Unrestricted Grammar, Recursively Enumerable Language, Closure Properties of RL, CFL, CSL and Recursively Enumerable Language.

UNIT-III: PARSING AND PUSH DOWN AUTOMATA

- Parsing and its types, Parser (LL, LR), Derivation Techniques, Representation of Derivation / Parse Tree, Ambiguity in CFG, Design of any one type of Parser (LL/LR)
- PDA and its types, Non-Deterministic Push Down Automata (NPDA), NPDA and its equivalence with CFG

UNIT-IV: TURING MACHINE, COMPUTATIONAL COMPLEXITY & UNDECIDABILITY

- TM and its types, Universal TM, Halting Problem, Post Correspondence Problem, Measuring and Classifying Complexity, Church Turing Thesis and Undecidable problems about Languages.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving / Brainstorming activities.
- Individual / Group Presentations.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Peter Linz (2016). An Introduction to Formal Languages and Automata, 6/e, Jones & Bartlett.
- Hopcroft, Motwani and Ullman (2008). Introduction to Automata Theory, Languages and Computation, 3/e, Pearson.
- K.L.P. Mishra & N Chandasekharan (2006). Theory of Computer Science: Automata, Languages and Computation, PHI.
- C.K. Nagpal (2011). Formal Languages and Automata Theory, Oxford Higher Education.
- Shyamalendu Kandar (2013). Introduction to Automata Theory, Formal Languages and Computation,1/e, Pearson.
- Vivek Kulkarni (2013), Theory of Computation, Oxford Higher Education.

SEMESTER-II
CA-P-555
OBJECT-ORIENTED PROGRAMMING LABORATORY

Semester: Second Semester **Course Level: 500** **Total Marks: 100**

L+T+P:0+0+4= 4 Credits **Lecture: 45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Define and manipulate classes and objects in C++ and Java, using various types of constructors and member functions.

CLO2: Implement operator overloading in Python for operations such as matrix arithmetic and string comparisons.

CLO3: Utilize different types of inheritance (multiple, multi-level, hierarchical) and method overriding in program design.

CLO4: Implement method overloading for various operations including string concatenation and matrix arithmetic.

CLO5: Utilize run-time polymorphism to calculate areas of various user-defined shape objects.

CLO6: Implement threading in Java for tasks such as finding the smallest number in a large array, and create packages to implement string operations.

CLO7: Develop user interfaces for tasks like displaying employee details and calculator operations, and establish database connectivity for storing and retrieving data.

UNIT-I OBJECT ORIENTED PROGRAMMING, INTRODUCTION TO C++ AND JAVA, CLASS AND OBJECTS

- Define a class Vehicle and create five different types of vehicles such as Car, Bus, Truck, Jeep, Bike and use member function input and display the attribute values.
- Initialize above objects using different type of constructors and print their values using a member function.
- Define a class Matrix and perform addition, subtraction and multiplication between the matrix. Use constructor, destructor in your program.
- Use operator overloading (python) to perform above matrix operations.
- Define a class String and compare two strings by overloading (python) various comparison operators.

UNIT-II: INHERITANCE, POLYMORPHISM

- Define a basic two-dimensional Shape class from which objects such as rectangle, circle which can be derived. Let the user specify the position, size, of drawing 2-D object.
- Write programs to demonstrate the use of Multiple, Multi-level and Hierarchical inheritance to create different type of vehicles.
- Use method overriding in above programs.
- Use method overloading to add two strings (concatenation), two matrices and two Numbers and display the results.
- Use method overloading to calculate the length of a string, and an integer array.

- Use run time polymorphism to calculate the area of a user defined Shape objects such as rectangle, triangle, and circle.

UNIT-III: THREADS IN JAVA, ARRAY & STRING HANDLING IN JAVA

- Demonstrate the use of exception handling while implementing Stack class with push() and pop() operations.
- Use multiple threading to calculate smallest number in a large array of integers. Use each thread to calculate the local smallest number on sub-array and finally find the global smallest from all local smallest numbers.
- Use in-built library to implement Array data structure.
- Use in-built library to implement List data structure.
- Create your own package to implement all String related operations. Use your package to perform string related operations on user given strings.

UNIT-IV: EXCEPTION HANDLING, GUI PROGRAMMING IN JAVA, NETWORKING IN JAVA

- Create a user interface input and display Employee details of Sikkim University.
- Create a calculator with user friendly interface.
- Database Connectivity.
- Create a front-end to read Employee details and store into MySQL (or other).
- Retrieve and search records based on user query.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving
- Group discussion

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Schildt, Herbert (2017). Java-The Complete Reference, Oracle Press, 10th Ed.
- Balagurusamy, E. (2006). Programming with Java: A Primer, 3rd Ed., McGraw Hill.
- Eckel, Bruce (2006). Thinking in Java, 4th Ed., Prentice Hall.
- Liang, Y. Daniel (2018). Intro to Java Programming, 10th Ed., Pearson.
- Kanetkar, Y. (2017). Let us Python, 2nd Ed., BPB Publication.
- Balagurusamy, E. (2017). Introduction to Problem Solving with Python, Tata Mcgraw Hill.
- Dierbach, Charles (2012). Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley Publishing

SEMESTER-II
CA-P-556
DATA STRUCTURE LABORATORY

Semester: Second Semester **Course Level: 500** **Total Marks: 100**

L+T+P:0+0+4 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:
CLO1: Implement and manipulate fundamental data structures.
CLO2: Apply data structure operations effectively.
CLO3: Debug and troubleshoot data structure implementations.
CLO4: Analyze the efficiency of data structures.
CLO5: Design and implement algorithms using data structures.
CLO6: Experiment with advanced data structures and algorithms

UNIT-I: LINEAR DATA STRUCTURE

- Program to implement Merge Sort and Quick Sort.
- Program to implement Singly, Doubly, and Circular Linked list.
- Program to implement Stack and Queue using array and linked list.
- Programs to implement Infix to Postfix and Prefix conversion, Evaluation of expression.

UNIT-II: NON-LINEAR DATA STRUCTURE

- Program to implement Insertion and Deletion in a Binary tree.
- Program to implement Insertion and Deletion in a Binary Search tree (BST).
- Program to implement Inorder, Preorder and Postorder traversal on BST.
- Program to implement insertion and deletion in B tree.
- Program to implement insertion and deletion in AVL tree.

UNIT-III: HASHING

- Program to implement double hashing technique to map given key to the address space. Also write code for collision resolution (linear probing).

UNIT-IV: GRAPH

- Program to implement Breadth First search and Depth first search using linked representation of graph.
- Program to create a minimum spanning tree using Kruskal's algorithm

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving
- Group discussion

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Y Kanetkar (2022), Data Structures Through C, BPB Publication.
- AM Tanenbaum, Y Langsam and MJ Augustein (2019), Data structure using C, Prentice Hall India.
- S Lipschutz (2006), Data Structures, TMH.

Detailed Syllabus Third Semester

SEMESTER-III
CA-V-601
CYBER SECURITY

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Understand the basic terminologies related to cyber security and current cyber security threat landscape. They will also develop understanding about the Cyberwarfare and necessity to strengthen the cyber security of end user machine, critical IT and national critical infrastructure.

CLO2: Draw complete understanding of the cyberattacks that target computers, mobiles and persons. They will also develop understanding about the type and nature of cybercrimes and as to how report these crimes through the prescribed legal and Government channels.

CLO3: Understand the legal framework that exist in India for cybercrimes and penalties and punishments for such crimes, It will also expose students to limitations of existing IT Act,2000 legal framework that is followed in other countries and legal and ethical aspects related to new technologies.

CLO4: Understand the aspects related to personal data privacy and security. They will also get insight into the Data Protection Bill, 2019 and data privacy and security issues related to social media platforms.

UNIT-I: OVERVIEW OF CYBER SECURITY AND CYBER CRIMES

- Cyber security increasing threat landscape, Cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism, Protection of end user machine, Critical IT and National Critical Infrastructure, Cyberwarfare, Case Studies.
- Cybercrimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, virus, Trojans, ransomware, data breach., Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/ credit card fraud, Online payment fraud, Cyberbullying, website defacement, Cybersquatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking., Social Media Scams & Frauds- impersonation, identity theft, job scams, misinformation, fake newscyber crime against persons - cyber grooming, child pornography, cyber stalking., Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies.

UNIT-II: CYBER LAW

- Cybercrime and legal landscape around the world, IT Act, 2000 and its amendments. Limitations of IT Act, 2000. Cybercrime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and social media, Cyber Laws of other countries, Case Studies.

UNIT-III: DATA PRIVACY AND DATA SECURITY AND PRACTICAL SESSION

- Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection

Regulations(GDPR),2016 Personal Information Protection and Electronic Documents Act (PIPEDA)., Social media- data privacy and security issues.

Practical Questions

- Setting privacy settings on social media platforms.
- Do's and Don'ts for posting content on social media platforms.
- Registering complaints on a social media platform.

UNIT-IV: CYBER SECURITY MANAGEMENT, COMPLIANCE AND GOVERNANCE

- Cyber security Plan- cyber security policy, cyber crises management plan., Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy.

Practical Questions

- Prepare password policy for computer and mobile device.
- List out security controls for computer and implement technical security controls in the personal computer.
- List out security controls for mobile phone and implement technical security controls in the personal mobile phone.
- Log into computer system as an administrator and check the security policies in the system.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Sumit Belapure and Nina Godbole (2011). Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley India Pvt. Ltd.
- Dorothy F. Denning (1999). Information Warfare and Security, Addison Wesley.
- Henry A. Oliver (2015). Security in the Digital Age: Social Media Security Threats and Vulnerabilities, Create Space Independent Publishing Platform.
- Natraj Venkataramanan and Ashwin Shriram (2016). Data Privacy Principles and Practice, CRC Press.
- W. KragBrothy (2008). Information Security Governance, Guidance for Information Security Managers, 1st Edition, Wiley Publication.
- Martin Weiss, Michael G. Solomon (2015). Auditing IT Infrastructures for Compliance, 2nd Edition, Jones Bartlett Learning.

CA-C-602
DATABASE MANAGEMENT SYSTEM

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: acquire the full understanding of the Database Management System Theory as a basis for designing and implementing database applications.

CLO2: classify the types of Database Management Systems such as Relational DBMS and Non-Relational DBMS by means of its characteristics.

CLO3: interpret the ER modelling techniques and map the same to relations. Further, compare the diverse Normalization techniques namely 1NF, 2NF, 3NF, 4NF and BCNF to create redundancy free databases.

CLO4: analyze the different Query processing and Optimization techniques and implement the different Query Processing languages namely SQL and PL/SQL.

CLO5: recognize various desirable properties of Transactions along with numerous Database Recovery and Concurrency Control Techniques. Additionally, outline different NoSQL database categories along with the various advanced databases available in the market.

CLO6: carry out the modelling of the different DBMS applications scenarios by designing the ER models. Also, illustrate the mapping of ER design to relations and thereby normalize the relations using different Normalization mechanism.

CLO7: acquire the full understanding of the Database Management System Theory as a basis for designing and implementing database applications.

UNIT-I: INTRODUCTION TO DATABASE AND RELATIONAL DATA MODEL

- Database System Concepts, Database System Environment, Instances and Schemas, Database Languages and Interfaces, Classification of DBMS.
- Client/Server Architectures for DBMS, Relations and Integrity Constrains, Relational Algebra and Calculus.
- Entity Relationship (ER) Model, Mapping ER diagram to relations, Enhanced ER Model.

UNIT-II: QUERY LANGUAGE PROCESSING AND NORMALIZATION

- Features of SQL and PL/SQL, Various DDL and DML commands, PL/SQL Structures and advantages, Importance of Query Processing, Steps for Query Optimization and approaches to Query Optimization.
- Importance of Normalization, Functional Dependencies, First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF) and Boyce Codd Normal Form (BCNF).

UNIT-III: TRANSACTION PROCESSING AND INTRODUCTION TO BIG DAT

- Transaction states, Desirable properties of Transactions (ACID), Schedules and Recoverability, Lock based protocols, Transaction Processing.
- Concurrency Control Techniques, Database Recovery Techniques, Big Data

Characteristics, Types of Big Data, Big Data Architecture, Features.

UNIT-IV: NOSQL AND ADVANCED DATABASES

- SQL vs NoSQL, Advantages of NoSQL, Types of NoSQL database, when should NoSQL be used, CAP theorem in NoSQL, Querying and managing NoSQL.
- Temporal Database, Object-oriented Databases, Multimedia Database, Distributed Databases, Mobile Databases.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving / Brainstorming activities.
- Group discussions
- Individual / Group Presentations
- Collaborative concept mapping.

ASSESSMENT FRAMEWORK:

Assessment	Written Modes	Integrated Modes
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Elmarsri and Navathe (2017). Fundamentals of Database system, 7/e, Pearson.
- Silberschatz, Korth and Sudarshan (2013). Database System Concepts, 6/e, McGraw Hill.
- C J Dates (2002). An Introduction to Database Systems, 7/e, Pearson.
- Bipin C Desai (2012). An Introduction to Database System, Rev. Ed., Galgotias.
- Subhashini Chellappan & Seema Acharya (2019). Big Data and Analytics, 2/e, Wiley.
- Vince Reynolds (2016). Big Data for Beginners, Create space Independent Pub.
- Seema Acharya (2020). Demystifying NoSQL, Wiley.
- Malhar Lathkar (2019). Python Data Persistence: With SQL and NOSQL Databases, BPB Publ.
- P Raj, P., & Deka, G. C. (2018). A deep dive into NoSQL databases: the use cases and applications. Academic Press.

CA-C-603
SOFTWARE ENGINEERING

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: understand software engineering overview, including process, life cycle, development approaches, and quality standards.

CLO2: learn software requirement analysis and specifications, including anticipation, investigation, SRS formats, and quality criteria

CLO3: gain knowledge of software metrics, project planning, and associated activities.

CLO4: acquire skills in software design techniques and Unified Modelling Language (UML).

CLO5: explore software reliability, testing, debugging, and relevant tools and standards.

CLO6: familiarize with case tools, software maintenance, and current trends in software engineering.

UNIT-I: OVERVIEW OF SOFTWARE ENGINEERING AND SOFTWARE REQUIREMENT ANALYSIS AND SPECIFICATIONS

- Introduction, emergence and evolution, Software Process, Basic System Development Life Cycle, Different approaches and models for System Development along with their associated advantages, disadvantages and applicability, Overview of Quality Standards.
- Requirements Anticipation, Requirements Investigation, Requirements Specifications and related tools. Software requirement Specification (SRS) formats and Quality criteria.

UNIT-II: SOFTWARE METRICS AND PROJECT PLANNING

- Various software metrics with their associated advantages and disadvantages.
- Importance of planning and associated activities, Software Project Management Plan document formats and Quality criteria.

UNIT-III: SOFTWARE DESIGN, DESIGN AND TESTING

- Various design attributes and their significance. Design techniques including Function Oriented Design, Object Oriented Design and Service Oriented Design, Unified Modelling Language (UML).
- Software Reliability, Failure and Faults, Reliability Metrics and Reliability Models.
- Software Testing, Significance of testing, Testcase and its design techniques, Various Testing Approaches, Debugging, Testing Tools & Standards.

UNIT-IV: CASE TOOLS, SOFTWARE MAINTENANCE AND CURRENT TRENDS

- CASE tools, Type of CASE tools.
- Maintenance Process, Maintenance Models, Reverse Engineering, Software Re-engineering.
- Software Engineering for projects & products, Introduction to Web Engineering and Agile process.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving / Brainstorming activities
- Group discussions.
- Individual / Group Presentations
- Collaborative concept mapping.

ASSESSMENT FRAMEWORK:

Assessment	Written Modes	Integrated Modes
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- R. S. Pressman & B R. Maxim (2019), Software Engineering – A practitioner's approach", McGraw Hill (Indian. Ed.).
- Rajib Mall (2018), Fundamentals of Software Engineering, PHI.
- Pankaj Jalote (2010), Software Engineering: A Precise Approach, Wiley.
- Stephen R. Schach (1996), Classical & Object-Oriented Software Engineering, IRWIN.
- James Peter, W Pedrycz (2000), Software Engineering, John Wiley & Sons.
- Sommerville (1999), Software Engineering, Addison Wesley.

CA-E-6XX
Elective-I

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

The course will be offered by the Department. The paper will be offered based on the availability of subject expert and current demand on the subject. The detailed syllabus for each subject is a mere guideline. Concerned teacher may teach any essential and latest topic as he/she considers deem fit in addition to the listed topics. Students are encouraged and free to refer any current literature to get into any latest topic in a particular paper. List of Electives papers are given below:

Sl. No	Code	Name
1	CA-E-604	Data Science
2	CA-E-605	Machine Learning
3	CA-E-606	Artificial Intelligence
4	CA-E-607	Data Mining
5	CA-E-608	Cryptography & Network Security
6	CA-E-609	Cloud Computing
7	CA-E-610	Internet of Things
8	CA-E-611	Bioinformatics
9	CA-E-612	Operation Research
10	CA-E-613	Digital Image Processing
11	CA-E-614	Introduction to Computer Networks

Detail syllabus available in **Annexure-I**.

CA-P-615
WEB PROGRAMMING LABORATORY

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 0+0+4 = 4 Credit **Lecture:0 Hrs+Tutorial:0 Hrs+Practical 60 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: design and develop the architecture of the given system below.

1. Student Enrolment System.
2. Library Information system.
3. Income Tax Calculation System.

UNIT-I: HTML and CSS

(Ref: https://www.w3schools.com/html/)

- Create one login form using label, 2 text boxes & 1 button
- Create registration form using first name (textbox), last name (textbox), phone (textbox), age (textbox), sex (radio), address (text area), state (drop down) & one submit and clear button
- (Ref: https://www.w3schools.com/css/css_boxmodel.asp)
- Apply box model to the above login & registration form, border - 2, padding - 2, margin – 2
- Apply different colours to the labels.

UNIT-II: JavaScript

(Ref: https://www.w3schools.com/js/)

- Design web-based Calculator using Java Script.
- Implement sorting and searching in array using Java Script.
- Use mandatory client-side validation to the student registration form.

UNIT-III: BOOTSTRAP

- Apply grid system to the login form
  (Ref: https://getbootstrap.com/docs/4.0/layout/grid/
- Use add link & script tag in your above login.html file
  (Ref: https://getbootstrap.com/docs/4.3/ getting-started/download/)
- Design Departmental Information System (static pages) using Bootstrap framework.

UNIT-IV: PHP AND JavaScript FRAMEWORK

- Create client-server application using web-server (e.g. APACHE). Use form submit to send username & password to my sql db.
- Create web application using PHP-MYSQL.
- Create student record searching page using AJAX and jQuery.
- Design interactive web application (one of the above applications) using NodeJS, (Ref: https://nodejs.org/en/docs/)
- Design interactive web application using AngularJS and ReactJS.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	Written Modes	Integrated Modes
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Luke Welling and Laura Thomson (2016). PHP and MySQL Web Development, 5th Ed., Pearson.
- Laura Lemay et. al (2016). Mastering HTML, CSS & Javascript Web Publishing, BPB Publ.
- DT Editorial Services (2016). HTML 5 Black Book, 2 Ed., Dreamtech.
- Brad Dayley et al. (2018). Node.js, MongoDB and Angular Web Development, 2nd Ed., Pearson.
- Various free online resources.

CA-P-616
DATABASE LABORATORY

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 0+0+4 = 4 Credits **Lecture:0 Hrs+Tutorial:0 Hrs+Practical 60 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: acquire the full understanding of the SQL and PL/SQL as the Query Processing Languages.

CLO2: utilize the various DDL and DML commands in order to create databases, relations (with and without constraints) and further perform different operations into it.

CLO3: analyze various functions (Aggregate, string, math, built-in) to query and update the underlying relations and databases.

CLO4: trigger sub-queries, create views and perform joins on the relations utilizing the concepts of Inner Joins, Outer Joins, check options and various clauses.

CLO5: practice the procedural abilities over SQL using the features of PL/SQL as the Query Processing Languages.

CLO6: design and implement few of the simple database applications.

CLO7: Implement various operations using NoSQL database.

UNIT-I: DATA DEFINITION LANGUAGE AND DATA MANIPULATION LANGUAGE

- Viewing all databases, creating a database, Viewing all Tables in a Database,
- Creating Tables (with and without Constraints),
- Inserting/Updating/Deleting/Displaying Records in / from a Table,
- Altering a Table,
- Dropping/Truncating/Renaming Tables,
- Backing up / restoring a Database.

UNIT-II: SQL QUERIES / SUB QUERIES/ JOINS AND VIEWS

- Simple Queries, Simple Queries with Aggregate functions, Queries with Aggregate functions (group by and having clause),
- Queries involving- Date Functions, String Functions, Math Functions.
- Join Queries: Inner Join, Outer Join,
- Subqueries: With IN clause, With EXISTS clause.
- Creating Views (with and without check option).
- Dropping views.
- Selecting from a view.

UNIT-III: /SQL

- Pl/SQL program using Basic Loop / While Loop/ FOR Loop to insert ten rows into a database table.
- PL/SQL program to illustrate iterations.
- PL/SQL program to illustrate various operators such as arithmetic/relational/ comparison/ logical/string.
- PL/SQL program to illustrate decision making.
- PL/SQL program to illustrate CURSOR.
- PL/SQL program to illustrate TRIGGER.

UNIT-IV: DATABASE APPLICATIONAND NoSQL HANDS ON

- Database Design and Implementation for few scenarios such as Banking System, Library Management System etc.
- To practice and implement various operations using NoSQL database(s)(MongoDB/DynamoDB/CouchDB/Neo4j/InfluxDB).

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	Written Modes	Integrated Modes
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Vikram Vaswani (2017). MySQL: The Complete Reference, McGraw Hill (Indian Ed.).
- Luke Welling and Laura Thomson (2016). PHP and MySQL Web Development, 5/e, Pearson.
- Kevin Loney (2008). Oracle Database 11g The Complete Reference, Oracle Press (Indian Ed.).
- Ivan Bayross (2010). SQL, PL/SQL the Programming Language of Oracle, 3/e, BPB Publications.
- Urman, Hardman, McLaughlin (2004). Oracle Database 10g PL/SQL Programming, Oracle Press.
- Shannon Bradshaw (2020). MongoDB: The Definitive Guide - Powerful and Scalable Data Storage, 3/e, O'Reilly.

Detailed Syllabus Fourth Semester

SEMESTER-IV
CA-E-651
Elective-I (MOOC)

Semester: Fourth Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+0+0 = 3 Credits **Lecture:45 Hrs**

A 3-credit course, offered by SWAYAM and NPTEL, covering advanced and latest topic related to computer science to opt, in consultation with MOOC coordinator, duly approved by the department. No course should opt that are already taught as regular paper. The course should be pursued through online mode. Timing of the classes to be managed by the student him/her self. A student may undertake the course as per his/her convenience at any point of time during the MCA course. However, the proof of successful course completion and credit earned to be submitted to the MOOC coordinator 15 days before the internal/external marks submission deadline of the University. Failing which the paper will be considered as incomplete.

SEMESTER-IV
CA-E-652
Elective-II (MOOC)

Semester: Fourth Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+0+0 = 3 Credits **Lecture:45 Hrs**

A 3-credit course, offered by SWAYAM and NPTEL, covering advanced and latest topic related to computer science to opt, in consultation with MOOC coordinator, duly approved by the department. No course should opt that are already taught as regular paper. The course should be pursued through online mode. Timing of the classes to be managed by the student him/her self. A student may undertake the course as per his/her convenience at any point of time during the MCA course. However, the proof of successful course completion and credit earned to be submitted to the MOOC coordinator 15 days before the internal/external marks submission deadline of the University. Failing which the paper will be considered as incomplete.

CA-I-653
INTERNSHIP

Semester: Fourth Semester	**Course Level: 600**	**Total Marks: 50**
2 Credits	**Internship: 45 Hrs**	

- A minimum 15 days internship program may be pursued during summer break or winter vacation (after 2nd Sem or 3rd Sem). However, it will be evaluated during the fourth semester.
- A student may approach any external academic & research organization or software development industry (reputed/registered) for the program. Necessary financial support may be provided as per university norms. Student needs to take prior approval from the Department before pursuing any internship program.
- A student may continue an internship program with Dissertation (if undergoing in the same company/organization). In the case where the external internship is not available, the student may undergo an in-house internship programme within the Department or any other Departments of the University.

CA-R-654
DISSERTATION

Semester: Fourth Semester **Course Level: 500** **Total Marks: 350**

16 Credits **Research:45 Hrs**

The dissertation (or project) is one of the most vital subjects in the MCA program to be undertaken with the utmost seriousness in order to learn on tackling any challenging problem. The entire semester needs to be devoted to the dissertation work. The dissertation may involve software application development or novel problem-solving. It is recommended to work on any latest topic involving popular software tools and techniques. Conducting dissertation work in any reputed external organizations are encouraged; however, there will be an internal supervisor in such a case. In the case where external opportunities are not available, the student may perform his/her dissertation work within the department under the supervision of an internal supervisor. Jointly supervised work involving external and internal supervisors may also be allowed with the prior approval from the Department.

Annexure-I
CA-E-604
DATA SCIENCE

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: understand Data Science fundamentals: Concepts, principles, tasks, and applications.
CLO2: learn Data Preparation: Types, normalization, missing values, feature selection.
CLO3: explore Proximity Measures: Characteristics, types for numeric, categorical, and mixed data.
CLO4: acquire Classification skills: Models, validation methods, metrics, Bayesian and Naïve Bayes classification.
CLO5: familiarize with Decision Trees: Rules, attribute selection, gain, Gini Index.
CLO6: learn Distance-Based Classification: Nearest Neighbor Classifier.
CLO7: gain knowledge of SVM and Neural Networks.

UNIT-I: INTRODUCTION TO DATA SCIENCE AND DATA PREPARATION

- Concepts, Principle, Knowledge discovery and Data Science, what is not Data Science? Evolution of Data Science, Data Science Tasks, Applications.
- Data types-Nominal, Ordinal, Categorical, and Ratio, Normalization, Discretization, Missing Value Estimation, Sampling, Feature Selection.

UNIT-II: PROXIMITY MEASURES AND INTRODUCTION TO CLASSIFICATION

- Proximity Measures and its Characteristics, Identity, Non-negativity, Symmetricity, Types of Proximity Measures-Numeric, Categorical, Mixed-type.
- Definition, Machine Learning Model, Classification and Prediction, Data Separability and Decision Boundary, Validation Methods, Cross-validation, Bootstrapping, Assessment Metrics- Confusion Matrix, Sensitivity and Specificity, Accuracy.

UNIT-III: CLASSIFICATION MODELS

- Bayesian Classification, Naïve Bayes Classification.
- Decision Tree: Decision Rules, Attribute Selection Measures, Gain, Gini Index, ID3
- Distance Based Classification: Simple Approach, Nearest Neighbour Classifier.
- Support Vector Machines: SVM Classifier, Vector Kernels, Application-specific Kernels, Implementing SVM using R/Python.
- Neural Network: Biological brain, Single Layer Perceptron, Multilayer Perceptron, Feed-Forward and Back-Propagation, Implementing ANN using R/Python.

UNIT-IV: CLUSTERING AND BIG DATA ANALYSIS

- Euclidean Distance, Manhattan Distance, Minkowski Distance, Partitional, Hierarchical, Density-based techniques, Assessment methods.
- Big Data, Overview, Big Data Analytics Architecture, Big Data Analytics Tool, Design of Big Data Mining Algorithms, Incremental and Distributed Algorithm.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- J Kalita, DK Bhattacharyya, S Roy (2023), Fundamentals of Data Science-Theory & Practice, Elsevier.
- Tom M. Mitchell (2017), Machine Learning, Mc Grew Hills.
- Dunham, M. H. (2006). Data mining: Introductory and advanced topics. Pearson Education India.
- Han, J., Pei, J., & Tong, H. (2022). Data mining: concepts and techniques. Morgan kaufmann.
- VanderPlas, J. (2016). Python data science handbook: Essential tools for working with data. " O'Reilly Media, Inc.

CA-E-605
MACHINE LEARNING

Semester: Third Semester **Course Level: 500** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: understand machine learning basics: Programming vs. machine learning, applications, types, validation, and evaluation metrics.

CLO2: learn feature selection: Importance, filter, wrapper, hybrid methods.

CLO3: gain knowledge of regression: Linear, non-linear, logistic, Poisson regression.

CLO4: explore support vector machines (SVM): SVM classifiers, kernels, R/Python implementation.

CLO5: familiarize with Bayesian classification: Bayes theorem, classifier, naïve Bayes.

CLO6: acquire neural network skills: Perceptron, feed-forward/back-propagation, recurrent, deep networks, R/Python implementation.

CLO7: learn clustering: Partitional, hierarchical, density-based, validation, R/Python implementation.

UNIT-I: INTRODUCTION TO ML AND FEATURE SELECTION

- Traditional programming vs. Machine learning, Application, Types of Learning, Basic framework, Validation, Cross-validation, Confusion Matrix, Precision-Recall, Accuracy, ROC.
- Features and selection, Importance, Filter, Wrapper, Hybrid method.

UNIT-II: REGRESSION & SUPPORT VECTOR MACHINES

- Linear Regression, Non-Liner Regression Model, Logistic Regression, Poisson Regression.
- SVM Classifier, Vector Kernels, Application-specific Kernels, Implementing SVM in R/Python.

UNIT-III: CLASSIFICATION

- Bayes Theorem, Bayes Classifier, Naïve Bayes Classification.
- Neural Network: Single Layer Perceptron, Multilayer Perceptron, Feed-Forward and Back-Propagation, Recurrent Neural Network, Deep Neural Network, Implementing ANN in R/Python.

UNIT-IV: CLUSTERING

- Partitional Clustering, Hierarchical Clustering, Density based Clustering, Cluster validation measures, Implementing clustering in R/Python.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz,	Presentation, Seminars,

Summative Marks: 50	Assignments Poster Presentations. Semester-end examinations conducted by the university will be considered the mode of summative assessment.

SUGGESTED READINGS:

- Tom M. Mitchell (2017), Machine Learning, Mc Grew Hills.
- Ng, A. (2017). Machine learning yearning. (http://www. mlyearning. Org).
- J Kalita, DK Bhattacharyya, S Roy (2023), Fundamentals of Data Science-Theory & Practice, Elsevier.
- S. J. Russell, P. Norvig. Artificial Intelligence: A Modern Approach. Third Edition, Prentice-Hall, 2010.
- C. M. Bishop (2016), Pattern Recognition and Machine Learning, Springer.

CA-E-606
ARTIFICIAL INTELLIGENCE

Semester: Third Semester **Course Level: 500** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: understand the concepts of Intelligent Agents and their interaction with different environments.

CLO2: implement problem-solving strategies using both uninformed and informed search techniques.

CLO3: apply game theory to AI, including optimal decision making and alpha-beta pruning.

CLO4: develop knowledge-based agents using propositional logic and resolution techniques.

CLO5: utilize First Order Predicate Logic (FOPL) in AI applications.

CLO6: understand and apply different forms of machine learning, including inductive learning, decision tree learning, and ensemble learning.

CLO7: understand and create rule-based system architectures, including expert systems.

UNIT-I: INTRODUCTION TO INTELLIGENT AGENTS, PROBLEM SOLVING

- Agents and Environments, The concept of rationality, Nature of Environments, Structure of Environments.
- Solving Problems by Searching: Problem solving agents, Uninformed Search strategies, Avoiding repeated states, Informed Searches and Exploration, Informed search strategies, Heuristic functions, Local search algorithms and optimization problems.

UNIT-II: ADVERSARIAL SEARCHES, KNOWLEDGE AND REASONING

- Games, Optimal decision in games, Alpha beta pruning, and Imperfect real-time decisions.
- Knowledge based agents, Propositional logic, Resolution, Effective propositional inference, Agents based on propositional logic.

UNIT-III: FIRST-ORDER LOGIC, LEARNING

- Syntax and semantics of First order logic, Using FOPL.
- Learning from Observations: Form of learning, Inductive learning, Learning decision tree, Ensemble learning, Computational learning theory.

UNIT-IV: EXPERT SYSTEMS

- Characteristic features of expert systems, Background history, Applications, Importance of expert systems, Rule based system architectures such as the knowledge base, the inference process, explaining how or why, building a knowledge base, I/O interface.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	Written Modes	Integrated Modes
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Nillson, Nils J. (2003). Artificial Intelligence: A New Synthesis, Morgan Kauffman.
- Russel, S., & Norvig, P. (2015). Artificial Intelligence: A Modern Approach, 3rd Ed., Pearson education.
- Luger (2003). Artificial Intelligence, Pearson education.
- Knight, Kevin, Rich, Elaine, & Nair, S B. (2017). Artificial Intelligence, 3rd Ed., McGraw Hill.
- Current Literature.

CA-E-607
DATA MINING

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Explain the basic principles of Data Mining, related issues and matrices.
CLO2: Understand the functionality of the various data mining component.
CLO3: Appreciate the strengths and limitations of various data mining models.
CLO4: Describe different methodologies used in data mining and data warehousing.
CLO5: Deliberate on different types of data mining techniques.
CLO6: Deliberate on various classification and clustering techniques.
CLO7: Deliberate on various association rules.

UNIT-I: INTRODUCTION

- Basic Data Mining Tasks, Data Mining Issues, Data Mining Metrics, Data Mining from a Database Perspective. Data Mining Techniques: A Statistical Perspective on Data Mining, Similarity Measures, Data Pre-processing.

UNIT-II: CLASSIFICATION

- Distance-Based Algorithms, Decision Tree-Based Algorithms, Artificial Neural Networks, Support Vector Machine, Random Forest.

UNIT-III: CLUSTERING

- Similarity and Distance Measures, Partitional Techniques, Hierarchical Techniques, Density based Techniques, Incremental Clustering, Clustering with Categorical Attributes, Biclustering.

UNIT-IV: ASSOCIATION RULES

- Introduction, APRIORI, FP-Growth, Parallel and Distributed Algorithms, Incremental Rules, Quantitative rules.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- M. H. Dunham (2006). Data Mining: Introductory and Advanced Topics Pearson.
- J. Han and M. Kamber (2011). Data Mining: Concepts and Techniques 3rd

Ed., Morgan Kaufmann.
- AK Pujari (2016). Data Mining Techniques 4th Ed., University Press.
- Pang-Ning Tan et al (2016). Introduction to Data Mining, Pearson Current Literatures.

CA-E-608
CRYPTOGRAPHY & NETWORK SECURITY

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Explain the fundamentals of cryptography and understand classical encryption techniques.
CLO2: Learn about how to maintain the Confidentiality, Integrity and Availability of data.
CLO3: Analyze and design block ciphers and stream ciphers.
CLO4: Understand hash functions, their types and threats.
CLO5: Analyze public-key cryptography, RSA and other public-key cryptosystems such as Diffie-Hellman Key Exchange.
CLO6: Analyze and design digital signatures.
CLO7: Understand and design user authentication techniques.
CLO8: Discuss public-key infrastructure (PKI), secure socket layer (SSL), and Kerberos.
CLO9: Learn System Modeling, Verification and performance analysis of security algorithms.

UNIT-I: INTRODUCTION AND STREAM CIPHERS

- Basic Data Mining Tasks, Data Mining Issues, Data Mining Metrics, Data Mining from a Database Perspective. Data Mining Techniques: A Statistical Perspective on Data Mining, Similarity Measures, Data Pre-processing.

UNIT-II: MESSAGE DIGEST, PUBLIC-KEY PARAMETERS AND INTRACTABLE PROBLEMS

- Properties of hash functions, MD2, MD5 and SHA-1, keyed hash functions, attacks on hash functions.
- Modular arithmetic, GCD, Primality testing, Chinese remainder theorem, modular square roots, finite fields.
- Integer factorization problem, RSA problem, modular square root problem, discrete logarithm problem, Diffie-Hellman problem.

UNIT-III: PUBLIC-KEY ENCRYPTION AND DIGITAL SIGNATURES

- RSA, Rabin and EI Gamal schemes, side channel attacks. Key exchange: Diffie-Hellman and MQV.
- RSA, DSA and NR signature schemes, blind and undeniable signatures.

UNIT-IV: ENTITY AUTHENTICATION, NETWORK SECURITY AND STANDARDS

- Passwords, challenge-response algorithms, zero-knowledge protocols IEEE and ISO standards.
- Certification, public-key infra-structure (PKI), secure socket layer (SSL), Kerberos.
- Assignments: System Modeling assignment using Rhapsody, system Verification, Assignment using SPIN, performance analysis assignment using Chronos.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Alfred J. Menezes et al. (1996). Handbook of Applied Cryptography, CRC Press.
- William Stallings (2017). Cryptography and Network Security: Principles and Practice, 7th Ed., Pearson.
- Jonathan Katz and Yehuda Lindell (2014). Introduction to Modern Cryptography, 2nd Ed., CRC Press, 2014.
- Johannes Buchmann (2009). Introduction to Cryptography, 2nd Ed., Springer.
- A Das, C A V Madhavan (2009). Public-Key Cryptography: Theory and Practice, Pearson.
- Current Literature.

CA-E-609
CLOUD COMPUTING

Semester: Third Semester	**Course Level: 500**	**Total Marks: 100**
L+T+P: 3+1+0 = 4 Credits	**Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**	

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

- understand and apply Virtualization Concepts, including various types of virtualization and high availability/disaster recovery strategies.
- comprehend the building blocks of Cloud Computing and differentiate between public and private cloud environments.
- utilize Amazon Web Services (AWS) for managing and creating virtual instances and storage volumes.
- build and manage a private cloud environment using open-source tools and understand auto provisioning and integration of public and private clouds.
- understand the use of cloud in IoT and Big Data scenarios.
- understand the domains and scope of work in cloud computing, including concepts like Platform as a Service (PaaS) and Software as a Service (SaaS).
- gain insight into the market trends in cloud computing and its future.

UNIT-I: VIRTUALIZATION

- Virtualization Concepts, Types of Virtualization & its benefits, Introduction to Various Virtualization OS such as Vmware, KVM etc, HA/DR using Virtualization, Moving VMs, SAN backend concepts.

UNIT-II: CLOUD FUNDAMENTALS, CLOUD AS IAAS

- Cloud building blocks, Understanding public & private cloud environments. Private cloud environment such as: Basics of private cloud infrastructure, QRM cloud demo.

UNIT-III: PUBLIC CLOUD ENVIRONMENT

- Understanding & exploring Amazon Web services, Managing and Creating Amazon, EC2 instances, Managing and Creating Amazon EBS volumes, Tata Cloud details & demo, Managing Hybrid Cloud environment, Big Data, IoT and Cloud.

UNIT-IV: SETTING UP OWN CLOUD, FUTURE DIRECTIONS

- How to build private cloud using open-source tools? Understanding various cloud plugins, setting up your own cloud environment, Auto provisioning, Custom images, integrating tools like Nagio, Integration of Public and Private cloud.
- Cloud Domain and scope of work, Cloud as PaaS, SaaS, Cloud Computing Programming, Introduction, Trends and market of cloud.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	Written Modes	Integrated Modes
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Kavis, M. J. (2014). Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, & IaaS), Wiley.
- Gonzales, D. (2010). Cloud Computing Bible: A Practical Approach To Cloud Computing Security, Cloud Problems To Be Aware of and More, Kindle E.
- Erl, T. (2013). Cloud Computing: Concepts, Technology & Architecture, Prentice Hall.
- Nielsen, L. (2014). The Little Book of Cloud Computing, Kindle E.
- Bunker, G. & Thomson, D. (2006). Delivering Utility Computing, John Wiley & Sons.
- Reese, G. (2009). Cloud Application Architectures, O'Reilly.
- Gillam, L. (2010). Cloud Computing: Principles, Systems and Applications, Springer.
- Current Literature.

CA-E-610
INTERNET OF THINGS

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Understand the fundamentals of the internet and Internet of Things (IoT), including transport services and socket programming.

CLO2: Apply network layer concepts including forwarding, routing, IP addressing, DNS, and NAT, and understand mobile networking principles.

CLO3: Understand and implement real-time networking and become familiar with the definitions and architecture of IoT.

CLO4: Identify the trends in IoT research, including data analytics, edge and fog computing, and IoT security.

CLO5: Understand and apply IoT in various case studies, including home automation, health monitoring, smart agriculture, and smart cities.

CLO6: Differentiate between Machine-to-Machine (M2M) and IoT, and understand the management of IoT, IoT platforms, and languages.

CLO7: Gain proficiency in the use of IoT for local area networks, including protocols such as Ethernet and Wi-Fi 802.11.

UNIT-I: INTERNET AND INTERNET OF THINGS (IOT), TRANSPORT SERVICES

- Layers, protocols, packets, services, performance parameters of a packet network as well as applications such as web, Peer-to-peer, sensor networks, and multimedia, TCP, UDP, socket programming.

UNIT-II: NETWORK LAYER, MOBILE NETWORKING

- Forwarding & routing algorithms (Link, DV), IP-addresses, DNS, NAT, and routers; Local Area Networks, MAC level, link protocols such as: point-to-point protocols, Ethernet, Wi-Fi 802.11, cellular internet access, and Machine-to-machine, Roaming and handoffs, mobile IP, and ad hoc and infrastructure less networks.

UNIT-III: PUBLIC CLOUD ENVIRONMENT

- Soft and real time, quality of service/information, resource reservation and scheduling, and performance measurements, Overview, applications, potential & challenges, and architecture, Domains of IoT, M2M vs IoT, Management of IoT, IoT platforms, IoT languages, IoT physical systems.

UNIT-IV: SETTING UP OWN CLOUD, FUTURE DIRECTIONS

- Data analytics using IoT, Edge computing, Fog computing, Security in IoT, Home automation, Health monitoring, Smart agriculture and irrigation, Smart city and others.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	Written Modes	Integrated Modes
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Chou, Timothy (2017). Precision: Principles, Practices and Solutions for the Internet of Things, McGraw Hill.
- Hersent, Olivier et al. (2015). The Internet of Things: Key Applications and Protocols, Wiley.
- McEwen, A. & Cassimally, H. (2013). Designing the Internet of Things, Wiley.
- Pfister, C. (2013). Getting started with the Internet of Things, O'Reilly.
- Hersent, O., Boswarthick, D., & Elloumi, O. (2015). The Internet of Things: Key Applications and Protocols, Wiley.
- Current Literature.

CA-E-611
BIOINFORMATICS

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Understand Bioinformatics: Introduction, applications, DNA-RNA, proteins, databases, tools.

CLO2: Learn Sequence Analysis: DNA, protein sequences, alignment, scoring, multiple alignment.

CLO3: Explore Phylogenetic Analysis: Tree building methods, phylogenetic tree.

CLO4: Acquire Gene Identification skills: Prediction methods, homology-based, statistical, HMM.

CLO5: Learn Gene Expression Data Analysis: Microarray, RNA counts, clustering, expression profiles.

CLO6: Gain knowledge of Network Biology: Network models, gene regulatory network, protein interaction network, module detection.

UNIT-I: INTRODUCTION TO BIOINFORMATICS

- Introduction, Application, Central dogma of molecular biology, DNA-RNA, Amino acids, Protein, Major databases, biological data retrieval tools.

UNIT-II: SEQUENCE AND PHYLOGENETIC ANALYSIS

- DNA and Protein Sequence, Next Generation Sequencing (NGS), FASTA format, Pair-wise sequence alignment, Dot Matrix methods, Scoring matrices, Dynamic Programming, Multiple sequence alignment, SP Method, Progressive Alignment, Alignment-free sequence analysis.
- Phylogenetic Tree, Tree building methods (UPGMA, NJ maximum livelihood maximum parsimony).

UNIT-III: GENE IDENTIFICATION AND PREDICTION & GENE EXPRESSION DATA ANALYSIS

- Basis of Gene prediction, Gene Prediction Methods- Homology based methods. Statistical and Hidden Markov Model.
- Microarray, RNA Read counts, Clustering & Biclustering of gene expression Profiles.

UNIT-IV: NETWORK BIOLOGY

- Complex Network Models, Gene Regulatory Network-Inference & Analysis, Protein Interaction Network-Inference & Analysis, Network module/complex detection.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	Written Modes	Integrated Modes
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Bosu & S Kaur Thukral (2007), Bioinformatics: Experiments, Tools, Databases, and Algorithms, Oxford Higher Education.
- Arthur Lesk (2014), Introduction to Bioinformatics, Oxford Higher Education.
- P H Guzzi & S Roy (2020), Biological Network Analysis: Trends, Approaches, Graph Theory, and Algorithms, Elsevier.
- SC Rastogi et al. (2013), Bioinformatics: Methods and Applications, PHI.
- Current literature.

CA-P612
OPERATION RESEARCH

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Apply principles of Operation Research in quality managerial decision-making under different situations.

CLO2: Develop linear programming (LP) models for product-mix problems and perform sensitivity analysis.

CLO3: Deploy methods of finding the Initial basic feasible solution and optimal solution.

CLO4: Propose the best strategy using decision-making methods under uncertainty and game theory.

CLO5: Use CPM and PERT techniques, to plan, schedule, and control project activities.

CLO6: Apply Poisson and exponential distribution in estimating arrival rate and service rate.

CLO7: Apply management techniques for effectively handling projects.

UNIT-I: OPERATIONS RESEARCH AND DECISION-MAKING ENVIRONMENTS

- Uses, Scope and Applications of Operation Research in managerial decision-making.
- Decision-making under certainty, uncertainty and risk situations; Decision tree approach and its applications.

UNIT-II: LINEAR PROGRAMMING AND TRANSPORTATION PROBLEM

- Mathematical formulations of LP Models for product-mix problems; graphical and simplex method of solving LP problems; sensitivity analysis; duality.
- Various methods of finding Initial basic feasible solution and optimal solution. Assignment model: Algorithm and its applications.

UNIT-III: GAME THEORY AND SEQUENCING PROBLEM

- Concept of game; Two-person zero-sum game; Pure and Mixed Strategy Games; Saddle Point; Odds Method; Dominance Method and Graphical Method for solving Mixed Strategy Game.
- Johnsons Algorithm for n Jobs and Two machines, n Jobs and Three Machines, Two jobs and m - Machines Problems.

UNIT-IV: QUEUING THEORY AND REPLACEMENT PROBLEM

- Characteristics of M/M/I Queue model; Application of Poisson and Exponential distribution in estimating arrival rate and service rate; Applications of Queue model for better service to the customers.
- Replacement of assets that deteriorate with time, replacement of assets which fail suddenly. Project Management. Rules for drawing the network diagram, Applications of CPM and PERT techniques in Project planning and control; Crashing of operations.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Taha Hamdy (2019). Operations Research - An Introduction, 10th Ed., Pearson.
- Frederick Hillier (2009). Introduction to Operations Research, 9th Ed., McGraw-Hill.
- Billy Gilett (1979). Introduction to Operations Research: A Computer - Oriented Algorithmic Approach, Tata-McGraw Hill.
- Kothari (2009). Quantitative Techniques, Vikas.
- V.K.Kapoor (2005). Operations Research, S. Chand.

CA-E-613
DIGITAL IMAGE PROCESSING

Semester: Third Semester **Course Level: 600** **Total Marks: 100**
L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: Explain and analyze the steps of image formation, sampling, quantization and representation digitally.

CLO2: Outline and understand how images are processed by discrete, linear, time-invariant systems.

CLO3: Apply how images are perceived by humans and how color is represented and solve problems.

CLO4: Verify the correctness of an argument using symbolic logic and truth tables.

CLO5: To obtain knowledge about Image registration and compression techniques.

UNIT-I: DIGITAL IMAGE FUNDAMENTALS

- A simple image model, Sampling and Quantization, Imaging Geometry, Digital Geometry, Image Acquisition Systems, Different types of digital images.
- Bilevel Image Processing: Basic concepts of digital distances, distance transform, medial axis transforms, component labeling, thinning, morphological processing, extension to grey scale morphology.

UNIT-II: BINARIZATION AND SEGMENTATION OF GREY LEVEL IMAGE AND DETECTION OF EDGES AND LINES IN 2D IMAGES

- Histogram of grey level images, Optimal thresholding using Bayesian classification, multilevel thresholding, Segmentation of grey level images, Water shade algorithm for segmenting grey level image.
- First order and second order edge operators, multi-scale edge detection, Canny's edge detection algorithm, Hough transform for detecting lines and curves, edge linking.

UNIT-III: IMAGES ENHANCEMENT AND COLOR IMAGE PROCESSING

- Point processing, Spatial Filtering, Frequency domain filtering, multi-spectral image enhancement, image restoration.
- Color Representation, Laws of color matching, chromaticity diagram, color enhancement, color image segmentation, color edge detection, color demosaicing.

UNIT-IV: IMAGE REGISTRATION AND DEPTH ESTIMATION

- Registration Algorithms, Setreo Imaging, Computation of disparity map. Image compression: Lossy and lossless compression schemes, prediction-based compression schemes, vector quantization, sub-band encoding schemes, JPEG compression standard, Fractal compression scheme, Wavelet compression scheme.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	Written Modes	Integrated Modes
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Gonzalez Woods, (2018). Digital Image Processing, 4th Ed., Pearson
- Sridhar S (2016). Digital Image Processing2nd Ed., Oxford Higher Education
- Jayaraman (2017). Digital Image Processing, McGraw Hill
- Castleman K R (2007). Digital Image Processing, Pearson
- Chanda B, Majumder D (2011). Digital Image Processing and Analysis, 2nd Ed., Prentice Hall Publications
- Current Literature.

CA-E-614
INTRODUCTION TO COMPUTER NETWORKS

Semester: Third Semester **Course Level: 600** **Total Marks: 100**

L+T+P: 3+1+0 = 4 Credits **Lecture:45 Hrs+Tutorial:15 Hrs+Practical: 0 Hrs**

COURSE LEARNING OUTCOMES:

Upon completion of this course, students should be able to do the following:

CLO1: explain basic concepts of data communication and network topologies.
CLO2: comprehend on OSI reference model, services and role of each layer of the OSI model and TCP/IP, networks devices and transmission media.
CLO3: discuss basic concepts of line coding schemes.
CLO4: elaborate on various forms of Transmission media. Discuss data link layer functions: channel allocation, framing, error and flow control techniques.
CLO5: explain the different access control protocols.
CLO6: describe the functions of the Network Layer i.e., logical addressing, sub-netting and routing.
CLO7: explain the different Transport Layer functions, congestion control, error control and flow control mechanism.
CLO8: explain the basic concepts of mobile technology.
CLO9: explain the different protocols used at the application layer.
CLO10: elaborate on various features related to network security and its algorithms.

UNIT-I: DATA COMMUNICATION, COMPUTER NETWORKS AND NETWORK MODELS

- Components of a Data Communication System, Simplex, Half-Duplex and Duplex, Modes of Communication; Analog and Digital Signals.
- Network Topologies, Local Area Networks, Metropolitan Area Networks, Wide Area Network.
- Reference Models; OSI and TCP/IP and Protocol Suite.

UNIT-II: PHYSICAL LAYER, DATA LINK LAYER AND MAC SUB LAYER

- Transmission media, Magnetic Media, Twisted Pair, Coaxial pair, Fiber Optics, Line coding and multiplexing.
- Framing, Error Detection and correction, Stop-and-Wait ARQ, Sliding Window, Go-back-n, Selective Repeat ARQ.
- ALOHA, Slotted ALOHA, CSMA protocols, Introduction to MAC Protocols: 802.3, 802.4, 802.5, 802.11 b/g/n.

UNIT-III: NETWORK LAYER, TCP/IP AND TRANSPORT LAYER

- Routing, optimality Principle, Shortest Path Routing Algorithm, Flooding, Distance Vector Routing. Congestion Control Routing: General principle of Congestion control, leaky bucket algorithm, Token Bucket Algorithm.
- TCP/IP architecture, IPV4 and IPV6, ARP, DHCP, Internet routing protocols: OSPF, BGP, Transport Services, Protocols; TCP, UDP.

UNIT-IV: APPLICATION LAYER, MOBILE TECHNOLOGY AND NETWORK SECURITY

- World Wide Web; DNS, SMTP, POP3, FTP, TELNET, HTTPS.
- GSM and CDMA; Services and Architecture of GSM, Middleware and Gateway

for Mobile Computing; Wireless Networks and Topologies; Cellular Topology, Wireless Geolocation Systems, GPRS and SMS.

- Malwares, Cryptography and Steganography; Introduction to: Secret-Key Algorithms, Public-Key Algorithms, Digital Signature, Virtual Private Networks, Firewalls.

SUGGESTED TEACHING LEARNING STRATEGIES:

(These activities are only indicative; the Faculty member can innovate any)

- Problem solving.
- Group discussions.

ASSESSMENT FRAMEWORK:

Assessment	**Written Modes**	**Integrated Modes**
Formative Marks: 50	Sessional, Quiz, Assignments	Presentation, Seminars, Poster Presentations.
Summative Marks: 50	Semester-end examinations conducted by the university will be considered the mode of summative assessment.	

SUGGESTED READINGS:

- Andrew S Tanenbaum and David J Wetherall (2010). Computer Networks, 5th Ed. Pearson.
- Behrouz A. Forouzan (2007). Data Communications and Networking, 5th Ed. McGraw Hill Education.
- Kurose JF (2005). Computer networking: A top-down approach featuring the internet, 3rd Ed. Pearson Education Ind.
- Douglas E. Comer (1991). Internetworking with TCP/IP Vol. 1: Principles, protocols, and architecture, 4th Ed.
- A. Perez (2013). Mobile networks architecture, 2nd Ed. John Wiley & Sons.
- William Stallings (2006). Cryptography and Network Security", 4th Ed., Pearson Education India.
- Behrouz A. Forouzan (2015). Cryptography & network security, 3rd Ed. McGraw-Hill.