

# **COIMBATORE INSTITUTE OF TECHNOLOGY**

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

**COIMBATORE - 641 014, TAMILNADU, INDIA**

**DIAMOND JUBILEE**

(1956 - 2016)



**DEPARTMENT OF COMPUTING - AI & ML**

**M.Sc. (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)**

**Curriculum and Syllabi**

**Under Choice Based Credit System**

(For the students admitted during 2019 - 2020 and onwards)

## INDEX

<b>S.No</b>	<b>Contents</b>	<b>Page No.</b>
1.	Vision and Mission of the Institute	1
2.	Vision and Mission of the Department of Computing - AI & ML	2
3.	Programme Educational Objectives (PEOs)	3
4.	Programme Specific Outcomes (PSOs)	4
5.	Programme Outcomes (POs)	5
6.	Curriculum	6
7.	Syllabi for Semester - I	12
8.	Syllabi for Semester - II	26
9.	Syllabi for Semester - III	42
10.	Syllabi for Semester - IV	53
11.	Syllabi for Semester - V	64
12.	Syllabi for Semester - VI	75
13.	Syllabi for Semester - VIII	87
14.	Syllabi for Semester - IX	92
15.	Syllabi for Electives	98
16.	Amendments	135

# **COIMBATORE INSTITUTE OF TECHNOLOGY**

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

## **VISION AND MISSION OF THE INSTITUTE**

### **VISION**

The Institute strives to inculcate a sound knowledge in Engineering along with realized social responsibilities to enable its students to combat the current and impending challenges faced by our country and to extend their expertise to the global arena.

### **MISSION**

The Mission of Coimbatore Institute of Technology (CIT) is to impart high quality education and training to its students to make them World-Class Engineers with a foresight to the changes and problems, and pioneers to offer innovative solutions to benefit the nation and the world at large.

**DEPARTMENT OF COMPUTING - ARTIFICIAL INTELLIGENCE AND  
MACHINE LEARNING  
COIMBATORE INSTITUTE OF TECHNOLOGY**

**VISION AND MISSION OF DEPARTMENT OF COMPUTING - AI & ML**

**VISION**

Department of Computing-Artificial Intelligence and Machine Learning endeavours to make the students, world class software engineers, cutting edge researchers in Artificial Intelligence (AI) and Machine Learning (ML) and data engineers with prudence of pioneering solutions to challengers of the nation and the world.

**MISSION**

- M1** : To impart strong conceptual knowledge along with intensive practical training and real time industry/ research project exposure to the students.
- M2** : To provide a learning ambience to enhance innovations, problem solving skills, leadership qualities, team spirit and ethical responsibilities.
- M3** : To establish Industry Institute Interaction program to provide exposure to a) latest AI, ML tools and technologies used in the IT organizations and enhance the entrepreneurship skills b) domain specific problems that will benefit from AI, ML solutions.

# **COIMBATORE INSTITUTE OF TECHNOLOGY**

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## **DEPARTMENT OF COMPUTING - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**

### **M.Sc. Artificial Intelligence and Machine Learning**

(Five-Year Integrated Programme)

### **PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)**

Our graduates will be able to :

- PEO1** : Develop software solutions demonstrating intelligent behaviour, handling uncertainty, constantly learning, and effectively using domain knowledge
- PEO2** : Promote research in intelligent technology and concepts
- PEO3** : Participate in life-long learning for effective professional growth and demonstrate leadership qualities to co-ordinate cooperative team in contributing for the betterment of the society.

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## DEPARTMENT OF COMPUTING - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

### M.Sc. Artificial Intelligence and Machine Learning

(Five-Year Integrated Programme)

### PROGRAMME SPECIFIC OUTCOMES (PSOs)

Our graduates will be able to :

- PSO1** : Review the various concepts of Statistics, Mathematics and Computing appropriate to the discipline and apply it in problem solving.
- PSO2** : Write optimized codes in languages such as Python, C and Java and use open source machine learning frameworks.
- PSO3** : Acquire knowledge and coding skills necessary to support their career in software development, web development, machine learning, artificial intelligence, computer vision and cyber security.
- PSO4** : Design and develop innovative computing solutions across domains and augment intelligence in the software.

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## DEPARTMENT OF COMPUTING - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

### M.Sc. Artificial Intelligence and Machine Learning

(Five-Year Integrated Programme)

### PROGRAMME OUTCOMES (POs)

Graduates of the programme will be able to:

- PO1** : Apply skills and concepts of computer science to abstract, design and code computing models and software solutions, from requirements of a problem.
- PO2** : Analyze real world problems, customer requirements from the perspective of developing software of good quality.
- PO3** : Analyse, design, develop and implement software solutions that meet requirements and can evolve to meet changes in the requirements.
- PO4** : Apply mathematical and statistical models to explore and analyze the massive amount of data in various domains.
- PO5** : Use techniques, skills and tools of both hardware and software including (but not limited to) programming languages, operations research, data storage, decision theory, knowledge representation, visualization, privacy, security to develop scalable techniques for software programming, data analysis, and design.
- PO6** : Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
- PO7** : Recognize the need for, and have the ability to engage in independent and life-long learning.
- PO8** : Design and develop Artificial Intelligence and Machine Learning systems for analysing the varied, voluminous data in fields of medicine, business, geosciences, legal, scientific research and other domains.
- PO9** : Recognize the importance of innovation and develop a critical and research thinking approach to develop leading innovative intelligent software products.
- PO10** : Recognize social, professional, cultural, humane and ethical values and issues involved in the use of software technology and consider these adequately in developing and deploying systems.
- PO11** : Communicate effectively, domain and technical information with decision makers and team members, to derive software systems of high quality.
- PO12** : Enhance self-learning as well as capability to adapt to emerging technologies and create innovative solutions for challenging issues of society, engineering and education as part of an organization or as an entrepreneur.

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## DEPARTMENT OF COMPUTING - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

### M.Sc. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

(Five-Year Integrated Programme)

Curriculum from the Academic Year 2019 - 2020 and onwards

#### Semester I

Course Code	Course Name	L	T	P	C	CAT
19MAM11	Technical English	2	0	0	2	HS
19MAM12	Applied Algebra	3	0	0	3	BS
19MAM13	Fundamental Statistical Methods	3	0	0	3	BS
19MAM14	Data Structures	3	0	0	3	PC
19MAM15	Theory of Programming Languages	3	0	0	3	PC
	<b>PRACTICALS</b>					
19MAM16	Algebra and Statistics Lab	0	0	4	2	PC
19MAM17	Data Structures Lab	0	0	4	2	PC
19MAM18	Python Programming Lab	1	0	4	3	PC
19FYEL11	Employability Skills	0	0	2	1	EEC
	<b>TOTAL CREDITS</b>				<b>22</b>	

#### Semester II

Course Code	Course Name	L	T	P	C	CAT
19MAMLE01	Professional English	2	0	0	2	HS
19MAM21	Applied Calculus	3	0	0	3	BS
19MAM22	Probability Distributions and Applications	3	0	0	3	BS
19MAM23	Computer System Architecture	3	0	0	3	PC
19MAM24	Advanced Data Structures	3	0	0	3	PC
	<b>PRACTICALS</b>					
19MAM25	Calculus and Probability Lab	0	0	4	2	PC
19MAM26	Programming Paradigm Lab	0	0	4	2	PC
19MAM27	Advanced Data Structures Lab	0	0	4	2	PC
19FYEL21	English for Employability	0	0	2	1	EEC
	<b>TOTAL CREDITS</b>				<b>21</b>	

**Semester III**

Course Code	Course Name	L	T	P	C	CAT
	<b>THEORY</b>					
19MAM31	Artificial Intelligence	3	0	0	3	PC
19MAM32	Theory of Computing	3	0	0	3	PC
19MAM33	Database Management Systems	3	0	0	3	PC
19MAM34	Predictive Analytics	3	0	0	3	BS
19MAM35	Human Computer Interaction	3	1	0	4	PC
	<b>PRACTICALS</b>					
19MAM36	Artificial Intelligence Lab	0	0	4	2	PC
19MAM37	Database Management Systems Lab	0	0	4	2	PC
19MAM38	Predictive Analytics Lab	0	0	4	2	PC
	<b>TOTAL CREDITS</b>				<b>22</b>	

**Semester IV**

Course Code	Course Name	L	T	P	C	CAT
	<b>THEORY</b>					
19MAM41	Operations Research	3	0	0	3	BS
19MAM42	Machine Learning	3	0	0	3	PC
19MAM43	Design and Analysis of Algorithms	3	0	0	3	PC
19MAM44	Data Communications and Networking	3	0	0	3	PC
19MAM45	Operating Systems	3	0	0	3	PC
	<b>PRACTICALS</b>					
19MAM46	Machine Learning Lab	0	0	4	2	PC
19MAM47	Design and Analysis of Algorithms Lab	0	0	4	2	PC
19MAM48	Network Programming Lab	0	0	4	2	PC
	<b>TOTAL CREDITS</b>				<b>21</b>	

**Semester V**

Course Code	Course Name	L	T	P	C	CAT
	<b>THEORY</b>					
19MAM51	Advanced Machine Learning	3	0	0	3	PC
19MAM52	Artificial Neural Networks	3	0	0	3	PC
19MAM53	Knowledge Based Systems	3	0	0	3	PC
19MAM54	AI Systems Engineering	3	0	0	3	PC
19MAM55	Distributed and Cloud Computing	3	0	0	3	PC
	<b>PRACTICALS</b>					
19MAM56	Advanced Machine Learning Lab	0	0	4	2	PC
19MAM57	Full Stack Web Development Lab	0	0	4	2	PC
19MAM58	Cloud Computing Lab	0	0	4	2	PC
19MAM59	Personality Development	0	0	2	1	EEC
	<b>TOTAL CREDITS</b>				<b>22</b>	

**Semester VI**

Course Code	Course Name	L	T	P	C	CAT
	<b>THEORY</b>					
19MAM61	Intelligent Agents	3	0	0	3	PC
19MAM62	Deep Learning	3	0	0	3	PC
19MAM63	Information Retrieval and Web Search	3	0	0	3	PC
19MAM64	Big Data Analytics	3	0	0	3	PC
	Elective - I	3	0	0	3	PE
	<b>PRACTICALS</b>					
19MAM65	Deep Learning Lab	0	0	4	2	PC
19MAM66	Mobile Application Development Lab	0	0	4	2	PC
19MAM67	Big Data Analytics Lab	0	0	4	2	PC
19MAM68	Communication Skills	0	0	2	1	EEC
19MAM69	Hackathon	0	0	2	1	EEC
	<b>TOTAL CREDITS</b>				<b>23</b>	

**Semester VII**

Course Code	Course Name	L	T	P	C	CAT
19MAM71	Project Work and Viva Voce - I	0	0	0	18	EEC
	<b>TOTAL CREDITS</b>				<b>18</b>	

**Semester VIII**

Course Code	Course Name	L	T	P	C	CAT
	<b>THEORY</b>					
19MAM81	Graph Representation Learning	3	0	0	3	PC
19MAM82	Reinforcement Learning	3	0	2	4	PC
19MAM83	Meta-Heuristic Optimization Techniques	3	0	0	3	PC
	Elective II	3	0	0	3	PE
	Elective III	3	0	0	3	PE
	<b>PRACTICALS</b>					
19MAM84	Meta-Heuristic Optimization Lab	0	0	4	2	PC
	Elective Lab I	0	0	4	2	PE
	Elective Lab II	0	0	4	2	PE
	<b>TOTAL CREDITS</b>				<b>22</b>	

**Semester IX**

Course Code	Course Name	L	T	P	C	CAT
	<b>THEORY</b>					
19MAM91	Computer Vision	3	0	0	3	PC
19MAM92	Cyber Threat Intelligence	3	0	0	3	PC
	Elective - IV	3	0	0	3	PE
	Elective - V	3	0	0	3	PE
	Elective - VI	3	0	0	3	PE
	<b>PRACTICALS</b>					
19MAM93	Computer Vision Lab	0	0	4	2	PC
19MAM94	Intelligent Cyber Security Lab	0	0	4	2	PC
	Elective Lab - III	0	0	4	2	PE
	<b>TOTAL CREDITS</b>				<b>21</b>	

**Semester X**

Course Code	Course Name	L	T	P	C	CAT
19MAM101	Project Work and Viva Voce - II	0	0	0	18	EEC
	<b>Total Credits</b>				<b>18</b>	
	<b>Grand Total of Credits</b>				<b>210</b>	

**PROFESSIONAL ELECTIVES - AI & ML**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CAT</b>
19MAME01	Ethics in AI	3	0	0	3	PE
19MAME02	Healthcare Analytics	2	0	2	3	PE
19MAME03	Smart Applications	3	0	0	3	PE
19MAME04	Spatial Data Modelling and Analysis	3	0	0	3	PE
19MAME05	Augmented and Virtual Reality	3	0	0	3	PE
19MAME06	Medical Image Processing	3	0	0	3	PE
19MAME07	Natural Language Processing	3	0	0	3	PE
19MAME08	Probabilistic Graphical Models	2	0	2	3	PE
19MAME09	Cognitive Computing	3	0	0	3	PE
19MAME10	Recommender Systems	2	0	2	3	PE
19MAME11	Robotics and its Applications	3	0	0	3	PE
19MAME12	Conversational AI	3	0	0	3	PE
19MAME13	Game Theory	3	0	0	3	PE

**PROFESSIONAL ELECTIVES-INFORMATION TECHNOLOGY**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CAT</b>
19MAME14	Agile Software Development	3	0	0	3	PE
19MAME15	SOA and Web Services	2	0	2	3	PE
19MAME16	Internet of Things	3	0	0	3	PE
19MAME17	Digital Signal and Image Processing	2	0	2	3	PE
19MAME18	Cyber Security	3	0	0	3	PE

**PROFESSIONAL ELECTIVES - ECONOMICS, FINANCE AND MANAGEMENT**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CAT</b>
19MAME19	Business Intelligence	3	0	0	3	PE

**PROFESSIONAL ELECTIVES - LABORATORY**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CAT</b>
19MAMEL01	Spatial Data Modelling and Analysis Laboratory	0	0	4	2	PE
19MAMEL02	Augmented and Virtual Reality Lab	0	0	4	2	PE
19MAMEL03	Natural Language Processing Lab	0	0	4	2	PE
19MAMEL04	Graph Analytics Lab	0	0	4	2	PE
19MAMEL05	Internet of Things Lab	0	0	4	2	PE
19MAMEL06	Cyber Security Lab	0	0	4	2	PE

**ONE CREDIT COURSES\*\***

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CAT</b>
19MAMOC01	Econometrics and Machine Learning in Finance	1	0	0	1	EEC
19MAMOC02	Java Programming	0	0	2	1	EEC

\*\*Over and above the CGPA

# 19MAM11 - TECHNICAL ENGLISH

L	T	P	C
2	0	0	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : *Apply the rules of Grammar and Construct right sentences.*

**CO2** : *Categorize the Barriers to communication and formulate solutions.*

**CO3** : *Interpret the Technical Graphical representation and compose passages.*

**CO4** : *Listen and specify appropriate responses for conversations and monologues.*

**CO5** : *Comprehend presentation Strategies and speak confidently.*

### FOCUS ON LANGUAGE: GRAMMAR & VOCABULARY

Changing Words from one form to another - Word Formation: Prefixes & Suffixes - Synonyms and Antonyms - Idioms - Phrasal Verbs - Nouns-Compound Nouns & Noun Phrases - Gerunds & Infinitives - Subject-verb Agreement- Tenses - Adjectives - Expressions of Quantity - Degrees of Comparison - Relative Clause - Modal Verbs - Wh Questions - Sequence Words. (6)

### TECHNICAL COMMUNICATION

Importance of Technical Communication- General and Technical Communication -Objective & Characteristics of Technical Communication - Process of Communication - Levels of Communication - Flow of Communication -Visual Aids in Technical Communication - Barriers to Communication: Noise - Classification of Barriers -Non-verbal Communication: Kinesics - Proxemics- Chronemics- Correlating Verbal and Non-verbal Communication- Cultural Variations. (4)

### READING

Reading & Interpreting Ideas - Interpreting Graphics in Technical Writing - Intensive & Extensive Reading- Reading Comprehension - Techniques for Good Comprehension - Skimming & Scanning - Sequencing of Sentences- Reading text on different topics. (4)

### WRITING

Techniques for Good Writing - Right Words and Phrases - Sentences: Sentence Patterns- Salient Point of Sentence Construction - Paragraph Construction - Paragraph Patterns - Kinds of Paragraph - Writing a First Draft, Revising & Finalizing - Steps to Effective Précis Writing - Process Description - Dialogue Writing - Essays. (6)

### LISTENING

Meaning and Art of Listening-Importance of Listening & Empathy in Communication - Reasons for Poor Listening - Traits of a good listener - Listening modes - Short Dialogues and Conversation- Listening to monologues. (4)

### SPEAKING

Introducing oneself - Exchanging personal information - Asking for and giving information - Expressing likes and dislikes - Making requests - Agreeing and Refusing Requests - Complaining, apologizing - Giving excuses, instructions and suggestions- Describing positive and negative features, favourite snacks, vacation plans, technology, holidays, festivals, customs and special events - - Making comparisons - Talking about food - giving step by step instructions, travel advice - Achieving Confidence, Clarity & Fluency

- Vocal Cues - Barriers to Speaking - Types of Speaking - Persuasive Speaking - Public Speaking - Effective Presentation Strategies - Planning - Outlining & Structuring - Nuances of Delivery - Controlling Nervousness & Stage Fright - Visual Aids in Presentation - Applications of MS Power Point. (6)

**Practical sessions based on the above syllabus**

**TOTAL : 30**

### **TEXT BOOKS**

1. Jack C Richerds, *'Interchange - 2'*, CUP, Fourth Edition, Chennai, 2015.
2. Meenakshi Raman, Sangeeta Sharma, *'Technical Communication - Principles and Practice'*, Oxford University Press, New Delhi, 2015.

### **EXTENSIVE READING**

1. Abhijit Acharjee & Rakesh Ramamoorthy, *'Frontiers of Communication - An Anthology of Short Stories and Prose'*, CUP, 2018. (Only Essay Questions)

### **REFERENCES**

1. Sudharshana N. P. and Savitha C, *'English for Technical Communication'*, CUP, 2016.
2. Sudharshana N. P. and Savitha C, *'English for Engineers'*, CUP, 2018
3. Ronald Carter, Michael Mc Carthy, *'Cambridge Grammar of English'*, Cambridge University Press, 2011.
4. Michael Mc Carthy and Felicity O'Dell, *'English Vocabulary in Use'*, Cambridge University Press, 2012.
5. Mark Ibbotson, *'Cambridge English for Engineering'*, Cambridge University Press, 2012.

# 19MAM12 - APPLIED ALGEBRA

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Gain knowledge in sequences and series to analyse and study their area of applications

**CO2** : Become familiar in linear algebra concepts for data analysis in economics

**CO3** : Identify and understand linear algebra techniques which are applied in AI and ML

**CO4** : To incorporate the concepts of numerical solutions of linear systems which are widely used in Computer Applications.

**CO5** : Apply difference equation concepts in data modelling.

## SEQUENCES AND SERIES

Arithmetic, geometric, and harmonic sequences-Finite and infinite series. Convergence and divergence of infinite series-Simple examples-nth term test for divergence and p-series convergence. Applications of series in financial mathematics: Simple and Compound Interest-Nominal and Effective Interest Rates-Continuous Compounding -Future Value and Present Value-Annuities-Ordinary Annuity: Future and Present Value, Annuity Payment, Principal Sum, Period and Interest Rate, Annuity Due, Deferred Annuity and Perpetuity. (11)

## VECTOR SPACES

Definition of vector spaces-linearly dependent and independent-subspaces-basis and dimension-of vector space-rank and nullity of linear transformation. Inner product, properties- Cauchy Schwarz-inequality, norm and its properties, introduction of orthogonal basis and Gram-Schmidt orthogonalization process. (11)

## MATRIX ALGEBRA

Eigen Values and Eigen Vectors: Eigenvalues and eigenvectors-Cayley-Hamilton theorem (without proof)-Diagonalization-Quadratic form reduction in three variables-applications.

Matrix factorization techniques-special matrices-permutation matrix (non-negative elements)-Hessenberg matrix-sparse matrix-sparse matrix-band width-Linear system of equations-Gauss elimination-Gauss Jordan-Inverse of a matrix-Gauss-seidal-iteration method. Application of Linear systems: A homogeneous system in economics- non homogenous system by inversion-Applications of Matrices in Input-Output Analysis in Economics. (12)

## DIFFERENCE EQUATIONS

Finite differences-operators and their interrelations-Solutions of finite difference equations with constant coefficients-Solution of first order equation (Iterative Method)-General method of solving first order difference equation-simple applications in economics. (11)

**TOTAL : 45**

## TEXT BOOKS

1. Srimanta pal and Subodh C. Bhunia, "Engineering Mathematics", Oxford University Press India, 1st Edition, 2015. (Para I, Para IV).
2. Biswa Nath Datta, "Numerical Methods for Linear Control Systems Design and Analysis", Elsevier Academic press, 2004. (Para III).
3. David. C. Lay, "Linear Algebra and its Applications", Addison Wesley, 2003. (Para II).

4. Curtis F Gerald and Patrick O Wheatly, "Applied Numerical Analysis", Pearson Education, 2002. (Para V).
5. Mehta B.C, and G.M.K. Madani, "Mathematics for Economists", Sultan Chand & Sons, New Delhi, 2006. (Para III)

#### **REFERENCES**

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Eight Edition, John Wiley & Sons Asia Private Limited, 2008.
2. Grewal, B.S., "Higher Engineering Mathematics", Fourth Edition, Khanna Publishers, 2007.
3. Piskunov, "Differential and Integral Calculus", MIR Publisher Moscow, 1974.
4. Wylie C. R. & Barret L. C "Advanced Engineering Mathematics" Sixth Edition, McGraw Hill, New York, 1995.

# 19MAM13 - FUNDAMENTAL STATISTICAL METHODS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : To describe and discuss the key terminologies, concepts, statistical tools and techniques used in statistical analysis.

**CO2** : To calculate and apply measures of central tendency and measures of dispersion for grouped and ungrouped data.

**CO3** : To analyze probability and probability distributions and moments of random variables.

**CO4** : To understand basic concepts in sampling.

**CO5** : To analyze bivariate data using correlation and simple regression.

## INTRODUCTION TO STATISTICS

Definition -Data -Qualitative and Quantitative - Measurement of Data -Nominal and Ordinal - Raw data and grouped data - Primary and Secondary Data - Methods of Collection -Classification of Data - Tabulation -Frequency Distribution and Various Diagrammatic and Graphical Representations of Data. (8)

## SUMMARY STATISTICS

Measures of Central Tendency: Arithmetic Mean, median, mode, geometric mean and harmonic mean - Merits and demerits- Relationship between mean, median and mode-Relationship AM, GM and HM, computation of the measures for grouped and ungrouped data-Weighted arithmetic mean

Measures of Dispersion: Range, Mean Deviation and Standard Deviation - Coefficient of Variation and its Use- Quartiles and inter quartile range-Quintiles deciles and percentiles- Moving averages -Skewness and Kurtosis and their uses. (10)

## PROBABILITY

Deterministic and Random Experiments -Definition of Sample Space and Events- Classical and Axiomatic Definitions- Properties of Probability- Addition Theorem- Conditional Probability and Multiplication Theorem of Probability- Definition of Independent Events - Random Variables and their Probability Distributions-Discrete and Continuous Random Variables Probability Mass Function and Cumulative Distribution Functions -Definition - Mathematical Expectation-Mean and Variance - Mean and Variances of Linear Combination of Random Variables - Chebyshev's Theorem - Important Discrete Distributions-Discrete Uniform Distribution, Binomial, Poisson-Continuous Distributions: Probability Density Functions and Cumulative Probability Distributions-Normal Distribution and its Properties and Applications. (12)

## SAMPLING

Population and Sample- Sampling and its need -Sampling vs. Complete Enumeration -Parameter and Statistics-Probability Sampling and - Random Sampling- Simple Random Sampling, Lottery Method and Random Number Table Method- Stratified Random Sampling- Sampling distribution and standard error of a statistic. (8)

## CORRELATION AND REGRESSION

Definition of correlation - Scatter plot -Karl Pearson's correlation coefficient its properties- Definition of Regression - Simple Regression-Regression of x on y and y on x. (7)

**TOTAL : 45**

## **TEXT BOOK**

1. S.C. Gupta, *'Fundamentals of Statistics', 7th and Enlarged Edition, Himalaya Publishing House, 2014.*

## **REFERENCES**

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye , *'Probability and Statistics for Engineers and Scientists', Seventh Edition, Pearson Education, Inc., 2002.*
2. D M Levine T C Krehbiel and M L Berensen, *'Business Statistics: A First Course', Pearson Education, 2003.*

# 19MAM14 - DATA STRUCTURES

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : Understand the basics programming constructs of C language and write C programs to solve problems.
- CO2** : Recognize the representation of arrays, stacks, queues and linked list in memory and demonstrate its use in algorithms.
- CO3** : Solve computational problems using data structures such as arrays, stacks, queues and singly linked list.
- CO4** : Compare and use appropriate data structures in programming real world applications.
- CO5** : Learn and apply basic searching and sorting techniques in applications.

## INTRODUCTION TO C

Overview of C - Basic data types - Identifier Names - Variables and Initialization - Constants - Operators - Expressions - Input/ Output. **Control Statements:** Selection statements - Iteration statements - Branch statements - Expression statements. **Functions:** General form of a function - Accessing a function - Scope of a function - Passing Arguments to function - function prototype - Call by value - Call by reference - Recursion. **Arrays** : Single Dimensional arrays - Multi Dimensional arrays - Passing arrays to a function - Arrays and Strings. **Pointers** : Definition - Pointer type declaration - Pointer assignment - Pointer initialization - Pointer variables - Pointer operators - **Structures** : Defining and Accessing Structures. (12)

## BASIC CONCEPTS

Algorithm Specification - Data Abstraction - Primitive Data Structures - Iterative and Recursive algorithms - Performance Analysis: Space Complexity, Time Complexity, Asymptotic Notation. (6)

## ARRAYS

Array as an Abstract Data Type (ADT) - Implementation of One-Dimensional Array, Two Dimensional Arrays - Sparse Matrices- Applications- Representation of Multidimensional Arrays -String ADT. (8)

## STACKS AND QUEUES

Stack Primitive Operations- Array Representation and Implementation-Applications: Subroutine Handling, Recursion and Expression Processing. Queue Operations-Sequential Implementation - Circular Queues - Dequeues-Applications. (8)

## LINKED LISTS

Singly linked lists- Operations- Applications (4)

## SEARCHING AND SORTING

Linear Search and Binary Search-Selection Sort-Insertion Sort and Bubble Sort. (7)

**TOTAL : 45**

## TEXT BOOKS

1. Ellis Horowitz, Sartaj Sahni, Anderson-Freed, 'Fundamentals of Data Structures in C', University Press, Second Edition, 2008.
2. Yashavanth Kanetkar, 'Let Us C', BPB Publications, Fifteenth Edition, 2002. (Para I)

## REFERENCES

1. Byron Gottfried, 'Schaum's Outline of Programming with C', McGraw-Hill, Fourth Edition, 2018
2. Mark Allen Weiss, 'Data Structures and Algorithm Analysis in C', Pearson Edition, 2014.
3. Aaron M. Tenenbaum, Yedidiah Langsam and Moshe J. Augenstein, 'Data structures using C & C++', Prentice Hall, 2012.
4. Krishnamoorthy R, 'Data Structures using C', Mc Graw-Hill Education Pvt. Ltd, 2010.

# 19MAM15 - THEORY OF PROGRAMMING LANGUAGES

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Identify the paradigms of programming languages and apply the concepts of imperative programming in program development

**CO2** : Analyze various components of object-oriented programming and apply them to real-world applications.

**CO3** : Understand the concepts of functional, programming and relate them to apply in various programming languages.

**CO4** : Understand the concept of logical programming and implement them using PROLOG.

**CO5** : Comprehend Assembly level language programming and gaining knowledge in writing assembly language programs.

## PROGRAM CONSTRUCTS AND THEIR TYPES

Introduction to program constructs: Program units and Program types. (4)

## IMPERATIVE PROGRAMMING

Programming Paradigms- Statements: Structured Programming- Syntax-Directed Control Flow. Design Considerations: Syntax. Special Cases in Loops. Invariants. Partial Correctness. Control flow. Types: Data Representation-Role of Types- Basic Types Arrays-Records-Sets-Pointers- String Tables-Types and Error Checking-Procedure Activations-Activation Records- Parameter-Passing Methods-Scope Rules for Names-Nested Scopes in Source Text-Lexical Scope. (8)

## OBJECT-ORIENTED PROGRAMMING

Groupings of Data and Operations-Constructs for Program Structuring-Information Hiding- Design with Modules-Modules and Defined Types-Class Declarations-Dynamic Allocation. Templates: Parameterized Types-Object-Oriented Programming-Object-Oriented Thinking- Inheritance-Derived Classes and Information Hiding-Objects in Smalltalk. (8)

## FUNCTIONAL PROGRAMMING

Elements of Functional Programming. Types: Values-Operations-Function Declarations. Approaches to Expression Evaluation-Lexical Scope-Type Checking- Functional Programming in a Typed Language-Exploring a List-Functions as First-Class Values-Functional Programming with Lists- Structure of Lists- List Manipulation. (10)

## LOGICAL PROGRAMMING

Connectives - Conditional and Bi-conditional statements -Statement formulae and Truth tables -Tautologies and Tautological Implications -Normal forms -Disjunctive and Conjunctive Normal Forms - The Theory of Inference for the Statement Calculus - Consistency of Premises - The Predicate Calculus - Variables and Quantifiers - Special variable formulae involving Quantifiers-Theory of Inference for the Predicate Calculus. (6)

Computing with Relations. Prolog: Data Structures-Programming Techniques-Control. (3)

## ASSEMBLY LANGUAGE PROGRAMMING

Introduction to 8085 Instructions: Data Transfer Operations-Arithmetic Operations-Logic Operations-Branch Operations-Writing Assembly Language Programs. (6)

**TOTAL : 45**

## **TEXT BOOKS**

1. Ravi Sethi, '*Programming languages: Concepts and Constructs*', Second Edition, Addison Wesley 1995. (Para II-VI: Chapters 1, 3 to 11).
2. E.V. Krishnamoorthy, '*Introduction to Theory of Computation*', East West Press, 1983. (Para I).
3. Ramesh Gaonkar, '*Microprocessor Architecture, Programming and Applications with the 8085*', 2002, Sixth Edition, PENRAM International Publishing Pvt. Ltd. (Para VII)

## **REFERENCES**

1. Ellis Horowitz, '*Fundamentals of Programming Languages*', Springer-Verlag, 1983.
2. Terrence W Pratt, Marvin Zelkowitz, '*Programming Languages Design and Implementation*', Pearson Education, Fourth Edition, 2003.

## 19MAM16 - ALGEBRA AND STATISTICS LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

**CO1** : Solve problems in linear algebra using Scilab / R scripts and commands

**CO2** : Compute measures of central tendency and dispersion using Spreadsheets in built functions

**CO3** : Graphically represent statistical data using Spreadsheet tools

**CO4** : Analyze Bi-variate data using Spreadsheet's Data Analysis Tools

**CO5** : Develop skills in writing script files and analyze data using R and Spreadsheet's Data Analysis Pack

### CONCEPTS TO BE COVERED

1. Scilab/R Fundamentals
2. Algebraic operations on matrices, Transpose of a matrix, Determinants, inverse of a matrix,
3. Solving System of linear equations and consistency,
4. Row reduced echelon form and normal form.
5. Eigen values, Eigen vectors, Rank of a matrix.
6. Solving algebraic and system of equations.
7. Estimating numerical values for given data by means of interpolation.
8. Perform data manipulation using spreadsheet.
9. Perform graphical and diagrammatic representation of statistical data, like bar diagram, pie, histogram and line diagram
10. Construct the pivotal tables and apply statistical functions to calculate the descriptive statistics
11. Practice the theory behind the descriptive statistics, like measures of central tendency, dispersion, skewness and kurtosis
12. Apply and implement the theory of probability in various applications
13. Simple probability and random sampling
14. Practicing the simple correlation and regression techniques.

**Software/Tools** : Scilab or R & Spreadsheet

**TOTAL : 60**

### REFERENCES

1. K.N.Berk and P.Carey, *Data Analysis with Microsoft Excel*, Brooks/Cole, USA, 2010
2. Gilberto E.Uroz, *Matrices and Linear Algebra with SCILAB*, [http://www.tf.uns.ac.rs/~omorr/radovan\\_omorjan\\_003\\_prll/s\\_examples/Scilab/Gilberto/scilab5a.pdf](http://www.tf.uns.ac.rs/~omorr/radovan_omorjan_003_prll/s_examples/Scilab/Gilberto/scilab5a.pdf)
3. Graeme Chandler and Stephen Roberts, *Scilab Tutorials for Computational Science*, [http://paginapessoal.utfpr.edu.br/previero/calculo-numerico-ma64a-em41-e-em42/informacoes-da-disciplina/Scilab\\_Tutorials.pdf](http://paginapessoal.utfpr.edu.br/previero/calculo-numerico-ma64a-em41-e-em42/informacoes-da-disciplina/Scilab_Tutorials.pdf)

# 19MAM17 - DATA STRUCTURES LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

- CO1** : Solve the given problem by devising an algorithm and implementing it into a program.
- CO2** : Develop reusable and efficient solutions using functions, pointers and structures.
- CO3** : Write programs to perform operations on strings using library functions.
- CO4** : Implement stacks, queues and singly linked list using Arrays
- CO5** : Write programs to implement linear search, binary search and sorting algorithms like selection, insertion and bubble sort.

## CONCEPTS TO BE COVERED

### Basic Programming

1. Programs to understand the concepts of data types.
2. Writing algorithms and converting them to programs to get familiarity on using conditional, control and Iterative statements.
3. Programs on recursion
4. Programs on string manipulations
5. Programs on one- and two-dimensional arrays
6. Declaring and defining functions, passing arguments, calling functions
7. Programs using pointers-variables and expressions
8. Creating and accessing structures

### Data Structures

1. Sparse and dense matrix operations using arrays.
2. Stack implementation and operations using arrays.
3. Queue implementation and operations using arrays.
4. Singly linked list implementation and operations using arrays
5. Programs on linear search and binary search
6. Programs on selection sort, insertion sort and bubble sort

**TOTAL : 60**

## REFERENCES

1. Yashavanth Kanetkar, 'Let Us C', BPB Publications, Fifteenth Edition, 2002.
2. Richard F. Gilberg and Behrouz A. Forouzan, 'Data Structures- A Pseudocode Approach with C', Cengage Learning, Second Edition, 2005.
3. Deitel H. M. and Deitel P. J., 'C - How to Program', Prentice-Hall, Fifth Edition, 2006.

## 19MAM18 - PYTHON PROGRAMMING LAB

L	T	P	C
1	0	4	3

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

- CO1** : *To write, test, and debug simple Python programs.*
- CO2** : *To implement Python programs using conditional, control and repetition statements.*
- CO3** : *Use functions and recursive functions for structuring Python programs.*
- CO4** : *Represent compound data using lists, tuples, dictionaries.*
- CO5** : *Read and write data from or to files in Python and use of libraries.*

### CONCEPTS TO BE COVERED

1. Naming conventions, basic operators, data types
2. Use of conditional, control and repetition statements
3. String operations and using string functions
4. Demonstrate use of Lists and Tuples
5. Demonstrate use of Dictionaries
6. Implement simple search and sort techniques
7. Demonstrate usage of basic regular expression
8. Demonstrate use of advanced regular expressions for data validation.
9. Implement linear data structures - arrays, stack and queue
10. Read and write into a file.
11. Create Comma Separate Files (CSV), Load CSV files into internal Data Structure
12. Demonstrate Exceptions in Python
13. Use of Python Libraries such as numpy, pandas, matplotlib, etc.

**TOTAL : 75**

# 19FYEL11 - EMPLOYABILITY SKILLS

L	T	P	C
0	0	2	1

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

**CO1** : *Demonstrate, command over conversations using appropriate functional expressions.*

**CO2** : *Generate Ideas and speak confidently for speaking tasks.*

**CO3** : *Solve objective questions on Logical Reasoning and Verbal ability.*

**CO4** : *Comprehend the text correctly and perform the speaking activity.*

**CO5** : *Listen to monologues, conversations and produce appropriate responses.*

## INTRODUCTION TO SPOKEN ENGLISH

Self-Introduction - Barriers to Speaking and Listening - Introduction to Spoken English, Greetings, Thanking - Apologizing, Congratulating - Giving Directions, Shopping - Role Play. (6)

## VOCABULARY

Activity based on newspaper articles - Word Building - A picture and a few words activity - Current Events. (4)

## VERBAL APTITUDE

Alphabet test - Alphabet Order, Alphabet Series - Letter Word Problem, Word Formation and Scramble - Series Completion -Para Jumbles- Synonyms and Antonyms- Types and Exercises- Sentence Completion -Types and Exercises. (8)

## READING

Reading Comprehension- Skimming and Scanning - Reading Prose - Bacon's Essays (Speaking Activity based on the essays) - Story Building- Extempore - Movie Reviews. (4)

## LSRW SKILLS

Speech Sounds - Word Vocabulary - Reading Comprehension - Listening Practice- I -Dialogue Writing - Conversational Exercise - I - Focus on Language - Creative Writing - Conversational Exercise - II - Listening Practice - II. (8)

**TOTAL : 30**

# 19MAMLE01 - PROFESSIONAL ENGLISH

L	T	P	C
2	0	0	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Apply the rules of Grammar and write grammatically correct sentences.

**CO2** : Acquire Telephonic skills and Negotiation skills.

**CO3** : Perceive the text, make notes and summarize.

**CO4** : Compose Business Letters and prepare a Job Application Letter with Resume.

**CO5** : Identify the Barriers to Listening and produce correct responses for Listening tasks.

**CO6** : Acquire Interview skills and Group Discussion skills.

## FOCUS ON LANGUAGE : ENGLISH GRAMMAR & VOCABULARY

One Word Substitutes - Homophones - Homonyms - Eponyms - Direct Indirect Speech - Active Passive Voice - Conditional Sentences - Adverbs - Conjunctions - Prepositions - Articles - Relative Clause - Pronouns - Cause and Effect Expressions - Purpose and Function - Modals. (6)

## BUSINESS ENGLISH

Telephoning Skills: Understanding Telephone communication - Telephonic Conversations and Etiquettes - Handling Calls - Leaving a Message - Making Requests - Asking for and Giving Information - Giving Instructions - Negotiations: Types of Negotiation - Six Basic Steps of Negotiations - Informal and formal Negotiations. (4)

## READING

Summarizing - SQ3R Reading Technique - Note Making: Outline/Linear Method- Sentence Method - Schematic/Mapping Method - Understanding Discourse Coherence - Cloze Comprehension - Critical Reading: Creative and Critical Thinking- Reading proverbs, online advice forum. (4)

## WRITING

Letter Writing - Business Letters - Cover Letters - Resumes - Memos - Emails - Reports - Technical Proposals - Instructions & Recommendations - Technical Description - Checklist - Writing a paragraph - Writing a description of a person's past present and future, recent experiences, movie review, list of roles - Writing a job application letter, Advice column list - Writing a guide book introduction - Writing about people response to a survey. (6)

## LISTENING

Stress and Intonation -Types of Listening - Barriers of Effective Listening - Listening for Generic Content and Specific Information - Listening & Note Taking - Intensive Listening - Listening to Descriptions - Listening to predicaments, call in radio show and excuses. (4)

## SPEAKING

Group Communication: Forms of Group Communication - Using Body Language in Group - Discussions - Group Discussions - Organizational GD - GD as a Part of Selection Process - Meetings - Conferences - Symposia & Seminars - Interviews: Objectives of Interviews - Types of Interviews - Job Interviews -Media Interviews - Press Conference - Describing abilities and Skills, acceptable and prohibited behaviour in different situations, Personality Traits, Countries, a predicament, Recent past

events and experiences, movies and books - Giving Advice and suggestions- Making polite requests - Making invitations and excuses- Speculating about past and future events. (6)

**Practical sessions based on theory**

**TOTAL : 30**

### **TEXT BOOKS**

1. Jack C Richerds, *'Interchange - 2', Fourth Edition, Cambridge University Press, 2015.*
2. Meenakshi Raman, Sangeeta Sharma, *'Technical Communication - Principles and Practice', Oxford University Press, 2015.*

### **REFERENCES**

1. Sudharshana N. P and Savitha C, *'English for Technical Communication', CUP, 2016.*
2. Sudharshana N. P and Savitha C, *'English for Engineers', CUP, 2018.*
3. Ronald Carter and Michael Mc Carthy, *'Cambridge Grammar of English', Cambridge University Press, 2011.*
4. Michael Mc Carthy and Felicity O'Dell, *'English Vocabulary in Use, Cambridge University Press, 2012.*
5. Mark Ibbotson, *'Cambridge English for Engineering', Cambridge University Press, 2012.*

# 19FY22F - BASIC FRENCH

L	T	P	C
2	0	1	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : *Understand the basics of the Language*

**CO2** : *Write simple narration and description and speak to communicate idea.*

**CO3** : *Demonstrate confidence in Social Interactions.*

## INTRODUCTION

(2)

### UNITÉ-1

Faire connaissance - inviter et répondre à une invitation - décrire les personnes- articles définis et indéfinis - genre et nombre des noms et des adjectifs- interrogation et négation - conjugaison du présent. Paris monuments et lieux publics - la vie de quatre parisiens de professions différentes.

(7)

### UNITÉ-2

Exprimer l'ordre et l'obligation demander et commander - évaluer et apprécier- féliciter et remercier - articles partitifs -adjectifs démonstratifs et possessifs prépositions et adverbes de quantité et de l'imperatif verbes pronominaux - une région de France la Bourgogne - vie quotidienne à la campagne.

(6)

### UNITÉ-3

Raconter et rapporter - donner son avis - se plaindre et réprimander - expliquer et justifier - pronoms compléments -futur proche - passé composé et imparfait. Plusieurs régions de France - différents univers sociaux.

(7)

### UNITÉ-4

Demander l'autorisation - interdire - formuler des projets - discuter et débattre. Pronoms < en > et < y > - pronoms relatifs et superlatifs - conjugaison du futur - présent continu et passé récent. La vie administrative et régionale - problèmes économiques et écologiques - traditions et modernité.

(8)

## Practical sessions based on theory

(15)

**TOTAL : 45**

## TEXT BOOK

1. *Le Nouveau Sans Frontières - Philippe Dominique, Jacky Girardet Michèle Verdelhan, Michel Verdelhan*

## REFERENCES

1. *Dondo Modern French Course - Mathurin Dondo.*

2. *Modern French Grammar - Margaret Lang and Isabelle Perez.*

# 19FY22G - BASIC GERMAN

L	T	P	C
2	0	1	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : *Understand the fundamental concepts of the Language*

**CO2** : *Write simple narration and description and speak to communicate idea.*

**CO3** : *Demonstrate confidence in Social Interactions.*

## EINFUHRUNG

Begrüßung - Name - Vorname - Familienname - Anrede

(5)

## THEMA

Hallo ! Wie geht's?

Begegnungen

Guten Tag, ich suche...,

Im Supermarkt

Arbeit und Freizeit

Familie und Haushalt

(7)

## GRAMMATIK-I

Position des Verbs : Aussage, W - Frage und

Ja/Nein - Frage; Artikel die der das.

W - Frage; Konjugation in Präsens;

Nominativ : bestimmter, unbestimmter und negative Artikel

Akkusativ : unbestimmter und negativer Artikel

Adjektive : Akkusativ-Ergänzung

(10)

## GRAMMATIK-II

Artikel als Pronomen Dative - Ergänzung : Personalpronomen und Ortsangaben; Imperativ Modalverben; Ortsangaben;

Richtungsangaben; Zeitangaben; Ordinalzahlen Possessiv - Artikel; trennbare und nicht trennbare Verben; Wechselpräpositionen

(8)

**Practical sessions based on theory**

(15)

**TOTAL : 45**

## TEXT BOOK

1. *Studio d A1: Kurs - und Übungsbuch (Deutsch als Fremdsprache) Cornelsen Verlag.*

## REFERENCE

1. *Tangarm aktuell 1 : Kursbuch + Arbeitsbuch (Deutsch als Fremdsprache) Max Hueber Verlag*

# 19MAM21 - APPLIED CALCULUS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM12

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Become familiar in calculus tools to solve problems in optimization

**CO2** : Understand the concepts of integral calculus with a view towards applications.

**CO3** : Apply differential equations modeling.

**CO4** : Gain knowledge in Fourier series to analyze and study pattern recognition.

**CO5** : Get in-depth knowledge in numerical methods which are widely used in computer applications.

## DIFFERENTIAL CALCULUS

Rate of change and limits-rules for finding limits-extensions of the limit concept-continuity-tangent lines-the derivative of function-related rates of change-extreme values of functions-the mean value theorem-first derivative test for local extreme values. (7)

## APPLICATIONS OF DIFFERENTIAL CALCULUS

Curvature-Evolutes-Envelopes-partial differentiation-Jacobians-Functions of several variables--Hessian Matrix-Expansions and extreme values- Constrained extrema using Lagrange's multiplier method. (8)

## INTEGRAL CALCULUS

Integration-definition and geometrical meaning-double integrals as volumes-changing the order of integration, triple integrals in rectangular coordinates-applications to areas and volumes--compound interest. Special Functions: Beta and Gamma Functions-Double and triple integrals - Applications: Area - Volume. (7)

## FOURIER SERIES

Dirichlet's conditions-Full range series-Half range series-Complex form of series-Parseval's identity -Harmonic analysis. (8)

## ORDINARY DIFFERENTIAL EQUATIONS

Formation of differential equations-geometrical interpretation of ODE- Higher order differential equations with constant coefficients-Euler Cauchy Type-Applications in microeconomics. (7)

## NUMERICAL METHODS

Solution of Algebraic and transcendental Equations-Bisection Method and Newton Raphson Method--Real World Applications of Newton Raphson Method: Finding the Break Even Point of a Firm and finding the interest rates of Annuities -Interpolations-Newton's and Lagrange's method. Numerical solution of system of Equations. Numerical Integration-Numerical solution of ordinary differential equation of First order - RK method of order four-Milne Thomson method. (8)

**TOTAL : 45**

## TEXT BOOKS

1. Thomas & Finney, 'Calculus', Pearson Education, Ninth Edition, 2006. (Para I,II, & III).
2. Srimanta Pal and Subodh C. Bhunia, 'Engineering Mathematics', Oxford University Press India, First Edition, 2015. (Para IV, Para V).
3. Mehta B.C, and G.M.K. Madani, 'Mathematics for Economists', Sultan Chand & Sons, 2006. (Para II, Para III, Para V)
4. Kandasamy P.et.al., 'Numerical Methods', First Revised Edition, Tata McGraw Hill Publishing Company Ltd., 2008. (Para VI)

## REFERENCES

1. Erwin Kreyszig, '*Advanced Engineering Mathematics*', Eighth Edition, John Wiley & Sons Asia Private Limited., 2008.
2. Grewal, B.S., '*Higher Engineering Mathematics*', Fourth Edition, Khanna Publishers, 2007.
3. Piskunov, '*Differential and Integral Calculus*', MIR Publishers, Moscow 1974.
4. Wylie C.R. & Barret L.C, '*Advanced Engineering Mathematics*', Sixth Edition, Mc Graw Hill, New York, 1995.
5. Steven C. Chapra and Raymond P. Canale, '*Numerical Methods for Engineers*', Sixth Edition, McGraw Hill, 2002.

# 19MAM22 - PROBABILITY DISTRIBUTIONS AND APPLICATIONS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM13

## ASSESSMENT : THEORY

### COURSE OUTCOMES

- CO1** : To understand the properties and applications of advanced probability distribution.
- CO2** : To determine the moments and moment generating functions of important probability distributions and to impart knowledge on the functions of random variables.
- CO3** : To provide a good knowledge on the various methods of estimation of parameters.
- CO4** : To apply various tests of statistical hypothesis on a given statistical data.
- CO5** : Demonstrate the use and applications of Bayesian Analysis

### PROBABILITY DISTRIBUTIONS

Discrete Random Variables : Geometric, negative binomial distributions and hyper geometric distributions. Continuous Probability Distributions : Uniform, Exponential, Gamma, Beta, Chi-square Log Normal and Weibull distributions and their properties. (8)

### FUNCTIONS OF RANDOM VARIABLES

Moments and Moment Generating functions of important distributions-Transformations of Variables and finding their distributions -method of direct transformation and method of moment generating functions - Joint and Marginal Probability mass functions (for discrete) and density functions(for continuous) - Conditional probability distributions-conditional mean and variance-Independence of random variables. (10)

### ESTIMATION

Estimation of parameters using method of moments- Maximum Likelihood Point Estimation(MLE) -Properties of estimators-Unbiasedness, minimum variance consistency, efficiency and sufficiency-Mean Square Error-Asymptotic properties-consistency-Fisher Information and Cramer-Rao's Inequality - Interval Estimation. (8)

### SAMPLING AND TESTS OF HYPOTHESIS

Derivation of sampling distribution of mean and  $S^2$ - t-distribution and F-distribution-Central limit theorems- Test of significance - Basic concepts - null hypothesis - alternative hypothesis - level of significance - Standard error and its importance - steps in testing-One and two tailed tests-The use of p-values for Decision making - Large sample tests and Small sample tests for : Single sample: Testing on a single mean with variance known and variance unknown-Two samples-tests on means -One sample test on a single proportion-two sample tests of two proportions-Goodness of Fit tests, One and two sample tests concerning variances-Tests of independence for categorical data, tests for homogeneity. (12)

### BAYES THEOREM AND BAYESIAN STATISTICS

Partition of a sample space and Bayes Theorem (with proof)-Simple applications -Bayesian Concepts-Subjective Probability-Conditional Perspective-Bayesian Inferences-Prior and posterior distributions- Point Estimation Using the Posterior Distribution-Bayesian Interval Estimation-Bayes Estimates using Decision Theory framework: Bayes estimate under squared error loss function and absolute error loss function. (7)

**TOTAL : 45**

## TEXT BOOKS

1. S.C. Gupta, 'Fundamentals of Statistics', Seventh and Enlarged Edition, Himalaya Publishing House, 2014. (Para I-IV).
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, 'Probability and Statistics for Engineers and Scientists', Seventh Edition, Pearson Education, Inc., 2002. (Para V).

## REFERENCES

1. S.C. Gupta and V.K. Kapoor, 'Fundamentals of Mathematical Statistics', Tenth Revised Edition, Sultan Chand & Sons, 2002.
2. Meyer, Paul L., 'Introductory Probability and Statistical Applications', Addison Wesley, Second Edition, 1970.
3. Anthony O'Hagan and Bryan R. Luce, 'A Primer on Bayesian Statistics in Health Economics and Outcomes Research', MEDTAP International, Inc., 2003.
4. Michael Baron, 'Probability and Statistics for Computer Scientists', CRC Press, 2014.
5. Gianluca Bontempi, 'Handbook Statistical Foundations of Machine Learning', 2017.

# 19MAM23 - COMPUTER SYSTEM ARCHITECTURE

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Understand the basic structure and operation of digital computer

**CO2** : Perform arithmetic operation on the various number systems and conversions among them

**CO3** : Apply Boolean algebra to solve logic functions.

**CO4** : Understand the basics of pipelining and I/O interfaces.

**CO5** : Evaluate the performance of memory systems.

**CO6** : Understand parallel processing architectures and GPUs.

## BASIC COMPUTER SYSTEM

Introduction-Technologies for Building Processors and Memory - Performance - Instructions: Language of the Computer-Operations, Operands - Instruction Representation. (4)

## NUMBER SYSTEMS AND CODES

Decimal, Binary, Octal and Hexadecimal Systems - Number base conversions-BCD (8421) code - Gray code and conversion-ASCII code - Error detecting and correcting codes: parity bit, block parity, Hamming code. (7)

## BINARY ADDITION AND SUBTRACTION

1's, 2's, 9's, 10's, 15's, 16's Complement representation - 1's and 2's Complement subtraction - unsigned and signed numbers - BCD addition - 9's and 10's BCD subtraction - Binary Multiplication and Division. (8)

## BOOLEAN ALGEBRA AND LOGIC GATES

Laws of Boolean algebra - Basic theorem and properties - Boolean expression and function - Canonical and Standard forms - Minimization of Boolean expression - Karnaugh Map and Quine Mc-Cluskey Method- Basic logic gates and truth tables - universal gates implementation. (8)

## PROCESSOR AND CONTROL UNIT

Building a Data path - Control Implementation Scheme - Pipelining - Handling Data Hazards & Control Hazards - Exceptions. (6)

## MEMORY & I/O SYSTEMS

Memory Hierarchy - Memory Technologies - Cache Memory - Measuring and Improving Cache Performance - Virtual Memory: Page Faults, Translation Lookaside Buffer. (5)

## PARALLELISIM

Parallel Processing Challenges - Flynn's classification: SISD, MIMD, SIMD, SPMD, and Vector Architectures - Multi-Core Processors and other Shared Memory Multiprocessors - CUDA Basics-GPU versus CPU-Overview of GPU Architecture-GPU as a Co-processor. (7)

**TOTAL : 45**

## **TEXT BOOKS**

1. *David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Fifth Edition, Morgan Kaufmann / Elsevier, 2014. (Para I, V, VI).*
2. *A.P.Godse and Dr. D.A. Godse, 'Digital Electronics', Technical Publications, Pune, 2008. (Para II, III, IV).*
3. *William Stallings, Computer Organization and Architecture - Designing for Performance, Tenth Edition, Pearson India Education Services Pvt. Ltd., 2017. (Para VII)*

## **REFERENCES**

1. *Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, 'Computer Organization and Embedded Systems', Sixth Edition, Tata McGraw Hill, 2012.*
2. *John P. Hayes, 'Computer Architecture and Organization', Third Edition, Tata McGraw Hill, 2012.*

# 19MAM24 - ADVANCED DATA STRUCTURES

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM14

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : *Implement the linked representation and traversal operations on singly and doubly linked list.*

**CO2** : *Gain knowledge on non-linear data structures such as trees and graphs and use them in programming applications.*

**CO3** : *Solve problems using data structures such as AVL search trees, heaps and m-way search trees.*

**CO4** : *Apply appropriate sorting techniques for solving real-time problems.*

**CO5** : *Understand the working principle of hashing and collision resolution techniques*

## LINKED LISTS

Doubly Linked List-Circular Linked List-Traversals-Applications: Addition of Polynomials, Sparse matrix Representation-Linked Stacks-Linked Queues. (4)

## TREES AND BINARY SEARCH TREES

Representation of Trees-Binary Trees: Representation, Operations, Traversals, -Threaded Binary Trees. Binary Search Trees: Searching, Insertion and Deletion of elements, Analysis-Forests. (6)

## GRAPHS

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits- Euler Graphs -Hamiltonian Paths and Circuits. Elementary Graph Operations: Depth First Search, Breadth First Search, Connected Components, Spanning Trees. Minimum Cost Spanning Trees: Kruskal's Algorithm-Prim's Algorithm-Shortest Paths Algorithms: Single Source, Bellman Ford algorithm, All Pairs Shortest Paths. (8)

## HEAPS AND FORESTS

Priority Queues-Max Heap-Transforming a Forest into Binary Tree-Forest Traversals. (5)

## ADVANCED BINARY SEARCH TREES

AVL Trees: Balancing Trees- Searching, Insertion and Deletion of Elements-AVL Rotations, Analysis. Splay Trees: Notations, Analysis. (7)

## MULTIWAY TREES

M- Way Search Trees - B Trees - Red Black Trees - B+ Trees. (5)

## SORTING

Shell Sort-Quick Sort-Merge Sort-Heap Sort-Radix Sort-Time Complexity Analysis. (6)

## HASHING

Static Hashing: Hash Tables, Hash Functions-Dynamic Hashing-Collision Resolution: Open addressing - Linear Probing and Quadratic Probing. (4)

**TOTAL : 45**

## TEXT BOOK

1. Ellis Horowitz, Sartaj Sahni, Anderson-Freed, 'Fundamentals of Data Structures in C', University Press, Second Edition, 2008.

## REFERENCES

1. Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivert, Clifford Stein, 'Introduction to Algorithms', Second Edition, Prentice Hall of India, Publications, New Delhi, 2007.
2. Mark Allen Weiss, 'Data Structures and Algorithm Analysis in C++', Addison Wesley, 2014.
3. Anany Levitin, 'Introduction: The Design & Analysis of Algorithm', Pearson Education Inc., 2003.
4. S.K.Basu, 'Design Method & Analysis of Algorithm', PHI, 2005.

## 19MAM25 - CALCULUS AND PROBABILITY LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

19MAM21,19MAM22

### ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Solve differential equations of first and second order using R commands

**CO2** : Understand properties of probability distributions using R programming and MS-Excel Tools

**CO3** : Calculate definite integrals numerically using Trapezoidal and Simpson's methods

**CO4** : To perform statistical hypothesis testing using R programming.

**CO5** : To analyze the data using Bayesian data analysis technique with the aid of R programming.

### CONCEPTS TO BE COVERED

1. Extreme Value of functions-finding local extrema
2. Numerical differentiation based on Newton's formula, Lagrange's formula.
3. Functions of several variables--Hessian matrix-Expansions and extreme values- Constrained extrema using Lagrange's multiplier method-applications
4. Numerical integration-Trapezoidal and Simpson's 1/3 rules.
5. Solution of Ordinary Differential Equations,
6. Discrete and Continuous probability distributions
7. Joint Probability Distributions
8. Estimation of population parameters
9. Statistical Hypothesis testing- Large Sample tests
10. Statistical Hypothesis testing - Small Sample tests
11. Bayesian Data Analysis

**Software / Tools used** : R Studio

**TOTAL : 60**

# 19MAM26 - PROGRAMMING PARADIGM LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

Consent of the Instructor

## COURSE OUTCOMES

- CO1** : Understand the usage of different programming constructs of procedural programming
- CO2** : Apply the principles of object oriented programming to solve problems
- CO3** : Implement the concepts of logic programming and solve real world problems.
- CO4** : Develop solutions for problems using the concepts of functional programming paradigm.
- CO5** : Given a problem, develop solutions for it by applying all the four programming paradigms and compare it.

## CONCEPTS TO BE COVERED

### 1. Illustrate concepts of :

- Structured programming,
- Data and control abstractions,
- Programming with assertions (Programming with invariants)

### 2. Illustrate ideas of

- Typing, expressions,
- Pure functions,
- Recursion,
- Higher order functions,
- Encapsulation,
- Inheritance

## Using

- Applicative programming and Python
- Object oriented programming paradigm

**Softwares** : C, Python, Java, PROLOG

**TOTAL : 60**

## 19MAM27 - ADVANCED DATA STRUCTURES LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

19MAM14

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

- CO1** : *Implement linked representation of linked list and its operations.*
- CO2** : *Implement and compare the complexities of various sorting algorithms including bubble sort, heap sort and quick sort.*
- CO3** : *Ability to define and apply tree data structures and binary search trees for real time applications.*
- CO4** : *Perform operations on graphs and heaps for real time problems.*
- CO5** : *Implement shortest path algorithms and hashing techniques for a given application.*

### CONCEPTS TO BE COVERED

1. Linked Lists Implementation -Singly linked lists, Doubly linked lists and Circular linked lists.
2. Programs on linked stacks.
3. Programs on linked queues.
4. Sorting algorithms, Quick sort, Heap sort and Radix sort.
5. Implementation of tree data structure and traversals
6. Applications of Binary search trees and its operations
7. Operations on AVL tree
8. B-Tree and its operations
9. Problems related to graphs and graph traversals
10. Construction of heap & its operation
11. Construction of minimum spanning tree algorithm.
12. Implementation of shortest path algorithms
13. Implementation of hashing techniques.

**Softwares** : Linux GCC, Putty, C

**TOTAL : 60**

## 19FYEL21 - ENGLISH FOR EMPLOYABILITY

L	T	P	C
0	0	2	1

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

**CO1** : *Formulate ideas and speak confidently on any topic.*

**CO2** : *Use appropriate functional language to communicate effectively.*

**CO3** : *Identify the errors in English and write correctly.*

**CO4** : *Interpret the text appropriately and speak fluently on the given text.*

**CO5** : *Acquire professional communication skills.*

### SPEAKING SKILLS

Ice Breakers - Just a Minute - Book Reviews - Describing an object - Extempore - Paraphrasing. (6)

### FUNCTIONAL ENGLISH

Spoken English - Travel and Transport, Complaining - Giving Instructions, Advising and Sympathizing - Requesting and warning people. (5)

### VERBAL APTITUDE

Logical Sequence of Words- Exercises - Sequential Order of Things - Comparison Type Questions - Introduction and Exercises - Idioms and Phrases - Types and Exercises - Vocabulary through Mythology - One-word Substitutes, Word Power Exercises - Common Errors in English - Sentence Correction. (7)

### VOCABULARY IN CONTEXT

Activity based on newspaper articles - Vocabulary - Homophones and Homonyms - Reading Prose - Reading Comprehension Activity. (4)

### GROUP DISCUSSION AND INTERVIEW SKILLS

Professional Communication - Mock Group Discussion - Mock Interview - Telephoning Skills - Personality Development Activities. (8)

**TOTAL : 30**

# 19MAM31 - ARTIFICIAL INTELLIGENCE

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM24

## ASSESSMENT : THEORY

### COURSE OUTCOMES

- CO1** : Apply various heuristic search strategies in optimal decision making
- CO2** : Understand uncertainty in real world situations.
- CO3** : Employ first order logic for building a knowledge base and demonstrate reasoning on this.
- CO4** : Express different planning strategies to deal with problems, describe and apply various knowledge representation techniques.
- CO5** : Review knowledge based Artificial Intelligent systems and approaches.

### INTRODUCTION

Foundation of AI - Agents and Environments- Concept of Rationality - Nature of Environments - Structure of Agents. (6)

### PROBLEM SOLVING

Problem-Solving Agents and examples - Uninformed and Informed Search Strategies - Heuristic Functions - Local Search Algorithms and Optimization Problems - Local search in Continuous spaces - Searching with Nondeterministic actions and Partial Observations. (12)

### ADVERSARIAL SEARCH AND CONSTRAINT SATISFACTION PROBLEMS

Games - Optimal Decisions in Games - Alpha-Beta Pruning. Constraint Satisfaction Problems (CSP) - Backtracking Search for CSPs - Local Search for Constraint Satisfaction Problems - Structure of Problems. (8)

### KNOWLEDGE AND REASONING

Knowledge based Agents - The Wumpus World - Logic - Propositional Logic- Syntax and Semantics of First-Order Logic - Using First-Order Logic - Knowledge Engineering in First-Order Logic - Unification and Lifting - Forward Chaining - Backward Chaining - Resolution - Knowledge Representation. (12)

### PLANNING

Definition of classical planning - Algorithms for Planning as State-Space Search - Planning Graphs - Hierarchical Task Network Planning - Planning and Acting in Nondeterministic Domains - Multi agent Planning. (7)

**TOTAL : 45**

### TEXT BOOK

1. Stuart J Russell and Peter Norvig, "Artificial Intelligence- A Modern Approach", Pearson Education Series, Third Edition, 2010. (Chapters 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12)

### REFERENCES

1. Dan W.Patterson "Introduction to AI and ES", Pearson Education, First Edition, 2007
2. Nilis J Nilsson "AI A new Synthesis" Morgan Kaufmann publishers, 1998

# 19MAM32 - THEORY OF COMPUTING

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : *Develop designs for different machine types: finite automata, pushdown automata.*
- CO2** : *Illustrate the mechanism of Turing machine and state its applications*
- CO3** : *Recognize partial recursive functions and its relationship to programs*
- CO4** : *Design different types of grammars and develop grammars to produce specific solutions.*
- CO5** : *Formulate methods to check the correctness of algorithms*

## FINITE STATE MACHINES

Deterministic finite state machine, Non-deterministic finite state machine, Pumping lemma for Regular grammar. Applications of Finite State Machines. (8)

## PUSH DOWN AUTOMATA

Deterministic push down automata. Recognizing context free grammars. Non deterministic push down automata and Ambiguous context free grammars. Applications of Push down Automata. (8)

## TURING MACHINES AND COMPUTABILITY

Turing Machines, recognizing Context sensitive grammars. Types of Turing machines, Halting problem. Effective procedure for algorithm and computability. Applications of Turing Machine. (9)

## FUNCTIONS

Basic functions and strategy set, Partial and Primitive recursive functions, Computability. McCarthy's formalism, Programs and Recursive functions. (6)

## PRODUCTIONS

Production system, Acceptors and Generators, Markov algorithms. (8)

## GRAMMARS

Rules, formalization, Ambiguity, Reduced Form, Derivation on Rule Tree, Chomsky hierarchy, Derivation graphs, Grammars and Compiler Design, Programming languages and Compilers, Sentential forms and Derivation trees, Parsing algorithms Stochastic grammars. (8)

## COMPUTATION

Approaches for checking correctness, Partial total correctness, Proof methods. Floyd Hoare Manna Inductive assertion. Functional methods. (8)

**TOTAL : 45**

## **TEXT BOOKS**

1. *EV Krishnamoorthy, "Introduction to Theory of Computation", East West Press, 1983. (Sections 2 to 5)*
2. *KLP Mishra, N.Chandrashekar "Theory of Computer Science -Automata, Languages and Computation" Second Edition, PHI, 1998.*

## **REFERENCES**

1. *John E Hopcroft, Jeffrey D Ullman, "Introduction to Automata theory languages and computation", Addison Wesley 2006.*
2. *Michael Sipser "Introduction to the theory of computation" PWS Publishing, 2006.*

# 19MAM33 - DATABASE MANAGEMENT SYSTEMS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : Understand the purpose and architecture of database systems from the perspective of persistent storage of real world data.
- CO2** : Analyze the problem statement, construct the Entity Relationship model and map it into relational model by applying normalization.
- CO3** : Generate Relational Algebra, Relational Calculus and SQL statements to perform queries of real world applications
- CO4** : Evaluate the indexing techniques and choose the suitable technique by analyzing the given application
- CO5** : Determine the concurrency control and recovery mechanisms based on the criticality of the transaction

## INTRODUCTION

Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases, Database Architecture, Database Users and Administrators.

**Relational Model** : Structure of Relational Databases, Database Schema, Keys, Schema Diagrams, Relational Query Language, Relational operations. **(10)**

## DATABASE DESIGN

Database Design and the E-R Model, Overview of the Design Process, The Entity-Relationship Model, Constraints, Removing Redundant Attributes in Entity Sets, Entity-Relationship Diagrams, Reduction to Relational Schemas, Extended E-R Features. Relational Database Design: Atomic Domains and First Normal Form, Decomposition Using Functional Dependencies, Functional-Dependency Theory. **(11)**

## INTRODUCTION TO SQL

Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Null Values, Aggregate Functions, Nested Sub queries, Modification of the Database. Intermediate SQL: Join Expressions, Views, Transactions, Integrity Constraints, SQL Data Types and Schemas, Authorization.

Advanced SQL: Accessing SQL from a Programming Language, Functions and Procedures, Triggers. Formal Relational Query Languages: The Relational Algebra, Tuple Relational Calculus, Domain Relational Calculus. **(7)**

## DATA STORAGE AND INDEXING

File Organization, Organization of Records in Files, Data-Dictionary Storage, Database Buffer. Indexing and Hashing: Basic Concepts, Ordered Indices, Overview of B+-Tree Index Index, Definition in SQL. **(7)**

## TRANSACTION, CONCURRENCY CONTROL AND RECOVERY

Concept, Simple Transaction Model, Atomicity and Durability, Isolation, Serializability, Isolation and Atomicity, Isolation Levels. Lock-based Concurrency Control, Time Stamp based Concurrency Control, Failure Classification, Recovery and Atomicity. **(7)**

**TOTAL : 45**

## **TEXT BOOK**

1. Abraham Silberschatz, Henry F.Korth and S.Sudarshan, "Database System Concepts", Sixth Edition, McGraw Hill, 2010.

## **REFERENCES**

1. Ramez Elmasri, Shamkant B. Navathe Durvasula, V.L.N. Somayajulu, Shyam K. Gupta, "Fundamentals of Database Systems", Fourth Edition, Pearson Education, 2006.
2. Christopher Allen, Simon Chatwin, Catherine A. Creary, "Introduction to Relational Databases and SQL Programming", Tata McGraw-Hill, 2003.

# 19MAM34 - PREDICTIVE ANALYTICS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM13, 19MAM22

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Analyze time series data and apply it to forecast the future.

**CO2** : Formulate and compute multiple linear regression model and understand its properties.

**CO3** : Classify objects into different groups using discriminant function, logistic regression equation.

**CO4** : Identify underlying factors in multivariate data sets using principal component analysis.

**CO5** : Understand the terminology of factor analysis, factor rotation and interpret factor loadings using R programming.

### MULTIPLE REGRESSION ANALYSIS (MLR)

Variables in Multivariate Data-Mean Vector, Covariance and Correlation Matrices and their properties-Estimation of missing values. Multiple Linear Regression Equation and Polynomial Regression Models- Estimation of the coefficients using method of least squares-Linear Regression using Matrices-Properties of Least Squares-Inferences in Multiple Linear Regression: ANOVA and testing the partial regression coefficients- Interpretation of R<sup>2</sup>-Standardized Regression Coefficient and its interpretation- Inclusion of categorical or indicator variables in MLR -Multi-collinearity problem-Stepwise Regression. (10)

### TIME SERIES FORECASTING

Regression Model for forecasting-Forecasting Time Series data with Seasonal Variation-Auto-Regressive(AR) Models- AR Model Identification: ACF and PACF, Moving Average -MA(q) and ARMA(p,q) Models-Auto-Regressive Integrated Moving Average (ARIMA) Process-Dickey Fuller Test-Augmented Dickey-Fuller Test-Transforming Non Stationary Process to Stationary Process using Differencing-ARIMA(p,d,q) model building-Ljung-box test for Auto-Correlations-Power of Forecasting: Theil's Coefficient. (12)

### DISCRIMINATION AND CLASSIFICATION

Discriminant Function Analysis- Fisher's discriminant function -Fitting discriminant functions using R and interpreting the results. Logistic Regression: Logistic Model-Definitions of Odds and Logit-Estimation of the logistic regression coefficients-Making Predictions-Multiple Logistic Regression-Fitting logistic regression equation using R and interpreting the results. (9)

### PRINCIPAL COMPONENT ANALYSIS

Data Reduction Techniques-Definition of Population Principal Components -Principal Components obtained by Standardized variables -Rules to retain number of Principal Components using Scree Plot-Graphing the Principal Components-Testing the equal correlation structure-Geometric and Algebraic bases of Principal Components. (7)

### FACTOR ANALYSIS

Factor Analysis -Definitions-The Orthogonal Factor Model-Its Covariance Structure- Estimation of loadings and communalities-Principal component method and Principal factor method-Factor Loadings and Interpretations- Rotation- Orthogonal and Oblique rotation-Exploratory and Confirmatory Factor Analysis- Estimation of PCA and FA using R. (7)

**TOTAL : 45**

## TEXT BOOKS

1. Alvin C. Rencher, William F. Christensen "Methods of Multivariate Analysis", 3rd Edition, Wiley Inter-science, 2012
2. Dinesh Kumar U, " Business Analytics", Wiley, First Edition, 2017
3. Richard A. Johnson and Dean W. Wichern, " Applied Multivariate Statistical Analysis", 6th Edition, Pearson Prentice Hall, 2007.

## REFERENCES

1. R.E. Walpole, R.H. Myers, S.L. Myers and K. Ye, "Probability and Statistics for Engineers and Scientists", 9th Edition, Prentice Hall, 2012.
2. Joseph F. Hair Jr., William C. Black, Barry J. Babin and Rolph E. Anderson, "Multivariate Data Analysis", 7th Edition, Pearson, 2010.
3. G. James, D. Witten, T. Hastie and R. Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer, 2015.

# 19MAM35 - HUMAN COMPUTER INTERACTION

L	T	P	C
3	1	0	4

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Learn the foundations of Human Computer Interaction (HCI)

**CO2** : Be familiar with the design technologies for individuals and persons with disabilities

**CO3** : Be familiar with models and theories of HCI

**CO4** : Develop an understanding of the intricacies of mobile HCI

**CO5** : Develop an understanding of the intricacies of web HCI

## FOUNDATIONS OF HCI

The Human: I/O channels - Memory - Reasoning and problem solving; The computer: Devices -Memory - processing and networks; Interaction: Models - frameworks - Ergonomics - styles -elements - interactivity- Paradigms. (9)

## DESIGN & SOFTWARE PROCESS

Interactive Design basics - process - scenarios - navigation - screen design - Iteration and prototyping. HCI in software process - software life cycle - usability engineering - Prototyping in practice - design rationale. Design rules - principles, standards, guidelines, rules. Evaluation Techniques - Universal Design. (9)

## MODELS AND THEORIES

Cognitive models -Socio-Organizational issues and stakeholder requirements -Communication and collaboration models-Hypertext, Multimedia and WWW. (9)

## MOBILE HCI

Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools. (9)

## WEB INTERFACE DESIGN

Designing Web Interfaces - Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies. (9)

**TOTAL : 45**

## TEXT BOOKS

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", Third Edition, Pearson Education, 2004. (Para I - III)
2. Brian Fling, "Mobile Design and Development", First Edition, O'Reilly Media Inc., 2009. (Para IV)
3. Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O'Reilly, 2009. (ParaV)

## REFERENCES

1. Isaias, Pedro, Blashki, Katherine "Interactivity and the Future of Human Computer Interface", IGI Global, 2020.

# 19MAM36 - ARTIFICIAL INTELLIGENCE LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

- CO1** : *Design and implement heuristic search procedures*
- CO2** : *Develop solutions for constraint satisfaction problem*
- CO3** : *Design and implement solutions for classical Artificial Intelligence problems*
- CO4** : *Design and implement knowledge-based system*
- CO5** : *Become familiar with use of Artificial Intelligence tools.*

## CONCEPTS TO BE COVERED

1. Implementing state space search algorithms for solving puzzle problems.
  - a. A\* Search
  - b. Hill-climbing Search.
2. Implementation of Min-Max Search Procedure with alpha beta pruning for finding the solutions of games.
3. Implementation of Constraint Satisfaction Problem for solving Crypt-arithmetic.
4. Implementation of Unification algorithm by considering Resolution concept.
5. Solve the classical Water Jug problem.
6. Solve the classical Monkey Banana problem.
7. Solve the classical Blocks World problem.
8. Develop a knowledge base system/ expert system consisting of facts and rules about some specialized knowledge domain of your choice.
9. Designing a Chatbot application
10. Development of programs for simulation of computer games like: Tic-Tac-Toe, N-queens Problems, travelling salesman problem, Chess, etc.

**Softwares** : Use of PROLOG, LISP, CLIPS or any open source framework

**TOTAL : 60**

# 19MMA37 - DATABASE MANAGEMENT SYSTEMS LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

- CO1** : *Design the conceptual data model as Entity Relationship diagram and create the database using DDL statements for a given application.*
- CO2** : *Formulate simple DML SQL queries to retrieve the required data for real world applications.*
- CO3** : *Generate DML queries with Subqueries, Joins, Group By, Order By and Aggregate functions to filter and aggregate the data of the real world applications.*
- CO4** : *Construct reusable PL/SQL blocks with Functions, Procedures, Packages, Triggers, Exception Handling, and Cursors as required by OLTP applications.*
- CO5** : *Develop a database project by constructing the ER model, creating Tables and generating SQL and PL/SQL blocks using RDBMS platform.*

## CONCEPTS TO BE COVERED

1. Designing a database for an application and representing it through ER diagram and map it to ER Scheme.
2. Creating and managing tables
3. Basic SQL SELECT statements
4. Restricting and sorting data
5. Single row functions
6. Displaying data from multiple tables
7. Aggregating data using Group function - Group By
8. Subqueries
9. Views, Sequence, Index, Synonym
10. SET operators, Date and Time functions
11. PL / SQL Programs
12. Exception Handling, Cursors, Functions, Procedures, Package, Triggers

**Softwares** : MySQL/Oracle

**TOTAL : 60**

# 19MAM38 - PREDICTIVE ANALYTICS LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

**CO1** : Use R software to analyze multivariate data using multiple linear regression, discriminant function, logistic regression equation models and cluster analysis tools.

**CO2** : Using R software to analyze Time Series Models

**CO3** : Identify underlying factors in multivariate data by applying factor analysis and principal component analysis models using R software packages.

**CO4** : Use R software to retain the components and loading of the Principal Components.

**CO5** : Use R to verify the data and to estimate the parameters of a factor model.

## CONCEPTS TO BE COVERED

1. Reading and plotting Multivariate Data-Matrix scatter plot and Scatter plot with the data points labeled by their group.
2. Calculating summary statistics for Multivariate Data-Means and variances per group, Between-groups Variance and within-groups variance for a variable.
3. Calculating Covariances, Correlations and Standardizing Multivariate data fitting Multiple Regression Equation using MS-Excel and interpreting the output.
4. Writing Script files in R for Fitting Multiple Regression Equation: Summary, extracting ? coefficients, Covariance matrix, standard errors, residuals and fitted values and plotting, Normal Probability Plot of residuals, Predictions-Compare the results using lm command.
5. Stepwise regression: forward, backward and stepwise.
6. Differencing a Time Series, selecting a Candidate ARIMA Model, Forecasting using ARIMA Model.
7. Fitting logistic regression equation: Prediction, goodness of fit and Plotting ROC Curve.
8. Discriminant function analysis and loadings for the discriminant functions.
9. Principal component Analysis : screen plot to decide on the number of components to retain and loadings for the PCs and Scatter Plots for PCs.
10. Factor Analysis using R

**Software** : R Studio

**TOTAL : 60**

# 19MAM41 - OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Solve Linear Programming, Transportation and Assignment based problems.

**CO2** : Discuss the elementary Inventory models, Price break models and Safety stock problems.

**CO3** : Solve Job sequencing and replacement problems.

**CO4** : Categorize the Queuing models.

**CO5** : Analyze the network models using CPM and PERT.

## LINEAR PROGRAMMING

Linear programming problem - canonical and standard forms - formulation - graphical solution - simplex method-Big M method using artificial variables- Transportation model - Initial Basic Feasible Solution using Northwest Corner method, Matrix Minima method and Vogels approximation method - Optimal solution by Modified Distribution Method-Unbalanced Transportation problems and Degeneracy - Assignment model-Solution by using Hungarian method. (12)

## SEQUENCING AND REPLACEMENT

Sequencing: Basic assumptions - Johnson's procedure for Sequencing of: i) n jobs on 2 machines ii) n jobs in 3 machines and iii) n jobs on m machines. Replacement: Need for replacement of equipments - failure mechanism of items - Replacement policy - Replacement of items that deteriorates gradually - Replacement of items that fail suddenly. (7)

## INVENTORY

Need for the inventory - Costs involved in inventory - Concepts of average inventory, economic order quantity - Deterministic model: Fixed ordering quantity models - EOQ model with uniform demand, finite and infinite replacement with or without shortages -EOQ with one price break. Inventory control - Buffer stock - Determination of optimum buffer stock - EOQ system of ordering - Multi item order model - ABC analysis. (9)

## QUEUING THEORY

Queuing system characteristics-Describing a queuing system by input pattern, service mechanism, queue discipline and customer behaviour- Steady, transient and explosive states in queuing systems-Designation of queue and symbols used in queuing models- M/M/1 ( $\infty$ /FIFO) model-Steady State solutions-Finite Queue Length Model: (M/M/1) : ( $\infty$ /FIFO). (8)

## PERT and CPM NETWORKS

Activities and events-Rules for forming a Network- Critical Path Method(CPM) for computing project completion time- network - Time estimation in CPM-Project Cost Analysis- critical path -Crashing-Least cost schedule algorithm- PERT - Network - Difference between PERT and CPM-Time estimates in PERT- Critical Path estimation - Probability of meeting a scheduled date of completion of the project. (9)

**TOTAL : 45**

## **TEXT BOOK**

1. Hamdy, A Taha, "Operations Research - An introduction", Pearson Education India, 2004.

## **REFERENCES**

1. Rama Murthy P. Operations Research, New Age International, Second Edition, 2007.
2. S. D. Sharma "Operations Research ", Kedar Nath Ram Nath & Co publishers, 10th Edition, 1995.
3. Kanti Swarup, P.K. Gupta, Mani Mohan, "Operations Research", Sultan Chand & Sons, 2001.
4. Hillier & Lieberman, "Operations Research - An Introduction", Tata McGraw-Hill, 2004

# 19MAM42 - MACHINE LEARNING

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM13, 19MAM22

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Recognize fundamental issues and challenges of machine learning: data, model selection, model complexity, supervised and unsupervised learning.

**CO2** : Apply Decision trees and Artificial Neural Networks for classification

**CO3** : Distinguish the strength and weakness of Bayesian learning.

**CO4** : Analyze and use Instance based learning and reinforcement learning in real time problems.

**CO5** : Learn association rules and clustering methods and apply to derive insights from data.

### INTRODUCTION

Basics of Machine Learning-Examples of Machine Learning Applications-Designing a Learning System. (3)

### CONCEPT LEARNING AND GENERAL TO SPECIFIC ORDERING

Concept Learning Task- Concept Learning as Search- Find-S- Version Space and Candidate Eliminate Algorithm-Inductive bias. (5)

### DECISION TREE LEARNING

Decision tree representation, Decision tree Learning Algorithm- Inductive bias-Issues in Decision Tree learning. (6)

### ARTIFICIAL NEURAL NETWORKS

Introduction- Neural Network Representations- Perceptron- Multi-layer Networks and Back Propagation Algorithm- Remarks on the Back propagation Algorithm- Face Recognition Example.

### EVALUATING HYPOTHESIS

Motivation, Estimating Hypothesis Accuracy, Basis of Sampling Theory- Difference in Error of Two Hypothesis- Comparing Learning Algorithms (8)

### BAYESIAN LEARNING

Bayes Theorem - Bayes theorem and Concept Learning- Maximum Likelihood and Least Square Error Hypothesis- Bayes Optimal Classifier- Naive Bayes Classifier-Bayesian Belief Networks- EM Algorithm. (8)

### INSTANCE BASED LEARNING

k-Nearest Neighbour Learning, locally weighted Regression- Radial Basis Functions- Case based Reasoning. Reinforcement Learning: The learning task - Non-deterministic Rewards and Actions - Relationship to Dynamic Programming. (8)

### UNSUPERVISED LEARNING

Introduction-k-means Clustering-Hierarchical Clustering. Association Rules - Apriori Algorithm. (7)

**TOTAL : 45**

## TEXT BOOKS

1. Tom M Mitchell, "Machine Learning", Indian Edition, McGraw Hill, 2013.
2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, 3rd Edition, 2014. (First and Last Para).
3. Jaiwei Han, Micheline Kamber Data Mining-concepts and techniques, 2/e, Morgan Kaufmann Publishers, San Francisco, 2006. (Last Para)

## REFERENCES

1. Bishop, C. Pattern Recognition and Machine Learning. Berlin: Springer-Verlag, 2006.
2. Stephen Marsland, Machine Learning: An Algorithmic Perspective, Chapman and Hall, 2014.

# 19MAM43 - DESIGN AND ANALYSIS OF ALGORITHMS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM14, 19MAM24

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : Able to apply divide and conquer, greedy methods in problem solving  
**CO2** : Able to use dynamic programming in real time problems and derive efficient solutions.  
**CO3** : Able to understand the concepts of backtracking and branch-bound techniques.  
**CO4** : Able to differentiate between NP, NP hard and NP Complete problems.  
**CO5** : Able to analyze the efficiency of different algorithm design techniques and their proper usage in application problems.

## INTRODUCTION

Fundamentals of algorithmic problem solving - Method of specifying an algorithm - proving the correctness - Analyzing an algorithm - Asymptotic Notations. (5)

## DIVIDE AND CONQUER

General Method- Binary Search - Finding the Maximum and Minimum- Merge Sort - Quick Sort - Strassen's Matrix Multiplication. (7)

## GREEDY METHOD

General Method - Knapsack Problem - Tree Vertex Splitting - Minimum-cost spanning trees- Single Source Shortest Paths.(7)

## DYNAMIC PROGRAMMING

General Method - Multistage Graphs - All-Pairs Shortest Paths - Single Source Shortest Path - Traveling Salesperson Problem. (7)

## BACK TRACKING

General Method - 8 Queens Problem - Sum of Subsets- Graph Coloring -Hamiltonian Cycles. (7)

## BRANCH AND BOUND

General Method - 0/1 Knapsack Problem - Traveling Salesperson Problem. (5)

## NP-HARD, NP-COMPLETE CLASSES

Basic concepts - Non-deterministic algorithms - Satisfiability Problem - NP-hard and NP-complete Problems. (7)

**TOTAL : 45**

## TEXT BOOK

1. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, "Fundamental of Computer Algorithms", Galgotia Publications, 1998.

## REFERENCES

1. Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivert, Clifford Stein "Introduction to Algorithms", Second Edition, Prentice Hall of India, Publications, New Delhi, 2007.
2. Any Levitin, "Introduction: The Design & Analysis of Algorithm", Pearson Education Inc., 2003.
3. Michael T.Goodrich, Roberto Tamassia, "Algorithm Design, Foundations, Analysis and Internet Examples", Wiley, 2011.
4. Jon Kleinberg and Eve Tardos, "Algorithm Design", Pearson Education, 2012.

# 19MAM44 - DATA COMMUNICATIONS AND NETWORKING

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Enumerate the layers of the OSI model and TCP/IP and compare the models.

**CO2** : Describe the relationship between data and signals, and distinguish among their types, behavior, properties, characterization, and transmission.

**CO3** : Given an inter-network topology configuration, can demonstrate how a packet reaches the destination.

**CO4** : Explain the services offered by each layer of TCP/IP protocol suite and the role of each protocol.

**CO5** : Given an application, can explain the role of the protocols involved.

## INTRODUCTION

Data Communications - Networks - The Internet - Protocols and Standards - OSI Model - TCP/IP Protocol Suite - Addressing. (9)

## PHYSICAL LAYER AND MEDIA

Data and Signals - Digital Transmission: Digital to Digital Conversion - Analog to Digital Conversion - Transmission Modes - Analog Transmission: Digital -to -Analog Conversion - Multiplexing Techniques. (10)

## DATA LINK CONTROL

Framing - Flow and Error Control - Protocols - Noiseless Channels - Noisy Channels. Multiple Access: Random Access Protocols - Ethernet - IEEE 802.11. (7)

## NETWORK LAYER

Switching - Packet switching at Network Layer - Network layer Services - Issues - IP Addresses - Delivery and Forwarding of Packets - Internet Protocol IPv4 - Address Resolution Protocol - Internet Control Message Protocol. (9)

## HIGHER LAYERS

Transport Layer: Services - User Datagram Protocol: User Datagram - UDP services - Transmission Control Protocol: TCP services - Features - Segment - TCP connection Management.

**Application Layer** : DNS - Worldwide Web. (10)

**TOTAL : 45**

## TEXT BOOKS

1. Behrouz A Forouzan, "Data Communications and Networking", Tata McGrawHill, 5th Edition, 2017. (Para 1-III)
2. Behrouz A Forouzan, "TCP/ IP Protocol Suite", Tata McGraw Hill, 2010. (Para IV-V)

## REFERENCES

1. Kevin Fall R and Richard Stevens W, "TCP/IP Illustrated, Volume 1: The Protocols", Addison-Wesley, 2011.
2. James F Kurose and Keith Ross, "Computer Networking: A Top-Down Approach", Pearson Addison-Wesley, 2012.
3. Douglas Comer, "Internetworking with TCP/IP", Prentice Hall, 2013.
4. William Stallings, "Data and Computer Communications", Pearson, 2013.

# 19MAM45 - OPERATING SYSTEMS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Demonstrate the structure of operating system, batch programming, system calls and virtual machines.

**CO2** : Demonstration of Kernel Management specific to concurrent process for Inter Process Communication systems.

**CO3** : Estimate system performance through scheduling algorithms - FIFO, round robin, priority, shortest job first.

**CO4** : Recognize memory allocation and deallocation for both static and dynamic storage.

**CO5** : Design and develop a new simple File System using Disk and File System Management

### INTRODUCTION

Abstract view of an Operating system - Extended view of resource manager - Overview: Simple Batch system - Multi programmed batch systems - Time Sharing Systems - Parallel Systems - distributed systems - Real time systems - System structure: IO structure- memory- CPU-Kernels and microkernels - Dual-mode operation - operating - system services - system calls - Structure of Operating system- Various components of Operating system. (9)

### PROCESS MANAGEMENT

Process Concepts - Process Creation - Process Termination - Process States - Process Description - Process Control - Relationship between process and threads - Thread State - Thread Scheduling- Thread Synchronization-Multithreading model - Concurrent Process -process synchronization: critical section problem - Mutual Exclusion - Dekker's algorithm -synchronization hardware - semaphore - classical problem of ynchronization - critical regions - monitors - atomic transaction - race condition. Deadlock characterization - handling deadlocks - prevention - avoidance - detection and recovery - combined approach. (10)

### PROCESSOR MANAGEMENT

Basic Concepts - Scheduling Criteria - Pre-emptive versus non-preemptive scheduling - Scheduling algorithms: FIFO - Shortest job first, priority, round robin, multi-level queue - Multi level feedback queue - multiprocessor scheduling. (9)

### MEMORY MANAGEMENT

Basic Concepts - Logical versus Physical address - Swapping - Fixed Partition and Dynamic Partition - Simple Paging - Multi Level Paging - Inverted Paging - Paging algorithms-Simple segmentation- Virtual Memory - Demand Paging - Thrashing-Working Set Model -Demand Segmentation. (9)

### I/O AND FILE MANAGEMENT

I/O: hardware - Application I/O interface - Logical Structure of I/O Functions -I/O Buffering - Disk I/O - Disk Scheduling. File Management: File Concepts - Access methods - Directory Structure - File System Structure - Allocation methods - Free Space Management.

### CASE STUDIES

Mobile Operating System-Cloud and IoT Operating Systems. (8)

**TOTAL : 45**

## **TEXT BOOKS**

1. Abraham Silberschatz, A, Peter Baer Galvin, Greg Gagne, "Operating System Concepts", John Wiley, 2013.
2. William Stallings, "Operating Systems: Internals and Design Principles", Prentice-Hall, Ninth Edition, 2018.

## **REFERENCES**

1. H.M.Dietel, "An Introduction to Operating Systems", Addison Wesley, 2nd Edition, 2007.
2. Andrew S. Tanenbaum, "Modern Operating Systems", Prentice Hall of India Pvt. Ltd, 2008.

## 19MAM46 - MACHINE LEARNING LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

19MAM18

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

- CO1** : *Able to prepare the data for machine learning using data pre-processing and dimension reduction techniques.*
- CO2** : *Able to build regression and classification models using benchmark datasets and give insights.*
- CO3** : *Able to evaluate the performance of models using different performance measures.*
- CO4** : *Able to use clustering techniques to group data and analyse the clusters.*
- CO5** : *Able to design and develop prediction systems by choosing appropriate machine learning algorithms on real-time datasets.*

### CONCEPTS TO BE COVERED

1. Perform descriptive analysis on different types of datasets
2. Apply pre-processing techniques on the dataset.
3. Build Regression models to predict future values for datasets like rainfall, earthquake etc.
4. Build Classification models and infer the results
  - a. Decision tree classifier
  - b. Naïve Bayes Classifier
  - c. k-Nearest Neighbor Classifier
5. Apply cross validation techniques and evaluate the models using various performance metrics
6. Implement Perceptron and Artificial Neural Network for simple problems
7. Implement the non-parametric Locally Weighted Regression algorithm to fit data points.
8. Clustering
  - a. Implement K-Means Clustering
  - b. Implement Hierarchical clustering
9. Use market basket dataset and mine association rules using Apriori algorithm.
10. Build a complete Machine Learning pipeline with data visualization capabilities for a given prediction problem.

Note: Benchmark datasets may be downloaded from UCI machine learning repository, Kaggle etc for each of the above problems.

**TOTAL : 60**

## 19MAM47 - DESIGN AND ANALYSIS OF ALGORITHMS LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

19MAM17, 19MAM27

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

**CO1** : Ability to analyze the efficiency of different algorithm design techniques and their proper usage in application problems.

**CO2** : Implementing string matching and network flow algorithms.

**CO3** : Able to apply data structure concepts in any applications of the dynamic programming

**CO4** : Implement the design technique of backtracking in application to analyze the types of problem solved using backtracking

**CO5** : Skill to compare, contrast, and understand the choice of various design techniques to solve a given problem.

### CONCEPTS TO BE COVERED

1. Problem using closest pair algorithm
2. Prim's minimum cost spanning tree
3. Kruskal's minimum cost spanning tree using min heap data structure, union and find operation
4. Problem related to greedy methods
5. Applications of dynamic programming
6. Application of all pairs shortest path problem
7. Application of graph coloring using backtracking
8. Applications of branch and bound technique
9. String matching algorithms

**TOTAL : 60**

## 19MAM48 - NETWORK PROGRAMMING LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

19MAM14

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

- CO1** : *Understand key protocols that support communication.*
- CO2** : *Develop and implement connection-oriented and connectionless communication using Socket API for a given set of requirements.*
- CO3** : *Develop and implement concurrent and iterative servers and analyze their functionality.*
- CO4** : *Apply advanced programming techniques such as Broadcasting and Multicasting.*
- CO5** : *Develop and implement simple network applications using NS-2 API for a given set of requirements and demonstrate its working.*

### CONCEPTS TO BE COVERED

1. Basic networking commands
2. TCP one-way communication
3. TCP two-way communication
4. UDP one-way communication
5. UDP two-way communication
6. Concurrent, Iterative Server Implementation
7. IP header setting by kernel and displaying IP header
8. IP header setting by user and displaying IP header
9. IP Checksum Computation
10. Ping Implementation
11. Broadcasting using UDP
12. Multicast Communication using UDP
13. Simulations / Developing networking applications

**Software / Tools : Java, Any open source Network Simulation tool**

**TOTAL : 60**

# 19MAM51 - ADVANCED MACHINE LEARNING

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM42

## ASSESSMENT : THEORY

### COURSE OUTCOMES

- CO1** : Use ensemble techniques and dimensionality reduction methods for building machine learning models.
- CO2** : Understand the optimization techniques and regularization adopted in machine learning algorithms.
- CO3** : Learn the properties of kernels, kernel functions and apply them in pattern analysis.
- CO4** : Recognize the application of markov chain approaches for random sampling and model probabilities and use them in applications.
- CO5** : Apply the concept of graphical models in machine learning problems

### ENSEMBLE LEARNING

Introduction to multiple models-Bagging: Bagged Decision Tree-Random Subspaces-Random Forest. Boosting: AdaBoost-Gradient Boosting Machines-Stochastic Gradient Boosting-XGBoost. Stacking: Voting.

Dimensionality Reduction Techniques: Principal Component Analysis- Factor Analysis- Multidimensional Scaling-Linear Discriminant Analysis- Singular Value Decomposition. (10)

### MODEL EVALUATION AND OPTIMIZATION

Classification Performance Metrics: ROC, PR Curves, Precision at K. Class Imbalance: Over and Under sampling, SMOTE. Bias-Variance Trade-offs-Cross Validation: Stratified Splits and Temporal CV. Model Tuning: Grid and Random Search Regularization: L1 and L2 Norm Methods-LASSO and Ridge Regression. (11)

### KERNEL MACHINES

Kernels-Optimal Separating Hyperplane-Kernel Trick-Vectorial Kernels-Multiclass Kernel Machines. Support Vector Classification-Support Vector Regression -Application of Support Vector Machines. (9)

### MARKOV CHAIN MONTE CARLO METHODS

Sampling-Markov Chains-The metropolis-Hastings Algorithm-Gibbs Sampling. (7)

### GRAPHICAL MODELS

Bayesian Networks-Belief Propagation-Undirected Graphs: Markov Random Fields-Hidden Markov Models: Forward algorithm. (8)

**TOTAL : 45**

### TEXT BOOKS

1. Stephen Marsland, *Machine Learning- An Algorithmic Perspective*, CRC Press, Second Ed., 2015. (Para-I)
2. Henrik Brink, Joseph Richards, Mark Fetherolf, *Real World Machine Learning*, Manning Publishers, 2016. (Para-II)
3. Ethem Alpaydin, *Introduction to Machine Learning*, Fourth Ed., PHI Publication, 2015. (Para III,IV,V)

### REFERENCES

1. Scholkopf, B. and Smola, A.J., *Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond*, The MIT Press, 2001.
2. Koller D. and Friedman, N., *Probabilistic Graphical Models: Principles and Techniques*, The MIT Press, 2009.
3. C. M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2010

# 19MAM52 - ARTIFICIAL NEURAL NETWORKS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Learn the fundamentals concepts of the early Neural Network architectures and its applications.

**CO2** : Implement Perceptron and Backpropagation learning rules to solve problems.

**CO3** : Understand the different types of unsupervised learning techniques of Artificial Neural Networks.

**CO4** : Apply Radial Belief Network for Classification problems

**CO5** : Design and implement associative memories networks.

## INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS

Artificial neural networks Vs Biological neural networks, ANN architecture, Basic building block of an artificial neuron, Activation functions, Early ANN architectures (basics only)-McCulloch & Pitts model, Perceptron, ADALINE, MADALINE-Feed forward neural network, feed backward neural network. (5)

## ARTIFICIAL NEURAL NETWORKS-SUPERVISED LEARNING

Perceptron and its learning law- Learning rule: Perceptron Learning Rule-Gradient Descent and the Delta learning rule- Limitations-Multi-Layer Perceptron-Backpropagation networks: Architecture, Backpropagation Learning Algorithm-Derivation-Training and Convergence-Accelerated learning in multilayer perceptron. (9)

## ARTIFICIAL NEURAL NETWORKS-UNSUPERVISED LEARNING

Hebbian Learning, Generalized Hebbian learning algorithm, Competitive learning. Self- Organizing Computational Maps: Kohonen Network- Hopfield Networks-Boltzmann Machine. (11)

## RADIAL BASIS FUNCTION (RBF) NETWORKS

Introduction-RBF regularization theory-Generalized RBF Networks-Learning in RBFs- RBF application to Face Recognition (10)

## ADAPTIVE RESONANCE THEORY

Network and learning rules. Associative memory: auto-associative memory, bi-directional associative memory (BAM). Regularization in ANNs-Applications of Neural Networks. (10)

**TOTAL : 45**

## TEXT BOOKS

1. Simon O. Haykin, *Neural Networks and Learning Machines*, Pearson Education, 2016.

## REFERENCES

1. L. Fausett, *Fundamentals of Neural Networks*, Prentice Hall, 2004
2. *Artificial Neural Networks-B*. Yegnanarayana, PHI, New Delhi, 1998.
3. C. Bishop, *Neural Networks and Machine Learning*, Springer, 1998.

# 19MAM53 - KNOWLEDGE BASED SYSTEMS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Understand the concepts central to the creation of knowledge bases and expert systems.

**CO2** : Identify the components of a knowledge based systems (KBS)

**CO3** : Explore the issues involved in the design and development of Artificial Intelligence Based Decision Support Systems and discuss the role these systems play in the business environment.

**CO4** : Select an appropriate knowledge representation and reasoning method, and anticipate potential difficulties in developing and introducing the expert systems.

**CO5** : Examine properties of knowledge search techniques and understand the application domains of KBS.

### INTRODUCTION TO KNOWLEDGE-BASED SYSTEMS (KBS)

Definition- Types of Knowledge -Comparing with Decision Support Systems-From File Server to Knowledge Server-Applications of Knowledge-based Systems-Limitations-Future of KBS- Artificial Intelligence and Expert Systems: Basics of Artificial Intelligence-Components of Expert Systems-Modes and Applications-Advantages and Limitations-Expert Systems vs Traditional Systems. (10)

### DEVELOPMENT OF KNOWLEDGE-BASED SYSTEMS

Development Strategies-Feasibility Study-Design and User Specification-Activities of Detailed Design. Knowledge Acquisition: Overview-Organization for Knowledge Acquisition-Decision Tables and Production Rules-Testing the Knowledge Base-Distribution of Repository. (8)

### DATA AND KNOWLEDGE REPRESENTATION

From Files to Knowledge Bases- Knowledge Coding and Representation Methods- Database and Knowledge Bases-Intelligent Systems. (7)

### INFERENCES AND UNCERTAINTY

Strategies for Reasoning and Searching-Control-Conflict Resolution-Rule Based Systems-Uncertainty Rules-Approaches to Uncertainty Management-Fuzzy Logic. (10)

### RESOURCES FOR KBS

Processors-Programming for KBS: LISP and PROLOG-CLIPS framework. Selected Expert System Applications: Marketing-Software Engineering-Management of Natural Resources-Medicine-Agriculture. (10)

**TOTAL : 45**

### TEXT BOOKS

1. D.Partridge, Hussain,K.M. Knowledge Based Information Systems, Mc Graw Hill, 1996.
2. Jay Liebowitz, The Handbook of Applied Expert Systems, 2019 (Para V).

## REFERENCES

1. Joseph Giarrantano, Gary Riley, *Expert Systems: Principles and Programming*, PWS Publishing Company, Paperback, 2007
2. Dan.W. Patterson, *Introduction to Artificial Intelligence and Expert Systems*, PHI, 2007.
3. Rajendra Arvind Akerkar, Priti Srinivas Sajja, *Knowledge Based Systems*, Jones & Bartlette Publishers, 2010.

# 19MAM54 - AI SYSTEMS ENGINEERING

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Understand the concept of an Intelligent System (IS) and goals of AI-Enabled Systems

**CO2** : Create intelligence using different approaches including machine learning

**CO3** : Implement production-quality systems that are robust to mistakes of AI components

**CO4** : Compare the intelligence and evaluate the accuracy of the AI-based systems using appropriate methods.

**CO5** : Build an AI based system from end to end and leverage machine learning in practice.

## APPROACHING AN INTELLIGENT SYSTEMS (IS) PROJECT

Elements of Intelligent Systems-Examples-Making an Intelligent System-Problems that need Information Systems- Working with data. Goals and Success Measure for AI-Enabled Systems: Defining Goals-Types of Goals-Measuring Goals-Component of Intelligent Experience-Modes of Intelligent Interaction-Properties of good data-Understand Outcomes-Verifying Intelligent Experiences. (12)

## MODELS TO AI-ENABLED SYSTEMS

Presenting Intelligence to Users-Achieving System Objectives-Minimizing Intelligence Flaws-Create Data to Grow the System-Trade-offs among modeling techniques. (8)

## RISKS AND PLANNING FOR MISTAKES

Mistakes made by IS-Changes in Intelligence-The Human Factor-Balancing Intelligent Experience-Dealing with Mistakes. (8)

## MODEL QUALITY AND TESTING

Evaluating Accuracy-Evaluating Other Types of Predictions-Using Data for Evaluation-Comparing Intelligence-Common Challenges-Quality Assessment in Production. (9)

## SOFTWARE ARCHITECTURE FOR AI-ENABLED SYSTEMS

Considerations for Positioning Intelligence-Static Intelligence in the Product-Client side and Server-side Intelligence-Backend and Hybrid Intelligence-An Intelligent System Checklist. (8)

**TOTAL : 45**

## TEXT BOOK

1. *Building Intelligent Systems: A Guide to Machine Learning Engineering*, Geoff Hulten, APress,2018. (Chap.1,2,3,4,5,6,7,8,9,10,13,15,18,19,24,26)

## REFERENCES

1. <https://ckaestne.github.io/seai/F2020/>
2. [https://github.com/ckaestne/seai/blob/F2020/assignments/11\\_case\\_study.md](https://github.com/ckaestne/seai/blob/F2020/assignments/11_case_study.md)

# 19MAM55 - DISTRIBUTED AND CLOUD COMPUTING

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Explain the core concepts of the cloud computing paradigm

**CO2** : Compare the service models offered by different service providers and choose appropriate platforms for implementing cloud computing solutions considering management, security and trust requirements.

**CO3** : Analyze various cloud programming models and apply them to solve problems on the cloud.

**CO4** : Elucidate the concept, features, use cases, and benefits of containers, and the difference between containers and virtual machines.

**CO5** : Explain the basic concepts of microservices and container orchestration.

## DISTRIBUTED SYSTEM MODELS AND ENABLING TECHNOLOGIES

Technologies for Network-Based Systems - System Models for Distributed and Cloud Computing -Software Environments for Distributed Systems and Clouds - Performance, Security, and Energy Efficiency. (6)

## CLUSTERS and VIRTUALIZATION OF CLUSTERS

Clustering for Massive Parallelism - Computer Clusters and MPP Architectures -Design Principles of Computer Cluster. Implementation Levels of Virtualization -Virtualization Structures/Tools and Mechanisms -Virtualization of CPU, Memory, and I/O Devices -Virtual Clusters and Resource Management -Virtualization for Data-Center Automation. (9)

## COMPUTING CLOUDS AND SERVICE ORIENTED ARCHITECTURE

Cloud Platform Architecture: Cloud Computing and Service Models -Data Center Design and Interconnection Networks - Architectural Design of Compute and Storage Clouds - Public Cloud Platforms: GAE, AWS, and Azure - Inter-cloud Resource Management - Cloud Security and Trust Management.

Service-Oriented Architecture for Distributed Computing: Services and Service oriented Architecture - Message- oriented Middleware - Service Registries - Basic Workflow. (12)

## CLOUD PROGRAMMING AND SOFTWARE ENVIRONMENTS

Features of Cloud and Grid Platforms - Parallel and Distributed Programming Paradigms - Programming Support of Google App Engine - Programming on Amazon AWS and Microsoft Azure - Emerging Cloud Software Environments. (9)

## MICROSERVICES AND CONTAINERS

Introduction to Microservices - Migrating and Implementing Microservices - Containerization: Docker Container - Container Orchestration - Container Management. (9)

**TOTAL : 45**

## TEXT BOOKS

1. Kai Hwang, Geoffrey C Fox, John J Dongarra, *Distributed and Cloud Computing From Parallel Processing to the Internet of Things*, Morgan Kaufmann, 2012. (Para I-IV)
2. Parminder Singh Kocher, *"Microservices and Containers"*, Addison Wesley, 2018. (Para V)

## REFERENCES

1. James E. Smith, Ravi Nair, "*Virtual Machines: Versatile Platforms for Systems and Processes*", Elsevier/Morgan Kaufmann, 2005.
2. Chris Wolf, Erick M. Halter, "*Virtualization: From the Desktop to the Enterprise*", Apress Series, 2005.
3. Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter, "*Cloud Computing - A practical Approach*", Tata McGraw Hill, 2010.

## 19MAM56 - ADVANCED MACHINE LEARNING LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

- CO1** : *Implement bagging, boosting and Random Forest methods for classification and regression problems.*
- CO2** : *Apply hyper-parameter tuning and dimensionality reduction techniques to improve the performance of the models.*
- CO3** : *Use support vector machines, Hidden Markov Models and Bayesian Belief networks on real-time datasets and draw insights.*
- CO4** : *Implement various neural network models like perceptron, associative nets, Self-organizing maps (SOM) etc without using libraries for simple problems.*
- CO5** : *Design and implement Artificial Neural Networks and Radial Belief Network to classify images.*

### CONCEPTS TO BE COVERED

- Ensemble learning methods in building classifiers
  - Bagging
  - Boosting and
  - Stacking algorithms
- Download a large dataset with more dimensions and apply dimensionality reduction techniques like PCA, LDA, SVD etc on it and compare the classifier performance using various metrics.
- Dealing with class imbalance in ML models using SMOTE methods
- Improving model performance through hyper-parameter tuning methods
  - Cross Validation
  - GridSearchCV, Random SearchCV, Optimization algorithms etc
  - Optimizing the models using L1 and L2 regression
- Support Vector Machine for classification and Regression
- Bayesian Belief network implementation
- Sequence classification using Hidden Markov Model

### Artificial Neural Networks (ANN)

- Design a perceptron for logic gates
- Implementing back propagation algorithm
- Implement Auto-associative Neural network and
- SOM implementation
- Classification using Radial Basis Networks
- Design and implement an ANN model to classify images. (with and without library)

**TOTAL : 60**

# 19MAM57 - FULL STACK WEB DEVELOPMENT LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

19MAM17

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

- CO1** : *Develop web pages that function using external data -HTML and CSS.*
- CO2** : *Use Javascript to implement client-side validations and perform AJAX calls*
- CO3** : *Apply AngularJS and /ReactJS to develop frontend dynamic web UI*
- CO4** : *Implement CRUD operations on database (MongoDB) in NODE.js*
- CO5** : *Build end-to-end web applications handling all the areas of the tech-stack and any of the web frameworks.*

## CONCEPTS TO BE COVERED

1. Front-End
  - HTML Basics
  - CSS-styling, selectors, box model, border, margin, padding
  - Develop responsive websites using HTML and CSS. (Eg.Video Player, Educational Game)
  - JavaScript
  - Fundamentals, Hoisting, Callbacks, Asynchronous JavaScript, DOM Manipulation, JSON, AJAX Calls, JQuery etc.
2. Front-End Frameworks and Libraries
  - Angular JS or React JS
  - Single page web application development
3. Back-end
  - Node.Js
  - Building a HTTP Server with Node.JS using HTTP APIs
  - Buffers, Streams, and Events
4. Work with MongoDB
  - Create a database and set up function to interface with it in a CRUD pattern
5. Work with APIs
  - Build an endpoint that can send out a tweet using the Twitter API

**Note : Development of complete web application end-to end may be the final exercise**

**TOTAL : 60**

# 19MAM58- CLOUD COMPUTING LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

- CO1** : *Demonstrate knowledge on creating, cloning and migrating virtual machines using Virtual Box.*
- CO2** : *Use public cloud to acquire instances for a given system configuration.*
- CO3** : *Develop applications, launch it on cloud and access it with proper authentication mechanisms.*
- CO4** : *Construct a private cloud using the open-source cloud technologies such as Open Stack / Cloud Stack / Open Nebula for a given requirement.*
- CO5** : *Able to create Micro services for an application, containerize and deploy.*

## VIRTUALIZATION - VIRTUAL BOX

- Create virtual machines of different configurations
- Communication between host and virtual machine
- Communication between virtual machine to virtual machine
- Show the virtual machine migration from one node to the other.

## PRIVATE CLOUD

Use Eucalyptus or OpenStack or CloudStack or equivalent to set up a private cloud and demonstrate:

- Create virtual machines of different configurations. Check how many virtual machines can be utilized at a particular time.
- Attach a virtual block to the virtual machine and check whether it holds the data even after the release of the virtual machine.
- Install a C compiler in the virtual machine and execute a sample program.
- Show the virtual machine migration from one node to the other.
- Install storage controller and interact with it.

## PUBLIC CLOUD

Explore any public cloud to access various services provided by it.

## CONTAINERIZATION

- Implement Docker and Kubernetes based application development and deployment
- Choose a ML Application, Containerize and deploy in Cloud.
- Adapt DevOps for basic testing (unit test) and deployment

**Software / Tools** : Virtual Box, Any Public Cloud, Docker and Kubernetes

**TOTAL : 60**

## 19MAM59 - PERSONALITY DEVELOPMENT

L	T	P	C
0	0	4	2

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

- CO1** : Ascertain the various concepts of Self like the Physical Self - Energy Self - Intellectual Self -Mental Self - Blissful Self with respect to the Western (Occidental) and Eastern (Oriental) theories of Self and Personality Development.
- CO2** : Acquire communication and listening skills.
- CO3** : Assess the various personalities and Attitudes and choose the best attitude for making bold decisions in personal and professional contexts.
- CO4** : Project the appropriate grooming and the right etiquette in the corporate context to excel in professional life.
- CO5** : Set Career goals and formulate strategies by Prioritizing, organizing and scheduling the required tasks.

### PERSONALITY DEVELOPMENT

One's Personality Sends Out a Signal That Others Read - Same Person: Consciously Different Personalities can be Powerful - There isn't One Right Personality; It Differs by Role - Learning about Personality Development from the Three Cases - Personality Analysis - Freudian Analysis of Personality Development - Swami Vivekananda's Concept of Personality - Development: Physical Self - Energy Self - Intellectual Self - Mental Self - Blissful Self - Personality Begets. (7)

### LEADERSHIP QUALITIES & INTERPERSONAL SKILLS

Resolving Conflict - A Smiling Face - Appreciative Attitude - Assertive Nature -Communication Skills - Listening Skills - Developing Empathy - The Personality Attribute of Taking Bold Decisions - Personality Types and Leadership Qualities - Mapping the Different Personality Types - Personality Tests: Example of a Personality Test: Jung Typology Test - Personality Assessment. (8)

### ETIQUETTE

Social Etiquette - Corporate Etiquette - Personal Grooming - Using minimal Body Language -Leadership and Entrepreneurship: Corporate Training - Professionalism - Self awareness -Creativity skills - Cognitive Development - Assertiveness - Positive Thinking and Attitude. (8)

### GOAL SETTING AND TIME MANAGEMENT

Goal Setting - Immediate, Short Term and Long Term Goals - Smart Goals - Strategies to Achieve Goals - Confidence Building, Self-esteem, Motivation - Time Management -Identifying Time Wasters - Time Management Skills. (8)

**TOTAL : 30**

### REFERENCES

1. Mitra K.Barun, "Personality Development and Soft Skills", Oxford University Press, 2011.
2. Krishna Mohan, Meera Banerji. "Developing Communication Skills" Macmillan Publishers, 2012.
3. Sai Lakshmi. B, "Poly Skills- A Course in Communication and Life Skills" Cambridge University Press, 2012.
4. Simon Sweeney, English for Business Communication, Cambridge University Press, 2013.
5. Meenakshi Raman, Sangeeta Sharma, Technical Communication - Principles and Practice, 2nd Edition, Oxford University Press, New Delhi, 2015.

# 19MAM61 - INTELLIGENT AGENTS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM31, 19MAM53

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Understand agents, agent types, structure and their interactions

**CO2** : Appreciate the utility of different types of AI agents.

**CO3** : Learn and use multi agent systems and their interactions to reach agreements.

**CO4** : Demonstrate communication language used by the agents for their coordination and coherence.

**CO5** : Review the cooperative distributed problem-solving techniques used by agents with task and result sharing.

### INTELLIGENT AGENTS

Introduction-Environments of Intelligent Agents-Agents and Objects-Agents and Expert Systems-Agents as Intentional Systems-Abstract Architectures for Intelligent Agents-Synthesizing Agents-Deductive Reasoning Agents. (8)

### PRACTICAL REASONING AGENTS

Practical Reasoning- Means-Ends Reasoning-The Blocks World- Implementing a Practical Reasoning Agent-Commitment to Ends and Means-The Procedural Reasoning System.

Reactive and Hybrid Agents: Brooks and the Subsumption Architecture-The Limitations of Reactive Agents, Hybrid Agents. (10)

### MULTI-AGENT INTERACTIONS

Utilities and Preferences- Multiagent Encounters- Dominant Strategies and Nash Equilibria-Competitive and Zero-Sum Interactions-The Prisoner's Dilemma.

Reaching Agreements

Mechanism Design, Auctions, Negotiation, Task-Oriented Domains, Worth-Oriented Domains, Argumentation. (12)

### COMMUNICATION AND CO-OPERATION

Speech Acts - Agent Communication Languages-KIF-KQML-The FIPA Agent Communication Languages-Ontologies for Agent Communication-Coordination Languages.

Cooperative Distributed Problem Solving-Coherence and Coordination-Task Sharing and Result Sharing-Task Sharing in the Contract Net-Result Sharing-Handling Inconsistency- Coordination-Multiagent Planning and Synchronization. (10)

### CASE STUDY

Applications of Agents in Various Domains-Building multi-agent systems. (5)

**TOTAL : 45**

### TEXT BOOKS

1. Michael Wooldridge, "An Introduction to Multi Agent Systems", 2nd Edition, John Wiley & Sons, 2009.
2. G. Weiss. "Multiagent Systems--A Modern Approach to Distributed Artificial Intelligence", 2nd Edition, MIT Press, Cambridge, 2013. (Last Para)

## REFERENCES

1. Praveen Palanisamy, *"Hands-On Intelligent Agents with OpenAI Gym: Your Guide to Developing AI Agents Using Deep Reinforcement Learning"*, Packt, 2018.
2. Fabio Luigi Bellifemine, Giovanni Caire, Dominic Greenwood, *"Developing Multi-Agent Systems with JADE"*, John Wiley & Sons, 2007.
3. Russell and P. Norvig, *"Artificial Intelligence: A Modern Approach"*, 3rd Edition, Pearson Education, 2015.

# 19MAM62 - DEEP LEARNING

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM52

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Understand the concepts of feed forward and deep networks and regularization principles.

**CO2** : Implement and visualize Convolutional Neural Networks algorithms for classification problems.

**CO3** : Identify Recurrent Neural Network algorithms which are more appropriate for various types of learning tasks in various domains.

**CO4** : Review the unsupervised deep learning models- deep generative models and autoencoders for predictive learning.

**CO5** : Apply the optimization techniques and fine tune the deep neural networks while designing deep learning algorithms for varied applications.

**CO6** : Learn the basics of transfer learning and its application in deep learning

### DEEP FEEDFORWARD NETWORKS

Feed Forward Networks-Learning XOR-Gradient Based Learning Hidden Units-Architectural Design- Empirical Risk Minimization-Backpropagation. (8)

### REGULARIZATION FOR DEEP LEARNING

Parameter Norm Penalties - Norm Penalties as Constrained Optimization - Regularization and Under - Constrained Problems - Dataset Augmentation - Noise Robustness - Semi-Supervised Learning - Multi-Task Learning - Early Stopping - Parameter Tying and Parameter Sharing - Sparse Representations -Bagging and Other Ensemble Methods - Dropout. (7)

### OPTIMIZATION FOR TRAINING DEEP MODELS

Learning vs Pure Optimization-Challenges in Neural Network Optimization-Basic Algorithms- Parameter Initialization Strategies-Algorithms with Adaptive Learning Rates-Approximate Second-Order Methods-Optimization Strategies and Meta-Algorithms. (7)

### CONVOLUTIONAL NEURAL NETWORKS(CNN)

Basic Structure of a Convolution Network-Training a CNN-Case Studies of CNN Architecture-Visualization and Unsupervised Learning -Applications of CNNs. Autoencoders: Architecture-Applications. (8)

### RECURRENT NEURAL NETWORKS (RNN)

Architecture of RNN-Challenges in Training NN- Echo state Networks-Long Short-Term Memory-Applications of RNN. Transformers in Deep Learning: Architecture-Comparison to RNN and CNN-Applications. (7)

### TRANSFER LEARNING

Fundamentals of Transfer Learning: Definition-Transfer Learning Types-Methodologies-Need and Challenges. Fundamentals of Pre-Trained Models-Examples-Image Classification using Pre-trained Models. (8)

**TOTAL : 45**

## TEXT BOOKS

1. *Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017. (Para I-III).*
2. *Charu C Aggarwal, "Neural Networks and Deep Learning", Springer, 2018. (Para IV,V)*
3. *Dipanjan Sarkar, Raghav Bali, "Transfer Learning in Action", Manning, 2021. (Para VI)*

## REFERENCES

1. *Nikhil Buduma, "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", O'Reilly Publications, 2017*
2. *Dipanjan Sarkar, Raghav Bali, T. Ghosh, "Hands-on Transfer Learning with Python", Packt, 2018.*
3. *<https://theaisummer.com/transformer/>*

# 19MAM63 - INFORMATION RETRIEVAL AND WEB SEARCH

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Understand the basic concepts and techniques in information retrieval

**CO2** : Apply the information retrieval models.

**CO3** : Evaluate an information retrieval system based on the relevance of the documents it retrieves.

**CO4** : Analyze the documents and query performances of system

**CO5** : Explore the techniques in text and multimedia retrieval process

## INFORMATION RETRIEVAL AND SEARCH PROCESS

Introduction to Information Retrieval(IR) - The IR Problem -The IR system - The web - User Interface for Search - Search by Users - Search Interfaces Today - Visualization in Search Interfaces - Design and Evaluation of Search Interfaces. (7)

## MODELING AND RETRIEVAL EVALUATION

IR Models - Classic Information retrieval-Boolean Model- Term weighting - TF-IDF Weight - Document Length Normalization - Vector Model - The Hypertext Model - Web based Models - Structured Text Retrieval - Multimedia Retrieval - Enterprise and Vertical Search - Retrieval Evaluation: The Cranfield paradigm - Retrieval Metrics - User Based Evaluation. (10)

## RELEVANCE FEEDBACK AND QUERY EXPANSION

Framework for Feedback Methods - Explicit Relevance Feedback - Explicit Feedback Through Clicks - Implicit Feedback Through Local Analysis. (8)

## DOCUMENTS AND QUERIES-LANGUAGES

Meta data - Document formats - Mark-up Languages and Properties- Document Pre-processing - Queries: Languages and Properties - Query Languages - Query Properties -Indexing and Searching- Inverted Indexes. (8)

## WEB RETRIEVAL AND CRAWLING

Search Engine Architecture - Search Engine Ranking- Managing Web Data -Search Engine User Interaction -Web Crawling: Applications of Web Crawler-Taxonomy of Crawlers - Crawler Architecture (7)

## TEXT AND MULTIMEDIA RETRIEVAL

Structuring Power - XML Retrieval - Multimedia Information Retrieval - Challenges - Content Based Image Retrieval (5)

**TOTAL : 45**

## TEXT BOOK

1. Ricardo Baeza-Yate, Berthier Ribeiro-Neto, "Modern Information Retrieval", Second Edition, ACM Press Books, 2011.

## REFERENCES

1. C. Manning, P. Raghavan, and H. Schütze, "Introduction to Information Retrieval", Cambridge University Press, 2009.
2. Stefan Büttcher, Charles L. A. Clarke, Gordon V. Cormac, "Implementing and Evaluating Search Engines", MIT Press, 2016.

# 19MAM64 - BIG DATA ANALYTICS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM42

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Learn the concepts of big data characteristics and its applications

**CO2** : Apply map-reduce programming to parallelize data centric problems using Hadoop and HDFS

**CO3** : Exposure to data analytics using various Hadoop ecosystem tools.

**CO4** : Understand stream processing and perform stream analytics on real-time problems.

**CO5** : Implement real-time streaming analytics using Spark Streaming API.

## INTRODUCTION TO BIG DATA

Big Data Characteristics - Scalability and Parallel Processing - Designing Data Architecture - Data Sources and Quality - Data Storage and Analysis - Big Data Analytics Applications and Case Studies. Data Analytics Lifecycle - Six Phases: Discovery-Data Preparation-Model Planning-Model Building- Communicate Results-Operationalize. (6)

## HADOOP AND MAP REDUCE

Hadoop and its Ecosystem- Installing Hadoop-Understanding Hadoop Features-Learning HDFS and MapReduce Architecture-Understanding Hadoop MapReduce Fundamentals-Writing a Hadoop MapReduce-Examples. (9)

## BIG DATA TECHNOLOGIES

NoSQL- Big Data Management using NoSQL, MangoDB and Cassandra, Hadoop Ecosystem Tools - Hive, HiveQL, Pig, Spark and Big Data Analytics - Apache Mahout Machine Learning Applications. (10)

## DATA STREAM MINING

Data Stream Concepts and Data Stream Management: Data stream concepts - Data Stream Model - Architecture - Data Stream Management System (DSMS) - Examples of sources of streams - Stream Queries - Stream Processing Issues - Real-time Processing, Stream Processing and Batch Processing - Stream Computing Aspects - Frequent Itemsets Mining in a Stream. (10)

## REAL-TIME ANALYTICS

Apache Spark Streaming-Real-time Analytics Platform (RTAP) Applications-Case Studies: Real-Time Sentiment Analysis, Positive Negative Sentiments Prediction and Stock Market Prediction. (10)

**TOTAL : 45**

## TEXT BOOKS

1. Raj Kamal and Preeti Saxena, "Big Data Analytics: Introduction to Hadoop, Spark, and Machine-Learning", McGraw-Hill Education, 2019. (Para I, III-V)
2. Vignesh Prajapathi, "Big Data Analytics with R and Hadoop", Packt Publishing, 2013. (Para II)
3. Data Science and Big Data Analytics, EMC Educational Services, Wiley, 2015. (Para I)

## REFERENCES

1. Kai Hwang and Min Chen, "Big-Data Analytics: for Cloud, IoT and Cognitive Computing", Wiley Edition, 2018.
2. Bill Chambers and Matei Zaharia, "Spark: The Definitive Guide", O'Reilly, 2018.

# 19MAM65 - DEEP LEARNING LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

- CO1** : *Design single and multi-layer feed-forward deep networks and tune various hyper-parameters.*
- CO2** : *Build classification models using convolutional neural networks, recurrent neural networks for real-time applications.*
- CO3** : *Implement hyperparameter tuning and optimization techniques to improve the performance of the Deep neural networks.*
- CO4** : *Use of Long Short Term Memory networks in real-time prediction problems.*
- CO5** : *Apply pretrained models in practice with large image datasets and perform classification efficiently.*

## CONCEPTS TO BE COVERED

- Implement a simple Neural network using image dataset
- Data augmentation techniques

### Convolutional NN

- CNN model building with varying parameters settings.
- Classify images (faces, melanomas, etc.) based on patterns and objects that appear in them.
- Audio and/or video data prediction

### Recurrent NN

- Time series data analysis
- Text Translation
- Sentiment Analysis
- Predict the next word using a sample text

### Long Short-Term Memory Networks

- Applications of LSTM in text processing
- Demonstrate the use of different optimization techniques and hyper-parameter tuning techniques
- Pre-trained models/Transfer learning for various domains (VGG-16, Resnet, BERT etc)

**Datasets : Benchmark datasets for image and text processing may be used. (Imagenet, CIFAR-10 etc)**

## REFERENCES

1. *Francois Chollet, "Deep Learning with Python", Kindle Edition, 2021.*
2. *Dipanjan Sarker, Raghav Bali, T. Ghosh, "Hands-on Transfer Learning with Python", Packt, 2018.*

**TOTAL : 60**

# 19MAM66 - MOBILE APPLICATION DEVELOPMENT LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

**CO1** : *Understand the components and structure of mobile application development frameworks for Android and windows OS-based mobiles.*

**CO2** : *Work with various mobile application development frameworks and develop mobile apps.*

**CO3** : *Apply the basic UI and important design concepts and issues of development in mobile applications.*

**CO4** : *Develop mobile apps for Android OS using GPS, Storage and RSS feed.*

**CO5** : *Design mobile applications based on the capabilities and limitations of mobile devices.*

## CONCEPTS TO BE COVERED

1. Develop an application that uses GUI components, Font and Colors
2. Develop an application that uses Layout Managers and event listeners.
3. Write an application that draws basic graphical primitives on the screen.
4. Develop an application that makes use of databases or back-end storage for mobile apps.
5. Develop an application that makes use of notification manager
6. Implement an application that uses multi-threading
7. Develop a native application that uses GPS location information
8. Implement an application that writes data to the SD card.
9. Implement an application that creates an alert upon receiving a message
10. Write a mobile application that makes use of RSS feed
11. Develop a mobile application to send an email.

**Softwares : Android SDK/Kotlin**

**TOTAL : 60**

## 19MAM67 - BIG DATA ANALYTICS LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

19MAM46

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

- CO1** : Write MapReduce programs to work on Hadoop clusters.
- CO2** : Work with NoSQL -MongoDB for learning basic CRUD operations.
- CO3** : Learn and apply basic Hadoop commands and read/write data to HDFS
- CO4** : Implement supervised and unsupervised machine learning algorithms using SparkML library.
- CO5** : Perform stream analytics using real time Spark framework.

### CONCEPTS TO BE COVERED

1. MapReduce Programming exercises
2. NoSQL operations (MongoDB and Cassandra)
3. Preparing data with Hadoop
4. Basic HDFS commands, Direct file transfer to HDFS
5. Importing data (CSV,Jason) into Hive Tables, using Spark
6. Data import and export with Sqoop
7. Work with Data Streams using Flume (Eg.Web Log Creation)
8. Creating Visualizations using comparison charts, composition, distribution and relationship charts.
9. Data Modelling with SparkML
  - a. Applications of machine learning algorithms-Supervised and Unsupervised
  - b. Evaluate Model (Cross-Validation, Model Tuning) and Prediction
10. Real-Time Analytics using SparkStreaming

**Software / Tools** : Virtual Box, Hadoop, Python Language

### REFERENCES

1. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.

**TOTAL : 60**

# 19MAM68 - COMMUNICATION SKILLS

L	T	P	C
0	0	2	1

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

**CO1** : *Conceive appropriate verbal responses from the learners to a given social situation, using the guidelines to effective speaking skills and body language.*

**CO2** : *Acquire soft skills, interpersonal and team playing skills.*

**CO3** : *Comprehend telephonic and negotiation skills.*

**CO4** : *Compose appropriate written responses to professional problems faced by a team at the workplace.*

**CO5** : *Perceive the nuances of interview skills and group behaviour.*

## INTRODUCTION

Introduction - Code and Content - Stimulus and Response: Source - The Encoding Process - The Channel - The Decoding Process - The Receiver - Speaking Skills - Effective Speaking Guidelines - Communicating Soft Skills: A Self-assessment - Closing Tips (4)

## SOFT SKILLS

Introduction to Soft Skills - Lessons from the Three Case Studies - Change in Today's Workplace: Soft Skills as a Competitive Weapon - Antiquity of Soft Skills - Classification of Soft Skills: Time Management - Attitude - Responsibility - Ethics, Integrity, Values and Trust - Self-confidence and Courage - Consistency and Predictability - Teamwork and Interpersonal Skills - Communication and Networking - Empathy and Listening Skills - Problem Solving, Troubleshooting and Speed reading - Leadership - Body Language (8)

## TELEPHONING SKILLS & NEGOTIATIONS

Preparing to make a telephone call - Receiving calls - Taking and leaving messages - Asking for and giving repetition - The secretarial barrier - Cross-cultural communication on the telephone - Setting up appointments - Changing arrangements - Ending a call - Cross-cultural communication on the telephone - Problem-solving on the telephone - Complaints - Negotiations: Types of negotiation - Preparation for a negotiation - Making an opening statement - Bargaining and making concessions - Accepting and confirming - Summarizing and looking ahead - Types of negotiator - Dealing with conflict - Rejecting - Ending the negotiation (8)

## WRITING SKILLS TO CREATE AN IMPRESSION

Fifteen Principle to Increase Clarity in Communication - Edit-Edit-Edit: The Reader's Perspective - Clarity of Thought - Clarity of Text. (3)

## SPEAKING

Job Interviews: Types of Interviews - Groundwork before the Interview -Importance of body Language in Interview - Need for proper Articulation - Concluding an Interview - Telephonic or Video Interview - A Mock Interview - Group Discussion: Introduction - Ability to Work as a Team - Communication Skills - Active Listening - Non-verbal Communication - Leadership and Assertiveness - Reasoning - Ability to Influence - Innovation. Creativity, and Lateral Thinking - Flexibility - Key Steps to Succeed in a Group Discussion - The Responsibility of the First Speaker - Concluding the Discussion - Dos and Don'ts during a Group Discussion (7)

**TOTAL : 30**

## 19MAM69 - HACKATHON

L	T	P	C
0	0	2	1

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

- CO1** : To familiarize students about the various programming challenges in Hackathons and encourage the students to participate in it.
- CO2** : To gain experience in devising solutions to real-time problems and challenges of industry in the domain of AI/ML.
- CO3** : To explore research problems in the area of AI/ML and implement it.

### IDEA SUBMISSION AND EVALUATION PROCESS

- Students are unveiled of problems on various hackathon portals, Kaggle competitions and similar challenges as given below.

Sl.No	Name of Hackathon
1.	Codevita / Hackerearth/AnalyticsVidhya
2.	Tata Cruicable Campus Hackathon
3.	Leetcode
4.	Smart India Hackathon
5	Kaggle Competitions

- The evaluation is done as continuous assessment based on the participation, problem and the solution implementation.

**TOTAL : 30**

## 19MAM71 - PROJECT WORK AND VIVA VOCE - I

<b>Credits</b>
<b>18</b>

### PRE-REQUISITES

Consent of the Instructor

### COURSE OUTCOMES

*Upon completion of the project, students will be able to:*

- C01** : *Acquire skills in developing software applications or AI/ML based applications by understanding real-time requirements and the domain.*
- C02** : *Propose new solutions for challenging tasks and develop new or augment existing methods.*
- C03** : *Communicate effectively in a team and work collaboratively to deliver outcomes as set by the organization/clients.*
- C04** : *Gain the latest technological skillsets and exhibit a deeper understanding of concepts.*
- C05** : *Document the project demonstrating the contributions and technical details of the project work carried out and formal viva*

# 19MAM81 - GRAPH REPRESENTATION LEARNING

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM21, 19MAM42, 19MAM61

## ASSESSMENT : THEORY

### COURSE OUTCOMES

- CO1** : Understand the fundamental concepts of graph theory.
- CO2** : Familiarize with the different graph reconstruction methods.
- CO3** : Model Graph Neural Networks to solve real-time problems
- CO4** : Apply Graph Generative Models for finding solutions for complex data problems
- CO5** : Learn about knowledge graph and its representation

### GRAPH THEORY AND CONCEPTS

Graphs -Graph Structures-Types of Graphs- -Machine learning on Graphs - Background and Traditional Approaches: Graph Statistics and Kernel Methods - Neighborhood Overlap Detection - Graph. (8)

### NODE EMBEDDINGS

Neighborhood Reconstruction Methods - Encoder-Decoder Perspective - Factorization-based approaches - Random Walk Embeddings -Limitations of Shallow Embeddings - Multi-relational Data and Knowledge Graphs (9)

### GRAPH NEURAL NETWORKS (GNNS)

The Graph Neural Network Model - Neural Message Passing - Generalized Neighborhood Aggregation - Generalized Update Methods - Edge Features and Multi-relational GNNs - Graph Pooling. Graph Neural Network in Practice: Applications and Loss Functions - Efficiency Concerns and Node Sampling - Parameter Sharing and Regularization. (10)

### GENERATIVE GRAPH MODELS

GNNs and Graph Convolutions - Graph Classification using GCNNs-GNNs and Probabilistic Graphical Models - GNNs and Graph Isomorphism. Generative Graph Models: Traditional Graph Generation Approaches - Deep Generative Models (9)

### KNOWLEDGE GRAPH

Emergence of the Knowledge Graph -Data and Graphs: Introduction-Representing Data and Knowledge in Graphs. Architecture: Creation of Knowledge Graphs - Reasoning in Knowledge Graphs. (9)

**TOTAL : 45**

## TEXT BOOKS

1. William L. Hamilton, 'Graph Representation Learning', Morgan & Claypool publishers, 2020. (Para I-IV)
2. Sean Martin, Ben Szekely, and Dean Allemang, 'The Rise of the Knowledge Graph: Toward Modern Data Integration and the Data Fabric Architecture', O'Reilly Media, Inc. 1 Edition, 2021. (Para V)

## REFERENCES

1. Aldo Marzullo, Claudio Stamile, and Enrico Deusebio, Graph Machine Learning, Packt Publishing, 2021.
2. Mark Needham, Amy E. Hodler, Graph Algorithms: Practical Examples in Apache Spark and Neo4j, O'Reilly, 2019.
3. Mayank Kejriwal, Craig A. Knoblock and Pedro Szekely, 'Knowledge Graphs: Fundamentals, Techniques, and Applications, MIT Press, 2021.

# 19MAM82 - REINFORCEMENT LEARNING

L	T	P	C
3	0	2	4

## PRE-REQUISITES

19MAM18,19MAM22

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : Familiarize with the fundamentals of Reinforcement Learning.
- CO2** : Understand and apply basic RL algorithms for simple sequential decision-making problems in uncertain conditions.
- CO3** : Examine the various model-based and model-free methods for model planning and learning.
- CO4** : Review the application of approximation-based algorithms for Reinforcement Learning
- CO5** : Learn the applications and latest trends in Reinforcement Learning
- CO6** : Implement reinforcement learning algorithms to solve a cognitive task

## REINFORCEMENT LEARNING PROBLEM

Reinforcement Learning-Examples-Elements of Reinforcement Learning-Limitations and Scope-An Extended Example: Tic-Tac-Toe-History of Reinforcement Learning (10)

## TABULAR SOLUTION METHODS

Bandit Problems and Online Learning-Markov Decision Processes and Value Functions-Dynamic Programming-Monte Carlo Methods-Temporal Difference Learning. (12)

## PLANNING AND LEARNING

Models and Planning with Tabular Methods-Eligibility Traces (8)

## APPROXIMATE SOLUTION METHODS

Function Value Approximation-On Policy Approximation of Action Values-Off Policy Approximation of Action Values. (10)

## CASE STUDIES

Examples of Reinforcement Learning System-Applications in different domains-Alpha Go-IBM Watson-Frontiers in Reinforcement Learning-Introduction to Deep Reinforcement Learning. (5)

## PRATICALS

Implement the reinforcement learning algorithms using OpenAI Gym and Tensor flow or any RL platform. (15)

**TOTAL : 60**

## TEXT BOOKS

1. Richard Sutton & Andrew G. Barto, 'Reinforcement Learning: An Introduction', 1st Edition, MIT Press,2015.
2. Sudharshan Ravichandran, Sean Saito, Rajalingappa Shanmugamani and Yang Wenzhao, "Python Reinforcement Learning", Packt, 2019. (Practicals)

## REFERENCES

1. Csaba Szepersvani, 'Algorithms for Reinforcement Learning', Morgan and Claypool Publishers, 2010.
2. Maxim Lapan, "Deep Reinforcement Learning", Packt2, 2018.
3. Parag Kulkarni, "Reinforcement and System Machine Learning for Decision Making", Wiley, 2012.

# 19MAM83 - META-HEURISTIC OPTIMIZATION TECHNIQUES

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : *Understand the basic concepts of heuristic optimization .*
- CO2** : *Familiarize with genetic and evolutionary algorithm and its applications in real world problem solving.*
- CO3** : *Apply Ant colony optimization algorithmic models for various optimization problems.*
- CO4** : *Implement particle swam optimization algorithm and Firefly algorithms for problem solving.*
- CO5** : *Solve computational problems using Honeybee optimization techniques.*

## OVERVIEW OF OPTIMIZATION

Optimization - Objective Function - Decision Variables - Solutions of an Optimization Problem - Decision Space - Constraints or Restrictions - State Variables - Local and Global Optima - Near Optimal Solutions (6)

## INTRODUCTION TO META HEURISTIC AND EVOLUTIONARY ALGORITHMS

Searching the Decision Space for Optimal Solutions - Definition of Terms of Meta Heuristic and Evolutionary Algorithms Principles of Meta Heuristic and Evolutionary Algorithms - Classification of Meta Heuristic and Evolutionary Algorithms - Meta Heuristic and Evolutionary Algorithms in Discrete or Continuous Domains - Generating Random Values of the Decision Variables - Dealing with Constraints - Selection of Solutions in Each Iteration - General Algorithm - Performance Evaluation of Meta Heuristic and Evolutionary Algorithms. (8)

## GENETIC ALGORITHMS

Introduction - Mapping the Genetic Algorithm (GA) to Natural Evolution - Creating an Initial Population - Selection of Parents to Create a New Generation - Population Diversity and Selective Pressure - Reproduction - Termination Criteria - User Defined Parameters of the GA. (8)

## THE ANT COLONY OPTIMIZATION METAHEURISTIC (ACO)

Combinatorial Optimization - The ACO Metaheuristic - Applying ACO - Other Metaheuristics - Ant Colony Optimization Algorithms for the Traveling Salesman Problem; The Traveling Salesman Problem - ACO Algorithms for the TSP - Ant System and Its Direct Successors - Particle Swarm Optimization; Introduction - Mapping Particle Swarm Optimization (PSO) to the Social Behavior of Some Animals - Creating an Initial Population of Particles - The Individual and Global Best Positions - Velocities of Particles - Updating the Positions of Particles - Termination Criteria - User Defined Parameters of the PSO. (10)

## HONEY BEE MATING OPTIMIZATION

Introduction - Mapping Honey Bee Mating Optimization (HBMO) to the Honey Bee Colony Structure - Creating an Initial Population - The Queen - Drone Selection - Brood (New Solution) Production - Improving Broods (New Solutions) by Workers - Termination Criteria - User Defined Parameters of the HBMO. (7)

## FIREFLY ALGORITHM

Introduction - Mapping the Firefly Algorithm (FA) to the Flashing Characteristics of Fireflies - Creating an Initial Population - Attractiveness - Distance and Movement - Termination Criteria - User Defined Parameters of the FA (6)

**TOTAL : 45**

## TEXT BOOKS

1. Omid Bozorg Haddad, Iran Mohammad Solgi, Iran Hugo A. Loaiciga, *"Meta Heuristic and Evolutionary Algorithms for Engineering Optimization"*, John Wiley & Sons, 2017.
2. Marco Dorigo, Thomas Stutzle, *"Ant Colony Optimization"*, PHI, 2005 (Para IV)

## REFERENCES

1. Leandro Nunes de Castro, *"Fundamentals of Natural Computing: Basic concepts, Algorithms and Applications"*, CRC Press, 2007.
2. Carlos A. Coello Coello Gary B. Lamont David A. Van Veldhuizen, *"Evolutionary Algorithms for Solving Multi-Objective Problems"*, Second Edition, Springer, 2007.
3. Kwang Y. Lee and Mohamed A. El-Sharkawi, *"Modern Heuristic Optimization Techniques Theory and Applications to Power Systems"*, Wiley, 2008.

# 19MAM84 - META-HEURISTIC OPTIMIZATION LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

- CO1** : *Implement optimization techniques on specific applications*  
**CO2** : *Understand and perform Binary and Continuous Genetic Algorithm in real time application*  
**CO3** : *Apply evolutionary computation methods to solve complex problems*  
**CO4** : *Learn and use various Meta Heuristic Optimization Algorithm for real time application*  
**CO5** : *Summarize current research in Genetic Algorithms and Evolutionary Computing*

## TOPICS TO BE COVERED

1. Implement ANT Colony Optimization and its applications
2. Implement Particle Swarm Optimization (PSO).
3. Implement Genetic Algorithm & its applications.
  - Multi objective optimization in Genetic Algorithm.
  - Adaptive mutation in Genetic Algorithm.
  - Binary Genetic Algorithm
  - Continuous Genetic Algorithm
  - Genetic Algorithm Based Approach in attribute weighting for a Medical Data Set.
4. Implement Honey Bee Mating Optimization & its applications.
5. Implement Firefly Algorithm & apply.

**Suggested Software: Python/Matlab**

## REFERENCES

1. *Fister Jr., X.-S. Yang, I. Fister, J. Brest, "Memetic firefly algorithm for combinatorial optimization in Bioinspired Optimization Methods and their Applications", Slovenia, 2012.*
2. *Marco Dorigo and Thomas Stützli, "Ant Colony Optimization", The MIT Press, 2004.*

**TOTAL : 60**

# 19MAM91 - COMPUTER VISION

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM42

## ASSESSMENT : THEORY

### COURSE OUTCOMES

- CO1** : Understand and use the vision technology in conjunction with real world applications.
- CO2** : Detecting features, discuss feature correspondences across different images and review image segmentation techniques like Active contours, Split and merge, Mean shift and mode finding.
- CO3** : Investigate techniques like shading and focus, merging multiple range or depth images into 3D models, and reconstructing them.
- CO4** : Perform pose estimation, camera's intrinsic calibration, estimate 3D point structure from 2D matches, 3D geometry, camera motion and the motion between two or more images.
- CO5** : Reconstruct the 3D shape of a scene from images taken from different views.

### IMAGE FORMATION AND FILTERING

Introduction to computer vision - Photometric image formation - The digital camera - Point operators - Linear filtering, neighborhood operators - Fourier transforms - Pyramids and wavelets. (8)

### FEATURE DETECTION AND SEGMENTATION

Feature Detection: Points and patches - Edges - Lines.

Segmentation: Active contours - Split and merge - Mean shift and mode finding (8)

### 3D RECONSTRUCTION

Shape from X - Active range finding - Surface representations - Point-based representations - Volumetric representations - Model-based reconstruction - Recovering texture maps and albedos. (8)

### MOTION ESTIMATION

Feature-based alignment: 2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration. Structure from motion: Triangulation - frame structure from motion - Factorization - Bundle adjustment - Constrained structure and motion. Dense motion estimation: Translational alignment - Parametric motion - Spline-based motion - Optical flow, Layered motion. (12)

### RECOGNITION

Object detection - Face recognition - Instance recognition - Category recognition - Context and scene understanding. (8)

**TOTAL : 45**

### TEXT BOOK

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer-Verlag London Limited, 2011.

### REFERENCES

1. Forsyth, D. and Ponce, J, "Computer Vision : A Modern Approach", Prentice Hall, 2002.
2. Vaibhav Verdhnan, "Computer Vision Using Deep Learning: Neural Network Architectures with Python and Keras", APress, 2021.
3. V Kishore Ayyadevara, Yeshwanth Reddy, "Modern Computer Vision with PyTorch", 2020.

# 19MAM92 - CYBER THREAT INTELLIGENCE

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM42

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Familiarize with the concepts of cyber threat intelligence and its requirements.

**CO2** : Identify methods to collect cyber threat intelligence Requirements

**CO3** : Analyze and Disseminate Cyber Threat Intelligence

**CO4** : Understand the role of cyber threat intelligence partner

**CO5** : Apply machine learning techniques to detect cyber security threats in web, network, emails etc.

### FUNDAMENTALS OF CYBER THREAT INTELLIGENCE (CTI)

The Need for Cyber Threat Intelligence: The menace of targeted attacks - Monitor and respond strategy - Cyber Threat Intelligence Defined, Key Characteristics: Adversary based, Risk focused - Process oriented - Tailored for diverse consumers -Benefits of Cyber Threat Intelligence.

Developing Cyber Threat Intelligence Requirements: Assets that must be Prioritized: Personal information - Intellectual property - Confidential business information - Credentials and IT systems information - Operational systems. Adversaries: Cybercriminals - Competitors and cyber espionage agents - Hacktivists. Intelligence Consumers: Tactical users - Operational users - Strategic users. (9)

### CYBER THREAT INFORMATION COLLECTION

Level One Threat Indicators - File hashes and reputation data - Technical sources: honeypots and scanners - Industry sources: malware and reputation feeds. Level Two Threat: Data Feeds - Cyber threat statistics - reports and surveys - Malware analysis. Level Three: Strategic Cyber Threat Intelligence - Monitoring the underground - Motivation and intentions - Tactics, techniques, and procedures. (8)

### ANALYZING AND DISSEMINATING CTI

Information versus Intelligence, Validation and Prioritization: Risk scores - Tags for context - Human Assessment. Interpretation and Analysis: Reports - Analyst Skills - Intelligence Platform - Customization. Dissemination: Automated Feeds and APIs - Searchable Knowledge Base - Tailored Reports. (8)

### CYBER THREAT INTELLIGENCE PARTNER

Types of Partners: Providers of Threat Indicators - Providers of Threat Data Feeds - Providers of Comprehensive Cyber Threat Intelligence. Important Selection Criteria: Global and Cultural Reach- Historical Data and Knowledge - Range of Intelligence Deliverables - APIs and Integrations - Intelligence Platform - Knowledge Base and Portal - Client Services - Access to Experts. Intelligence - Driven Security. (8)

### DETECTING CYBER SECURITY THREATS WITH AI

Email Cyber Security Threats with AI: Detecting Spam with Perceptron, Support Vector Machines and Naïve Bayes-Spam Detection with Logistic Regression and Decision Trees- Bayesian Spam Detector.

Malware Threat Detection: AI for Malware Analysis-Decision Tree Malware Detectors-Detecting Metamorphic Malware with Hidden Markov Models-Malware and Deep Learning.

Network Anomaly Detection Techniques: Network Attacks-BotNet Topology-Machine Learning for Botnet Detection. (12)

**TOTAL : 45**

## TEXT BOOKS

1. Jon Friedman, Mark Bouchard, CISSP. Foreword by John P. Watters, *Cyber Threat Intelligence, Definitive Guide TM*, 2015. (Para I to IV).
2. Alessandro Parisi, *"Hands-on Artificial Intelligence for Cyber Security"*, Packt, 2019. (Para V)

## REFERENCES

1. Christ Pace, Andrei Barysevich, Levi Gundert, Allan Liska, Maggie McDaniel, John Wetzel, *"The Threat Intelligence Handbook : A Practical Guide for Security Teams to unlocking the power of Intelligence"*, CyberEdge Group, 1997. (Para 4 : Chapters 2 and 4, Para 5 : Chapters 6,7, and 10)
2. Henry Dalziel, *How to Define and Build an Effective Cyber Threat Intelligence Capability* Elsevier Science & Technology, 2014.
3. John Robertson , Ahmad Diab , Ericsson Marin , Eric Nunes , Vivin Paliath , Jana Shakarian , Paulo Shakarian, *DarkWeb Cyber Threat Intelligence Mining* Cambridge University Press, 2017.

# 19MAM93 - COMPUTER VISION LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

19MAM65

## ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

- CO1** : *Explore the process of image construction and blending*
- CO2** : *Apply Image formation techniques and feature based process*
- CO3** : *Extract features from Images and do analysis of Images*
- CO4** : *Perform object detection and face recognition using CNNs and RCNNs.*
- CO5** : *Implement image classification using benchmark image datasets like CIFAR-10 and other types of images.*

## CONCEPTS TO BE COVERED

1. Create a set of rectangles and then modify their "pose" (2D transform)
2. Image blending, Feature-based morphing, Edge editing and enhancement
3. Interest point detector Implement one or more keypoint detectors and compare their performance
4. Implement 2D and 3D multi-object detection and segmentation
5. Combine CV with NLP to perform OCR, image captioning
6. Perform Object Detection with YOLOv3, Object Detection with Mask R-CNN,
7. Develop a New Object Detection Model
8. Feature-based image alignment for flip-book animations ( Eg. Take a set of photos of an action scene or portrait (preferably in motor-drive-continuous shooting-mode) and align them to make a composite or flip-book animation.)
9. Deep Learning for Face Recognition: Detect Faces in Photographs, Face Identification and Verification with VGGFace2
10. Face Classification with FaceNet
11. Classify Black and White Photos of Clothing
12. Classify Small Photos of Objects, Label Satellite Photographs of the Amazon Rainforest

**Suggested Software/Tools: PyTorch, OpenCV library, YOLO**

## REFERENCES

1. *Jan Erik Solem, "Programming Computer Vision with Python", O'Reilly, 2012.*
2. *Jason Brownlee, "Deep Learning for Computer Vision", Ebook, 2019.*

**TOTAL : 60**

## 19MAM94 - INTELLIGENT CYBER SECURITY LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

19MAM46,19MAM65

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

**CO1** : *Apply classification techniques for detection*

**CO2** : *Perform Preprocessing technique in face detection*

**CO3** : *Perform clustering technique for cyber security*

**CO4** : *Implement various techniques and security algorithms on specific problems.*

**CO5** : *Develop intelligent solutions/tools to detect and protect against cyber threat through data analytics for an enterprise.*

### CONCEPTS TO BE COVERED

- Email Spam filtering using machine learning techniques, Bayesian spam detector
- Phishing detection using ML.
- Protection against credential stuffing campaigns, a common threat tactic in the ecommerce and online services sector.
- Malware Detection using ML, PDF malware detection
- Windows Ransomware detection, Crypto Ransomware detection
- Communication Network Analysis to identify Anomalies, ML for Botnet detection
- Behavior Analytics
- Collect information from multiple sources(dark web, social media, cyber security research feeds etc ) to create a reliable repository of threat-related knowledge and derive insights.
- Dynamic Intelligence feed
- Bio-metric authentication with facial recognition

### Suggested Software/Tools: Python, OpenCTI

### REFERENCES

1. *Ali Dehghantanha, Mauro Conti, Tooska Dargahi, Cyber Threat Intelligence, Springer, 2018*
2. *Alessandro Parisi, "Hands-on Artificial Intelligence for Cyber Security", Packt, 2019. (Para V)*

**TOTAL : 60**

## 19MAM101 - PROJECT WORK AND VIVA VOCE - II

<b>Credits</b>
<b>18</b>

### PRE-REQUISITES

Consent of the Instructor

### COURSE OUTCOMES

*Upon completion of the project, students will be able to:*

- CO1** : *Comprehensively demonstrate understanding of the software development processes and practices in various domains and application areas.*
- CO2** : *Work to a professional standard in a specified role.*
- CO3** : *Contribute effectively or co-operatively within a team.*
- CO4** : *Exhibit industry-standards of professionalism in the project work through knowledge or use of latest techniques and tools.*
- CO5** : *Reflect on the work done and own role and present the work through a report and formal viva.*

**ELECTIVE**  
**19MAME01 - ETHICS IN AI**

L	T	P	C
3	0	0	3

**PRE-REQUISITES**

Consent of the Instructor

**ASSESSMENT : THEORY**

**COURSE OUTCOMES**

- CO1** : *Understand the concept of building ethics in machines*
- CO2** : *Develop and designs test cases for hypothetical cases in Self driving cars*
- CO3** : *Able to build the methodologies for ethical AI*
- CO4** : *Identify Ethical priorities in AI systems*
- CO5** : *Design AI with rights, consciousness, and freedom*

**ETHICAL LEARNING, NATURAL AND ARTIFICIAL**

Introduction - A Social Perspective -A Developmental Perspective - Default Trust and Default Cooperation - Ethical Development and Ethical Judgment - Artificial Ethical Psychology. **(8)**

**USE TROLLEY AND ETHICAL OPT-OUT PROBLEM**

A Hypothetical Case - Standard Trolley Cases - Other Cases - New and Old Threats - Particular Moral Issues in Self Driving Cars - Case studies - Passengers and Other Drivers - Introduction - Methodological Challenges - Second-Order Ethical Challenges. **(12)**

**REASONING PREFERENCES AND ETHICAL PRIORITIES IN AI SYSTEMS**

Introduction - Background: Frameworks to Model Constraints and Preferences - Modeling Ethical Theories via Hard and Soft Constraints - Using CP-nets to Model Preferences and Ethical Priorities - A Notion of Distance between (Orderings Induced by) CP-nets - Using Distance to Support Ethical Decisions - Distance and Meta preference. **(8)**

**AUTONOMOUS WEAPONS AND ETHICS OF ARTIFICIAL INTELLIGENCE**

Defining Autonomous Weapons - The Moral Problems Raised by Autonomous Weapons - Arguments for the Moral Desirability of Autonomous Weapons. **(5)**

**DESIGNING AI WITH RIGHTS, CONSCIOUSNESS, SELF-RESPECT AND FREEDOM**

Public policy and Super intelligent AI : The Prospect of Radically Transformative AI - A "Vector Field" Approach to Normative Analysis - The No- Relevant- Difference Argument and Its Two Central Parameters - Two Broad Moral Theories and the Ethical Precautionary Principle - The Puzzle of Consciousness and the Design Policy of the Excluded Middle - Cheerfully Suicidal AI Servants and the Self- Respect Design Policy - Case studies **(12)**

**TOTAL : 45**

**TEXT BOOKS**

1. Y.S. Matthew Liao, "Ethics of Artificial Intelligence", First Edition, Oxford University Press, 2020. (Para I-V)

**REFERENCE**

1. Mark Coeckelbergh, "AI Ethics", The MIT Press, 2020.
2. John C. Havens, "Heartificial Intelligence: Embracing Our Humanity to Maximize Machines", Tarcher Perigee, 2016.

## 19MAME02 - HEALTHCARE ANALYTICS

L	T	P	C
2	0	2	3

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : *To understand the various sources of healthcare data analyze it.*

**CO2** : *To gain a overall understanding about the electronic healthcare records.*

**CO3** : *To process the different types of healthcare data stored in health data sources.*

**CO4** : *To apply the appropriate biomedical image and text analysis techniques for analyzing biomedical image and clinical text data.*

**CO5** : *To generate the prediction health care model using temporal, sensor and text mining techniques.*

### INTRODUCTION

Introduction to Healthcare Data Analytics - Healthcare Data Sources and Basic Analytics - Advanced Data Analytics for Healthcare - Applications and Practical Systems for Healthcare - Resources for Healthcare Data Analytics. (5)

### HEALTHCARE DATA SOURCES AND BASIC ANALYTICS

Electronic Health Records: A Survey - History and components of EHR - Coding systems - Benefits of EHR - Challenging of Using EHR Data. (4)

### HEALTHCARE DATA ANALYTICS

Biomedical Image Analysis - Biomedical Imaging Modalities - Object Detection - Image Segmentation - Image Registration - Feature Extraction. Natural Language Processing and Data Mining for Clinical Text - Natural Language Processing - Mining Information from Clinical Text - Challenges of Processing Clinical Reports - Clinical Applications. Social Media Analytics for Healthcare - Social Media Analysis for Detection and Tracking of Infectious Disease Outbreaks - Social Media Analysis for Public Health Research - Analysis of Social Media Use in Healthcare. (8)

### ADVANCED DATA ANALYTICS FOR HEALTHCARE

Temporal Data Mining for Healthcare Data - Association Analysis, Temporal Pattern Mining - Sensor Data Analysis - Other Temporal Modelling Methods. Information Retrieval for Healthcare - Knowledge-Based Information in Healthcare and Biomedicine - Content of Knowledge-Based Information Resources - Indexing - Retrieval - Evaluation. Privacy-Preserving Data Publishing Methods in Healthcare - Data Overview and Pre-processing - Privacy-Preserving Publishing Methods - Challenges with Health Data (8)

### APPLICATIONS AND PRACTICAL SYSTEMS FOR HEALTHCARE

Fraud Detection in Healthcare, Mobile Imaging and Analytics for Biomedical Data - Image Formation, Data Visualization - Image Analysis - Image Management and Communication (5)

### PRACTICALS

Analysis of Healthcare (EHR) Data-Analysis of prescriptions-Social Media Analysis for Detection and Tracking of Infectious Disease Outbreaks-Analyzing healthcare images-Data Visualization of biomedical data. (30)

**TOTAL : 60**

## TEXT BOOK

1. Chandan K. Reddy and Charu C. Aggarwal, "HealthCare Data Analytics", CRC Press, 2015.

## REFERENCES

1. Laura B. Madsen, "Data-Driven Healthcare: How Analytics and BI are Transforming the Industry", Wiley and SAS Business Series, 2014.
2. Trevor L. Strome, "Healthcare Analytics for Quality and Performance Improvement", John Wiley & Sons, Inc., 2013.
3. Surbi Bhatia, Ashutosh Kumar Dubey, Rita Chikara, Poonam Chaudhary, Abishek Kumar, "Intelligent Healthcare-Applications of AI in eHealth". EAI/Springer Innovations in Communication and Computing, 2021.

# 19MAME03 - SMART APPLICATIONS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : Provides Comprehensive understanding of Artificial Intelligence and Intelligent Systems in the context of Knowledge Engineering.
- CO2** : Recognize the technologies behind AI and software-defined network/network function virtualization, highlighting the exciting opportunities to integrate those two worlds.
- CO3** : To get familiar with the various applications of these techniques in manufacturing systems.
- CO4** : Highlights the avionics and satellite communication systems and aerospace platforms
- CO5** : Provide an invaluable resource for artificial intelligence, and machine learning researchers.

## ARTIFICIAL INTELLIGENCE FOR INTELLIGENT SYSTEMS

Introduction - Intelligent Machines - Dark ages to Knowledge based systems-Neural Expert systems- ANFIS-- Models of Hybrid Computational Intelligence Architectures- Integrated Intelligent Systems - Neuro Fuzzy Systems- Evolutionary Fuzzy systems- EvoNF systems- Evolutionary Neural Network - General Framework Search of Connection weights- Architectures - Learning rules - Meta learning- Hybrid Evolutionary Algorithms. (9)

## ARTIFICIAL INTELLIGENCE FOR NETWORK AUTOMATION

Introduction- Generations of network transformation- From automation to AI- The role of artificial intelligence for network operations- zero-touch network - identifies SDN and AI are together providing the core technology and intelligences - Background overview of the tasks involved in operating a network- use of automation autonomous network run on data- Defined Network-Self-contained-self-optimizes- Software and hardware platforms-AI system architectures. (9)

## ARTIFICIAL INTELLIGENCE FOR MANUFACTURING SYSTEMS

Introduction - Traditional Manufacturing Systems - Changes in Manufacturing Systems: a Historical Perspective -Artificial Intelligence and Intelligent Manufacturing Systems - Technologies of Artificial Intelligence- Intelligent Manufacturing Systems- Properties of Intelligent Manufacturing Systems-Architecture of Intelligent Manufacturing Systems - Holonic Manufacturing Systems- Applications of Intelligent Manufacturing Systems. (9)

## ARTIFICIAL INTELLIGENCE FOR AEROSPACE

Planning - Applications of planning - Planning algorithms- The classical framework - STRIPS language and its extensions (ADL, PDDL...)- state - space search, plan-space search- GRAPHPLAN methods, SATPLAN and CSP-PLAN methods -Algorithmic Decision Theory ; Markov Decision - Processes Case study and Exercises Game Theory Formalization : Normal Form ; Pure and Mixed Strategies -Equilibrium (Nash, (iterated) Dominant Strategy Equilibrium) Algorithms -Condorcet Winner, Arrow's Theorem- Collective decision Applications. (9)

## ADVANCED TOPICS IN AI - PRESENT AND FUTURE

Introduction - AI and Concurrency - Agent-based Concurrent Engineering-Cloud computing and Intelligent Agents- Planning and logic -Business Intelligence and Analytics- Sentiment Analysis- Big data and sensory processing (SP) - Theory of Intelligence - Future of Intelligent Systems. (9)

**TOTAL : 45**

## **TEXT BOOKS**

1. Crina Grosan and Ajith Abraham, "*Intelligent Systems: A Modern Approach (Intelligent Systems Reference Library)*", Springer - Verlag Berlin Heidelberg, 2011. (Para I)
2. Mazin Gilbert, "*Artificial Intelligence for Autonomous Networks*", CRC press Publications, 2018. (Para II)
3. Parag Kulkarni and Prachi Joshi "*Artificial Intelligence: Building Intelligent Systems*", PHI Learning Private Limited, 2015. (Para III)
4. E. Oztemel, Lyes Benyoucef, Bernard Grabot , "*Artificial Intelligence Techniques for Networked Manufacturing Enterprises Management*", Springer-Verlag, 2010. (Para IV&V)

## **REFERENCES**

1. Michael Negnevitsky "*Artificial Intelligence A Guide to Intelligent Systems*", 2nd Edition, Pearson Education Limited, 2005.
2. Martin Osborne, "*Introduction to Game Theory*", Oxford University Press, 2009.

# 19MAME04 - SPATIAL DATA MODELING AND ANALYSIS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Use the fundamental concepts of Geographic Information Science and Technology

**CO2** : Design Geo Spatial Database

**CO3** : Describe the geospatial system and represent various data models.

**CO4** : Analyze Geospatial data using spatial and raster analysis techniques.

**CO5** : Create and design principles, including thematic map display, map projections, and cartographic design

## INTRODUCTION TO GIS

Introduction - GIS Components - GIS in Organizations. Data Models - Introduction - Common Spatial Data Models - Raster Data Models - Other Data Models - Data File and Structures. Geodesy, Datums, Map Projections and Coordinate Systems (9)

## DESIGNING GIS DATABASE WITH DIGITAL DATA

Maps, Data Entry, Editing and Output - Building GIS Database - Digitizing Coordinate capture - Coordinate Transformation - Output : Maps - Data - Meta Data. Digital Data - Introduction -National and Global Digital Data. Tables (9)

## GEOSPATIAL NAVIGATION SYSTEM AND DATA MODEL

Global Satellite Navigation System and Coordinate Surveying - Introduction - Differential Correction - Optical and Laser Coordinate Surveying - GNSS Applications. Aerial and Satellite Images - Basic Principles - Aerial Images - Satellite Images - Air born LiDAR (9)

## SPATIAL AND RASTER ANALYSIS

Basic Spatial Analysis - Introduction - Selection and Classification - Dissolve - Proximity Functions and Buffering - Overlay - Network Analysis. Topics in Raster Analysis - Map Algebra - Local Functions - Neighborhood, Zonal and Global Functions. Terrain Analysis (9)

## SPATIAL MODELING AND ESTIMATION

Spatial Estimation: Interpolation, Prediction, Core Area - Sampling - Spatial Interpolation Methods -Spatial Prediction -Core Area Mapping. Spatial Models and Modelling - Cartographic Modeling. Data Standards and Data Quality. New Developments in GNSS - GNSS - Datum Modernization-Improved Remote Sensing - Cloud Based GIS-Open GIS (9)

**TOTAL : 45**

## TEXT BOOK

1. Paul Bolstad, "GIS Fundamentals: A First Text on Geographic Information Systems", 6th Edition, 2019

## REFERENCES

1. Robert Haining, "Spatial Data Analysis Theory and Practice", Cambridge University, 2010.
2. Jay Gao, "Fundamentals of Spatial Analysis and Modelling", CRC Press, 2021.

# 19MAME05 - AUGMENTED AND VIRTUAL REALITY

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : Learn the fundamentals of Augmented Reality(AR)
- CO2** : Implement AR tools and predict the approximate future direction of Mixed Reality.
- CO3** : Explore the concept of Virtual Reality
- CO4** : Demonstrate appropriate perceptual model for building a virtual reality system
- CO5** : Design various stages for Virtual reality process

## INTRODUCTION TO AUGMENTED REALITY (AR)

Definition of Augmented Reality-Components of Augmented Reality-History of Augmented Reality- Augmented Reality vs Virtual Reality - Challenges with AR - Opportunities for Augmented Reality- Types of Augmented Reality - Augmented Reality Methods - AR Display Technology - Interaction in AR Applications. (10)

## INNOVATORS AND ORGANIZATIONS

Innovators and Organizations- Innovators in AR- Companies Specializing in AR- AR Tools- AR Blogs- Visions of the Future- The Big Trends- Technical Trends- Future Concepts for Augmented Reality. (9)

## VIRTUAL REALITY(VR)

Introduction to VR: Definition of Virtual Reality-History of VR- Overview of Various Realities-Immersion, Presence and Reality Trade-Offs- Design Guidelines. (9)

## PERCEPTION

Objective and Subjective Reality-Perceptual Models and Processes: Distal and Proximal Stimuli-Sensation versus Perception - Bottom-Up and Top-Down Processing-Perceptual Modalities: Sight-Hearing-Touch-Proprioception-Balance and Physical Motion. (9)

## ITERATIVE DESIGN

Philosophy of Iterative Design-The Define Stage- The Make Stage: Task Analysis- Design Specification-System Considerations-Simulation-The Learn Stage. (8)

**TOTAL : 45**

## TEXT BOOKS

1. Gregory Kipper, Joseph Rampolla Chris Katsaropoulos "Augmented Reality-An Emerging Technologies Guide to AR", 2013. [Para I, II]
2. Jason Jerald, "The VR Book-Human-Centered Design for Virtual Reality", ACM Books, 2016 [Para III, IV, V]

## REFERENCES

1. John Vince, "Virtual Reality Systems", Pearson Education, 2002
2. Paul Mealy, "Virtual & Augmented Reality for Dummies", Kindle Publication, 2018

# 19MAME06 - MEDICAL IMAGE PROCESSING

L	T	P	C
3	0	0	3

**ASSESSMENT : THEORY**

**PRE-REQUESTS**

Consent of the Instructor

**COURSE OUTCOMES**

**CO1** : Understand the fundamentals of medical imaging techniques

**CO2** : Learn various noise reduction filters and feature extraction for medical data analysis.

**CO3** : Apply various image restoration techniques on medical image data.

**CO4** : Familiarize with the bio-medical image segmentation methods

**CO5** : Use machine learning methods on MRI data to derive insights.

**INTRODUCTION TO MEDICAL IMAGES**

Digital Image-Components-Vision Fundamentals-Modalities of Medical Imaging-Problems-Image Enhancement Methods-Radiography-PET-CTA-Echocardiogram. (9)

**NOISE REDUCTION FILTERS AND FEATURE EXTRACTION**

Spatial Domain Filters-Frequency Domain Filters-Selection of Features-Space Related Features-Texture Analysis-Analysis of Tissue Structure. (9)

**MEDICAL IMAGE RESTORATION**

Image Restoration-Degradation Model-Estimation of Degradation Function-Blur Model-Blur Identification-Image Restoration Techniques-Applications. (8)

**BIOMEDICAL IMAGE SEGMENTATION**

Points Detection-Line Detection-Edge Detection and Methods-Histogram Based-Split and Merge Method-Region Growing Method-k-Means Clustering Method (10)

**BIG DATA AND MAGNETIC RESONANCE IMAGING**

Magnetic Resonance Imaging Techniques: MRI Signal Types-Machine Learning for Structural and Functional Imaging Data.(9)

**TOTAL : 45**

**TEXT BOOKS**

1. G.R. Sinha, Bhagwati Charan Patel, "Medical Image Processing", PHI India, 2014. (Para I-IV)
2. Ervin Sejdic, Tiago H.Falk, "Signal Processing and Machine Learning for Biomedical Big Data", CRC Press,2018. (Para V).

**REFERENCES**

1. AtamP.Dhawan, "Medical Image Analysis", Wiley Interscience Publication, 2003.
2. KavyanNajarian and Robert Splerstor, "Biomedical signals and Image processing", CRC, 2006.

# 19MAME07 - NATURAL LANGUAGE PROCESSING

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM51,19MAM62

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Learn and understand the fundamental units of language and its models.

**CO2** : Use vector semantics and implement vector models for texts.

**CO3** : Design and develop NLP systems using machine learning models like Naïve Bayes, Neural Networks.

**CO4** : Use Hidden Markov Model and Conditional Random fields in tagging parts-of-speech tagging

**CO5** : Apply the principles of deep learning techniques to process speech and texts based applications.

### REGULAR EXPRESSIONS AND NORMALIZATION

Introduction - Regular Expressions-words - Corpora - Text Normalization - Minimum edit distance - N gram Language Models: N-Grams - Evaluating Language Models- Sampling sentences from a language model- Generalization and Zeros- Smoothing- Kneser-Ney Smoothing- Huge Language Models and Stupid Backoff- Advanced: Perplexity's Relation to Entropy (8)

### VECTOR SEMANTICS AND EMBEDDINGS

Lexical Semantics-Vector Semantics-Words and Vectors-Cosine for Measuring Similarity-TF-IDF-Pointwise Mutual Information (PMI)-Applications of TF-IDF and PMI-Word2vec: Visualizing Embeddings-Semantic Properties of Embeddings-Evaluating Vector Models (7)

### NAIVE BAYES AND SENTIMENT CLASSIFICATION

Naive Bayes Classifiers - Training the Naive Bayes Classifier-Worked Example-Optimizing for Sentiment Analysis - Naive Bayes for other text classification tasks-Naive Bayes as a Language Model - Evaluation: Precision, Recall, F-measure - Test sets and Cross-validation - Statistical Significance Testing - Avoiding Harms in Classification-Applications. (7)

### NEURAL NETWORKS AND NEURAL LANGUAGE

Overview of Feedforward Neural Networks-Feedforward networks for NLP: Classification-Feedforward Neural Language Modelling- Training Neural Nets-Training the neural language model-Applications. (7)

### SEQUENCE LABELLING FOR PARTS OF SPEECH NAMED ENTITIES

English Word Classes- Parts of Speech Tagging-Named Entities and Named Entity Tagging. HMM parts of Speech Tagging: Markov Chains-Hidden Markov Model-Components of HMM tagger-HMM tagging as decoding-Viterbi Algorithm-Example. Conditional Random Fields (CRFs): Features in CRF POS Tagger-Features for POS Named Entities Recognizers-Inference and Training for CRFs-Evaluation of Named Entity Recognition. (8)

### DEEP LEARNING ARCHITECTURES FOR SEQUENCE PROCESSING

Overview of Recurrent Neural Networks (RNN)-RNNs as Language Models-RNNs for other NLP tasks-Stacked and Bidirectional RNN architectures-LSTM- Transformers as Language Models- Contextual Generations and Summarization. Machine Translation: Language Divergences and Typology-Encoder Decoder Models with RNNs. (8)

**TOTAL : 45**

## **TEXT BOOK**

1. Jurafsky and Martin, *"Speech and Language Processing"*, Pearson, 2022

## **REFERENCES**

1. Manning and Schutze, *"Foundations of Statistical Natural Language Processing"* MIT Press Cambridge, MA, 1999.
2. Denis Rothman *"Transformers for Natural Language Processing"*, Packt, 2021

# 19MAME08 - PROBABILISTIC GRAPHICAL MODELS

L	T	P	C
2	0	2	3

## PRE-REQUISITES

19MAM13, 19MAM22,19MAM47

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Understand the mathematical framework of probabilistic graphical models

**CO2** : Apply various representation models

**CO3** : Understand the basic concepts of probabilistic inference in graphical models

**CO4** : Apply the inference of Probabilistic models

**CO5** : Familiarize with the learning process of graphical models like Bayesian and Hidden Markov Model.

**CO6** : Implement Probabilistic graphical Models and draw inference for real world problems using Python libraries

### FOUNDATIONS

Structured Probabilistic Models - Foundations: Probability Theory - Graphs. Bayesian Network Representation: Exploiting Independence Properties - Bayesian Networks - Independencies in Graphs - From Distributions to Graphs. (5)

### UNDIRECTED GRAPHICAL MODELS

Parameterization -Markov Network Independencies - Parameterization Revisited - Bayesian Networks and Markov Networks - Partially Directed Models. (5)

### LOCAL PROBABILISTIC MODELS

Tabular CPDs - Deterministic CPDs - Context-Specific CPDs - Independence of Causal influence - Continuous Variables - Conditional Bayesian Networks. Gaussian Network Models: Multivariate Gaussians - Gaussian Bayesian Networks - Gaussian Markov Random Fields. (6)

### INFERENCE

Analysis of Complexity- Variable Elimination - Complexity and Graph Structure-Conditioning - Inference with Structured CPDs. Variable Elimination and Clique Trees - Message Passing: Sum Product - Message Passing : Belief Update - Constructing a Clique Tree (6)

### LEARNING GRAPHICAL MODELS

Goals of Learning - Learning as Optimization - Learning Tasks. Structure Learning in Bayesian Networks: Constraint-based Approaches - Structure Scores - Structure Search - Bayesian Model Averaging - Learning Models with Additional Structure. Specialized Models: Naïve Bayes and Hidden Markov Model. (8)

### PRACTICALS

Problems based on the above modules using Python library pgmpy and Tensorflow. (30)

**TOTAL : 60**

### TEXT BOOKS

1. Daphne Koller and Nir Friedman, "Probabilistic Graphical Models Principles and Techniques", MIT Press, Cambridge, Massachusetts, Lond, 2009.
2. Ankur Ankan and Abinash Panda, "Mastering Probabilistic Graphical Model in Python", Packt,2015. (Practicals)

### REFERENCES

1. Qiang Ji, "Probabilistic Graphical Models for Computer Vision", First Edition, Elsevier, 2019.
2. Luis Enrique Sucar, "Probabilistic Graphical Model", Springer, 2015.

# 19MAME09 - COGNITIVE COMPUTING

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : *Learn and understand the basics concepts of cognitive computing and its applications.*
- CO2** : *Identify the building blocks of a cognitive system and use it to design cognitive system for various business requirements.*
- CO3** : *Determine the role of NLP and knowledge representation in cognitive systems.*
- CO4** : *Build a complete cognitive system and test it successfully*
- CO5** : *Familiarize with the latest trends and case studies on cognitive computing systems.*

## FOUNDATIONS OF COGNITIVE COMPUTING

Cognitive Computing as a New Generation-Uses of Cognitive Systems-Characteristics of a Cognitive System-Domains of Cognitive Computing-Artificial Intelligence as the Foundation of Cognitive Computing-Understanding Cognition-Two Systems of Judgment and Choice-Understanding Complex Relationships Between Systems-Types of Adaptive Systems-Elements of a Cognitive System-Infrastructure and Deployment Modalities-Data Access, Metadata, and Management Services-Data Analytics Services-Continuous Machine Learning-Hypothesis Generation and Evaluation-The Learning Process-Presentation and Visualization Services-Cognitive Applications. (8)

## DESIGN PRINCIPLES AND BUSINESS IMPLICATIONS

Components of a Cognitive System-Building the Corpus-Corpus Management Regulatory and Security Considerations-Bringing Data into the Cognitive System-Leveraging Internal and External Data Sources-Data Access and Feature Extraction Services-Analytics Services-Infrastructure.

Preparing for Change-Advantages of New Disruptive Models-The Difference with a Cognitive Systems Approach-Using Business Knowledge to Plan for the Future-Answering Business Questions in New Ways-Building Business Specific Solutions-Making Cognitive Computing a Reality. (8)

## NATURAL LANGUAGE PROCESSING IN COGNITIVE COMPUTING

The Role of NLP in a Cognitive System: Context-Connecting Words for Meaning-Understanding Linguistics-Language Identification and Tokenization-Phonology-Morphology-Lexical Analysis-Syntax and Syntactic Analysis-Construction Grammars-Discourse Analysis-Pragmatics-Techniques for Resolving Structural Ambiguity-Importance of Hidden Markov Models-Word?Sense Disambiguation (WSD)-Semantic Web-Appling Natural Language Technologies-to Business Problems: Enhancing the Shopping Experience-Leveraging the Connected World of Internet of Things-Voice of the Customer-Fraud Detection. (9)

## REPRESENTING KNOWLEDGE IN TAXONOMIES AND ONTOLOGIES

Representing Knowledge-Developing a Cognitive System: Defining Taxonomies and Ontologies-Representing Knowledge-Managing Multiple Views of Knowledge-Models for Knowledge Representation-Taxonomies, Ontologies, Other Methods of Knowledge Representation: Simple Trees-Persistence and State-Implementation Considerations. (7)

## BUILDING A COGNITIVE APPLICATION

The Emerging Cognitive Platform-Defining the Objective, Domain, Users and Attributes-Exploring Insights-Typical Question Answer Pairs-Anticipatory Analytics-Acquiring the Relevant Data Sources-Importance of Leveraging Structured Data Sources-Analyzing Dark Data -Leveraging External Data-Creating and Refining the Corpora-Preparing the Data-Ingesting the Data-Refining and Expanding the Corpora-Governance of Data-Training and Testing. (7)

## **EMERGING COGNITIVE COMPUTING APPLICATIONS**

Characteristics of Ideal Markets for Cognitive Computing-Vertical Markets and Industries-Retail-Travel-Transportation and Logistics-Telecommunications-Security and Threat Detection-Other Areas That Are Impacted by a Cognitive Approach.

Case Studies: IBM'S Watson as a Cognitive System- Building a Cognitive Healthcare Application-Smarter Cities: Cognitive Computing in Government. (6)

**TOTAL : 45**

## **TEXT BOOK**

1. *Judith S. Hurwitz, Marcia Kaufman, Andrian Bowles, "Cognitive Computing and Big Data Analytics", Wiley Publications, 2015*

## **REFERENCES**

1. *Pradeep Kumar Mallick, Samarjeet Borah, "Emerging Trends and Applications in Cognitive Computing", IGI Global,2019.*
2. *Rob High, Tanmay Bakshi, "cognitive Computing with IBM Watson, Packt Publishers, 2019.*

# 19MAME10- RECOMMENDER SYSTEMS

L	T	P	C
2	0	2	3

## PRE-REQUISITES

19MAM42

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Familiarize with the basics concepts and applications of recommender systems.

**CO2** : Review the different methods of neighborhood based collaborative filtering.

**CO3** : Demonstrate the use of machine learning models for collaborative filtering.

**CO4** : Examine content based and knowledge-based systems and its categories to build recommender systems.

**CO5** : Develop new Recommender Systems for a number of domains like, Education, Health-care etc and evaluate its performance.

### INTRODUCTION TO RECOMMENDER SYSTEMS

Goals-Applications-Basic Models of Recommender Systems-Domain Specific Challenges-Advanced topics and applications. (5)

### NEIGHBOURHOOD BASED COLLABORATIVE FILTERING

Key Properties of Rating Matrices-Predicting Ratings with Neighborhood Based Methods-Clustering and Neighborhood Based Methods-Dimensionality Reduction and Neighborhood Methods-Regression Modelling View of Neighborhood Methods-Graph Models for Neighborhood Based Methods. (6)

### MODEL BASED COLLABORATIVE FILTERING

Extending Decision Trees for Collaborative Filtering-Rule Based Filtering-Naïve Bayes Collaborative Filtering-Latent Factor Models. (6)

### CONTENT AND KNOWLEDGE BASED RECOMMENDER SYSTEMS

Preprocessing and Feature Extraction-Learning User Profiles and Filtering-Content Based vs Collaborative Filtering-Using Content Based Models for Collaborative Filtering. Constraint Based Systems-Case Based Recommenders (7)

### EVALUATING RECOMMENDER SYSTEMS

Evaluation Paradigms-Goals of Evaluation Design. Evaluation Metrics for Offline Recommender Systems. (6)

### PRACTICALS

Predicting Ratings with Neighborhood Based Methods-Clustering and Neighborhood Based Methods-Regression Modelling View of Neighborhood Methods-Graph Models for Neighborhood Based Methods-Implement Collaborative Filtering Algorithms-Applications of Recommender Systems such as Recommending movies, music, books, websites, etc. (30)

**TOTAL : 60**

### TEXT BOOKS

1. Charu C. Aggarwal, "Recommender Systems", Springer, 2016.
2. Rounak Banik, "Hands on Recommender System Using Python, Packt, 2019 (Practicals)

## REFERENCES

1. Kim Falk, *"Practical Recommender Systems"*, Manning Publications, 2019.
2. Frank Kane, *"Building Recommender System with Machine Learning and AI"*, 2018.
3. Michael Schrage, *"Recommendation Engines"*, 2020.

# 19MAME11 - ROBOTICS AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM12, 19MAM21

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : Learn the basic components and building blocks of Robots.  
**CO2** : Develop the robot construction skills.  
**CO3** : Acquire skills to program the robots.  
**CO4** : Integrate the features and operations of automation products  
**CO5** : Explore the broad scope of robotic applications

## FUNDAMENTALS OF ROBOTICS

Robot Meaning - History of Robots - Classification of Robots - Fundamentals of Robot Technology, Programming, and Applications - Robot Anatomy - Robot Drive Systems - Control Systems - Precision of Movement - End Effectors - Robotic Sensors - Robot Programming and Work Cell Control - Robot Applications (9)

## ROBOT TECHNOLOGY: THE ROBOT AND ITS PERIPHERALS

Control Systems and Components - Basic Control Systems Concepts and Models - Controllers - Control System Analysis - Robot Sensors and Actuators - Velocity Sensors - Actuators - Power Transmissions Systems - Modeling and Control of a Single Joint Robot (9)

## ROBOT PROGRAMMING AND LANGUAGES

Robot Programming - Methods of Robot Programming - Lead through Programming Methods - A Robot Program as a Path in Space - Motion Interpolation - Wait, Signal, and Delay Commands - Branching. Robot Languages - Artificial Intelligence (9)

## APPLICATIONS ENGINEERING FOR MANUFACTURING

Robot Cell Design and Control - Robot Cell Layouts - Multiple Robots and Machine Interference - Other Considerations in Workcell Design - Workcell Control - Interlocks - Error Detection and Recovery - The Workcell Controller - Robot Cycle Time Analysis. Economic Analysis for Robotics - Economic Analysis: Basic Data Required - Methods of Economic Analysis - Subsequent use of the Robot - Differences in Production Rates - Robot Project Analysis Form. (9)

## ROBOT APPLICATIONS IN MANUFACTURING

Material Transfer and Machine Loading/Unloading - General Considerations in Robot Material Handling - Material Transfer Applications - Machine Loading and Unloading. Processing Operations - Spot Welding - Continuous Arc Welding - Spray Coating - Other Processing Operations using Robots. Assembly and Inspection (9)

**TOTAL : 45**

## TEXT BOOKS

1. Mikell P Groover, Mitchel Weiss, Roger N Nagel, Nicholas G Odrey, Ashish Dutta, "Industrial Robotics Technology, Programming and Applications", 2nd Edition, 2012. (Para I-V)
2. S.K. Saha, "Introduction to Robotics", Tata McGraw Hill Education, 4th Edition, 2011. (Para - I)

## REFERENCES

1. Danny Staple, *"Learn Robotics Programming: Build and Control AI-enabled Autonomous Robots Using the Raspberry Pi and Python"*, Packt Publishing, 2nd Edition, 2021
2. Robert J. Schilling, *"Fundamentals of Robotics, Analysis & Control"*, PHI Learning, 2010.
3. Robin R. Murphy, *"Introduction to AI Robotics"*, Prentice, Hall of India, New Delhi, 2007.

# 19MAME12 - CONVERSATIONAL AI

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAME07

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : Understand the basics of a dialogue system.
- CO2** : Learn rules to develop dialogue systems.
- CO3** : Develop statistical data driven dialogue systems
- CO4** : Design and evaluate the dialogue systems.
- CO5** : Explore the challenges and future scope.

## INTRODUCTION TO DIALOGUE SYSTEMS

Dialogue Systems - History of Dialogue Systems - Present Day Dialogue Systems - Modeling Conversation - Designing and Developing Dialogue Systems (8)

## RULE BASED DIALOGUE SYSTEMS: ARCHITECTURE, METHODS, TOOLS

Typical Dialogue Systems Architecture - ASR, NLU, Dialogue Management, NLG, TTS - Designing a Dialogue System, Tools for Developing Dialogue Systems - Visual Design Tools, Scripting Tools for Handcrafting Dialogue System, Advanced Toolkits and Frameworks, Research Based Toolkits (9)

## STATISTICAL DATA-DRIVEN DIALOGUE SYSTEMS

Motivating the Statistical Data Driven Approach - Dialogue Components - Natural Language Understanding - Dialogue Management - Natural Language Generation - Reinforcement Learning - Representing Dialogue a Markov Decision Process - From MDPs to POMDPs - Dialogue State Tracking - Dialogue Policy - Problems and Issues (10)

## EVALUATING DIALOGUE SYSTEMS

Conducting Evaluation - Evaluating Task-Oriented Dialogue Systems - Evaluating Open-Domain Dialogue Systems - Evaluation Frameworks - PARADISE, QoE, Interaction Quality (9)

## CHALLENGES AND FUTURE DIRECTIONS

Multimodality in Dialogue - Visual Dialogue and Visually Grounded Language - Data Efficacy - Reasoning and Collaborative Problem Solving in Dialogue Systems - Hybrid Dialogue Systems - Dialogue with Social Robots - Dialogue and the Internet of Things - Social and Ethical Issues (9)

**TOTAL : 45**

## TEXT BOOK

1. Michael F. McTear - "Conversational AI: Dialogue Systems, Conversational Agents and Chatbots", Morgan & Claypool Publishers, 2021.

## REFERENCES

1. Andrew R. Freed, "Conversational AI", Manning Publications, 2021.
2. Srinu Janarthanam, "Hands-On Chatbots and Conversational UI Development: Build chatbots and Voice User Interfaces with Chatfuel, Dialogflow, Microsoft Bot Framework, Twilio, and Alexa Skills", Packt Publishing, 2017.

# 19MAME13 - GAME THEORY

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : Model a 2 x2 evolutionary games in dynamical systems.
- CO2** : Develop model for applications using Network reciprocity
- CO3** : Analyse the evolution of communication in Constructivism Approach
- CO4** : Design and perform Cellular Automaton Model in realistic Traffic flow
- CO5** : Examine pandemic analysis as application to which evolutionary game theory can be applied.

## EVOLUTIONARY GAME THEORY AND ITS FUNDAMENTALS

Modeling a Real Complex World - Modeling a Real Complex World - Fundamental Theory for Evolutionary Games: Linear Dynamical Systems - Non-linear Dynamical Systems - 2-Player & 2-Stratey Games - Dynamics Analysis of the 2 x 2 Game - Multi-player Games - Social Viscosity; Reciprocity Mechanisms - Universal Scaling for Dilemma Strength in 2 x 2 Games - R-Universal Scaling for Dilemma Strength in 2 x 2 Games. (12)

## NETWORK RECIPROCITY

Most Influential to Enhance Network Reciprocity - Model Description - Effect of the Initial Fraction of Co-operators on Cooperative Behavior in the Evolutionary Prisoner's Dilemma Game - Several Applications of Stronger Network Reciprocity - Discrete, Mixed and Continuous Strategies Bring Different Pictures of Network Reciprocity - A Substantial Mechanism of Network Reciprocity (10)

## EVOLUTION OF COMMUNICATION

Communication as an Authentication Mechanism - An Evolutionary Hypothesis Suggested by Constructivism Approach (6)

## TRAFFIC FLOW ANALYSIS

Modelling and Analysis of the Fundamental Theory of Traffic Flow - A Cellular Automaton (CA) Model to Reproduce Realistic Traffic Flow - Social Dilemma Structure Hidden Behind Various Traffic Contexts (9)

## PANDEMIC ANALYSIS AND EVOLUTIONARY GAMES

Modeling the Spread of Infectious Diseases and Vaccination Behavior - Vaccination Games in Complex Social Networks. (8)

**TOTAL : 45**

## TEXT BOOK

1. Jun Tanimoto, "Fundamentals of Evolutionary Game Theory and its Applications", Springer 2016

## REFERENCES

1. Michael Maschler, Eilon Solan, Shmuel Zamir, "Game Theory", Cambridge University Press, 2013
2. Martin Osborne, "An Introduction to Game Theory", Oxford University Press, 2003

# 19MAME14 - AGILE SOFTWARE DEVELOPMENT

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : Understand the key principles of agile management.
- CO2** : Learn agile Project Management process and agile project planning.
- CO3** : Apply agile development management and product management in system development.
- CO4** : Identify the need for scrum and use scrum tools.
- CO5** : Compare scrum with conventional project management and waterfall methods.

## TRADITIONAL SOFTWARE DEVELOPMENT AND AGILE

Traditional Software Development - History of Project Management - Waterfall Approach - Project Management Triangle - Modified Waterfall Models. Overview of Agile Software Development - Lean Software Development - Project Management 2.0 - Agile Manifesto - Scrum - Test Driven Development - Extreme Programming - Rational Unified Process - Agile Unified Process - Agile Model Driven Development (7)

## AGILE PROJECT MANAGEMENT AND PLANNING

Software Production Metrics - Agile Project Management - Agile Project Planning - The Agile Manager's New Work - Considerations on Teaming and Leadership - Considerations on Planning and Architecture. (7)

## AGILE DEVELOPMENT MANAGEMENT AND PRODUCT MANAGEMENT

Agile Development Management - Software Resource Planning - An Agile Maturity Model - Setting the Governing Rules - Staffing Decisions - Operations Review - Agile Product Management - Financial Metrics for Software Services - Business Benefit of Agile Methods - Considerations on Project Execution. (10)

## FOUNDATIONS OF SCRUM

Need for Scrum- Scrum Team - Agile Product or Process Development - Eliminate Waste and Save Money - Improved Control or Assurance - Schedule and Budget Maintenance - Managing Changing User Requirements - Projects Candidates for Scrum. Overview of Scrum principles- Requirements - Product Backlog - Planning and Estimation - Release Backlog - Sprint - Sprint Retrospective - Iterative Product Delivery - Burndown Chart and Scope Changes - Meetings - Project Human Resources. (12)

## SCRUM AND PROJECT MANAGEMENT

Scrum and Conventional Project Management - Complex Project Management - Scrum and the Waterfall Method. Case Study: Scrum and Education - Scrum and Hospitals. Agile Tools : Scrumbler, Trello, Yodiz, ScrumDesk. (9)

**TOTAL : 45**

## TEXT BOOKS

1. Thomas Stober, Uwe Hansmann, "Agile Software Development - Best Practices for Large Software Development Projects", Springer, June 2009. (Para I, II, III)
2. David J. Anderson and Eli Schragenheim, "Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results", Prentice Hall, 2003. (Para II, III)
3. Kim H. Pries, Jon M. Quigley, "Scrum Project Management", CRC Press, 2011. (Para IV,V)

## REFERENCES

1. Sudipta Malakar, *"Agile Methodologies In - Depth: Delivering Proven Agile, SCRUM and Kanban Practices for High - Quality Business Demands"*, BPB Publications, 2021
2. Mike Cohn, *"Succeeding with Agile: Software Development Using Scrum"*, Addison Wesley, 2010.
3. Robert C. Martin, *"Agile Software Development, Principles, Patterns, and Practices"*, Alan Apt Series, 2011.

## 19MAME15 - SOA AND WEB SERVICES

L	T	P	C
2	0	2	3

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Examine the requirements of distributed applications and design web services.

**CO2** : Apply the concepts of Service Oriented Architecture in designing platform independent real time distributed applications.

**CO3** : Design and develop simple to complex web services that meet the specified requirements.

**CO4** : Develop web services based on requirements of the web application using Java APIs and also consume them in web applications.

**CO5** : Determine the security requirements of web services and incorporate them in building web applications.

### INTRODUCTION TO SOA

Introducing SOA: Fundamental SOA - Common Characteristics of Contemporary SOA - Common Misperceptions about SOA - Common Tangible Benefits of SOA - Common Pitfalls of Adopting SOA - Evolution of SOA (5)

### WEB SERVICES AND SOA

Web Services and Primitive SOA: The Web Service Framework - Services (as Web Services) - Service Descriptions (with WSDL) - Messaging (with SOAP); Web Services and Contemporary SOA (Part I: Activity Management and Composition): Message Exchange Patterns - Service Activity - Coordination - Atomic Transactions - Business Activities - Orchestration - Choreography (7)

### SOA AND SERVICE-ORIENTATION

Principles of Service-Oriented Architecture: Anatomy of a Service-Oriented Architecture - Common Principles of Service-Oriented Architecture - How Service-Oriented Principles Inter-relate: Service Layers. (6)

### BUILDING SOA

Service Oriented Analysis: Introduction - Service Modelling Guidelines; Service Oriented Design: Introduction to Service-Oriented Design, WSDL-Related XML Schema Language Basics - WSDL Language Basics - SOAP Language Basics, SOA Composition Guidelines, Service Design: Service Design Overview, Business Process Design: WS-BPEL Languages Basics - WS-Coordination Overview - Service-Oriented Business Process Design: Fundamental WS Extensions: WS-Security Language Basics. (6)

### WEB SERVICES IN JAVA

Building Web Services with JAX-WS - Binding between XML Schema and Java Classes - Streaming API for XML - SOAP with Attachments API for Java - Generating Client-Support Code from a WSDL - Building RESTful Web Service with JAX-RS. (6)

### PRACTICALS

Modelling the business services-Implement the Service Interface and Service Implementation Classes -Write WSDL document to describe services-Publish web services. Create Web Service Client-Create and send messages using SOAP Attachment API. Build RESTful APIs and Microservices using Flask/Django (30)

**TOTAL : 60**

## **TEXT BOOKS**

1. Thomas Eri, *"Service-Oriented Architecture- Concepts, Technology and Design"*, Pearson Education, Second Edition, 2008. (Para I to IV)
2. Eric Jendrock, Jennifer Ball, Debbie Carson, Ian Evans and Kim Haase, *"The Java EE5 Tutorial"*, Oracle Corporation Press, 2010 (Para V)

## **REFERENCES**

1. Gaston C. Hillar, *"Hands-On RESTful Python Web Services"*, Packt, 2018.
2. Martin Kalin, *"Java Web Services: Up and Running"*, O'Reilly Media Inc., First Edition, 2009.
3. Eric Newcomer, Greg Lemow, *"Understanding SOA with Web Services"*, Pearson Education, Inc, 2005.

# 19MAME16 - INTERNET OF THINGS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Assess the different IoT technologies that suits an application.

**CO2** : Recognize the challenges for smart object.

**CO3** : Demonstrate knowledge of main architectures and paradigms for the Internet of Things.

**CO4** : Demonstrate knowledge of MAC and routing protocols developed for Low Power and lossy networks.

**CO5** : Design simple IoT systems for the given requirements comprising sensors- edge devices- wireless network connections and data analytics capabilities.

## INTRODUCTION

Definition and Characteristics of IoT - Physical Design of IoT - Logical Design of IoT - Enabling Technologies - IoT Levels - Domain specific IoTs (5)

## SENSORS - PARTICIPATORY SENSING - RFIDS AND WIRELESS SENSOR NETWORK

Introduction-Sensor technology - Sensing the real world-Analog sensors- Examples of sensors - Reading temperature from Resistance sensor- capacitive sensor-Examples of sensors-Temperature-humidity-distance light-acceleration-vibrations and shocks-Gyroscope for angular acceleration- Magnetic sensors- Magnetometer Sound -Sensing the Things-bar code-QR code-Motion sensors-Pressure sensors-Location and LIDAR-Industrial IoT - in bicycle manufacturing process and Automotive IoT - Connected cars technology (10)

## DEVELOPING INTERNET OF THINGS

IoT and M2M - IoT System Management with NETCONF-YANG - IoT Design Methodology - Case Study: Weather monitoring - Motivation for using Python- Logical design using Python: Programming constructs - Python packages for IoT (6)

## IOT PHYSICAL DEVICES AND ENDPOINTS

Building Blocks of an IoT device - Intel Galileo Board - Raspberry pi (6)

## IOT CLOUD BASED SERVICES USING THE XIVELY- NIMBITS

Cloud storage models and communication API - WAMP-AutoBahn for IoT - Xively cloud for IoT - Django -Designing a RESTful Web API - Amazon Web services for IoT- Data collection-storage-Computing using Xively and Nimbits- Data channels using advanced features-security tokens-Alerts-Jabbing-Subscriptions-Public cloud IoT platforms like Paas and SaaS (10)

## DATA ANALYTICS FOR IOT

Apache Hadoop - Using map-reduce for batch data analytics (4)

## CASE STUDIES ILLUSTRATING IoT DESIGN

Home Automation - Cities - Environment - Agriculture - Productivity Applications (4)

**TOTAL : 45**

## TEXT BOOK

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.

## REFERENCES

1. Andy King, *"Programming the Internet of Things: An Introduction to Building Integrated Device-to-Cloud IOT Solutions"*, O'Reilly, 2021
2. Agus Kuniawa, *"Getting started with Intel IoT and Intel Galileo"*, Kindle Edition, 2015.
3. Raj Kamal, *"Internet of Things - Architecture and Design Principles"*, McGraw Hill, 2017

# 19MAME17 - DIGITAL SIGNAL AND IMAGE PROCESSING

L	T	P	C
2	0	2	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Learn the basic concepts of Signals and Images

**CO2** : Illustrate various filtering methods.

**CO3** : Evaluate continuous and discrete spectra estimation

**CO4** : Understand steps in image processing such as Image perception and sensing

**CO5** : Explore Image estimation and restoration methods.

### DETERMINISTIC SIGNALS

Signal Fundamentals: The concept of signal - The concept of system - Discrete Time Signals and sampling: The sampling theorem - Plotting a signal as a function of time - Spectral representation - Fast Fourier Transform (5)

### LINEAR FILTERS

Definitions and properties - The z-transform - Transforms and linear filtering - Different equations and rational TF filters - Minimum phase filters - Filter Design methods - Oversampling and Undersampling. (5)

### CONTINUOUS SPECTRA ESTIMATION

Non-parametric estimation of the PSD - Parametric estimation - Discrete Spectra Estimation: Estimating the amplitudes and the frequencies. (6)

### IMAGE PERCEPTION AND SENSING

Light and Luminance - Still Image Visual Properties - Time-variant Human Visual System Properties - Color - Color spaces - Image Sensors and Displays - Image Enhancement and Analysis: Simple Image processing filters - Image Enhancement - Image Analysis - Object detection. (7)

### IMAGE ESTIMATION AND RESTORATION

Two Dimensional random fields - Estimation for Random fields - Inhomogeneous Gaussian Estimation - Bayesian and Maximum A Posteriori Estimation - Image Identification and Restoration. (7)

### PRACTICALS

Implementation of FFT, DFT of Signals-Wavelet Transformation-Image Enhancement -Histogram Equalization-Smoothing- Sharpening-Compression-Segmentation-Morphology-Restoration-Edge Detection-Restoration. (30)

**TOTAL : 60**

### TEXT BOOKS

1. Gérard Blanchet, Maurice Charbit, "Digital Signal and Image Processing Using MATLAB", ISTE Ltd, 2006. (Para I-III)
2. John W. Wood, "Multidimensional Signal, Image and Video Processing and Coding", Second Edition, Academic Press. (Para IV & V).
3. OGE Marques John, "Practical Image and Video Processing using MATLAB", Wiley Publications, 2011 (Practicals)

### REFERENCES

1. R.Ramanathan and K.P. Soman, "Digital Signal and Image Processing", Elsevier Science, 2012.
2. Sandipan Dey, "Image Processing with Python", BPB, 2021.
3. Rafeal C. Gonzalez Richard, E. Woods, "Digital Image Processing", Pearson, 3rd Edition, 2006.

# 19MAME18 - CYBER SECURITY

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

- CO1** : Understand the theoretical concept of Cyber crime
- CO2** : Enumerate the different legal responses to Cybercrime
- CO3** : Understand and apply cyber forensics to detect threats and crimes.
- CO4** : Analyze and evaluate the cyber security needs of an organization.
- CO5** : Familiarize with case studies on cybercrimes and digital evidences

## INTRODUCTION TO CYBER CRIME

Role of Electronic Communication Devices and Information and Communication Technologies in Cybercrime - Types of Cyber Crime - Classification of Cyber Criminals - Tools used in Cyber Crime - Factors influencing Cybercrime - Challenges to Cybercrime - Strategies to prevent Cybercrimes - Terms and Terminologies associated with Cybercrime. (9)

## CYBERCRIME - THE PRESENT AND THE FUTURE

Cryptocurrency - Bitcoin - Ethereum - Blockchain - Ransomware. Cyber forensics: Interrelations among Cybercrime, Cyber Forensics and Cyber Security - Cyber Forensics - Definition - Disk Forensics - Network Forensics - Wireless Forensics - Database Forensics - Malware Forensics - Mobile Forensics - Email Forensics. (10)

## TOOLS AND METHODS USED IN CYBERCRIME

Proxy Servers and Anonymizers - Phishing - Password Cracking - Keyloggers and Spywares - DoS and DDoS attacks - SQL Injection - Buffer Overflow - Attacks on Wireless Networks. (9)

## ORGANIZATIONAL IMPLICATIONS

Web threats for Organizations - Security and Privacy implications from Cloud Computing - Social Media Marketing: Security Risks and Perils for Organizations - Social Computing and the Associated Challenges for Organizations - Protecting People's Privacy in the Organization-Forensics best practices for organizations. (9)

## DIGITAL EVIDENCE

Introduction to Digital Evidence and Evidence Collection Procedure - Sources of Evidence - Impediments to collection of Digital Evidence - Challenges with Digital Evidence.

Cybercrime: Real-Life Examples -Mini-Cases- Illustration of Financial Frauds in Cyber Domain - Digital Signature-related Crime Scenarios - Digital Forensics Case Illustrations-Online Scams. (8)

**TOTAL : 45**

## TEXT BOOKS

1. Dejey and S.Murugan, 'Cyber Forensics', Oxford University Press, 2018. (Para I, II, V)
2. Nina Godbole and Sunil Belapure, 'Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives', Wiley India. (Para III, IV, V)

## REFERENCES

1. James Graham, Richard Howard and Ryan Otson, 'Cyber Security Essentials', CRC Press.
2. Mead, Nancy, R.Woody, Carol, 'Cyber Security Engineering : A Practical Approach for Systems and Software Assurance', Pearson Education Asia, 2017.

# 19MAME19 - BUSINESS INTELLIGENCE

L	T	P	C
3	0	0	3

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

### COURSE OUTCOMES

- CO1** : *Apply Engineering approach to make better business decisions by analyzing risk factors.*
- CO2** : *Devise efficient managerial decisions based on mathematical models for real time business intelligence applications.*
- CO3** : *Develop strategic project planning by analyzing customer requirements in various dimensions with cost and time efficiency.*
- CO4** : *Differentiate various prototyping models and their applicability for data modeling based on real time requirements and infrastructure.*
- CO5** : *Specify ETL operations for real time business intelligence projects using tools and analyze the feasibility in terms of strengths and weaknesses.*

### BASICS OF BUSINESS INTELLIGENCE(BI)

Decision Support Systems: Definition - Representation of the decision-making process - Evolution of information systems - Development of DSS. Mathematical models for decision making: Structure -Development of a model - Classes of models.(10)

### BUSINESS INTELLIGENCE STAGES AND STEPS

BI definition - BI decision support initiatives - Development approaches - Engineering stages and the development steps - Parallel development tracks - BI project team structure.

Business Case Assessment: Justification - Drivers - Business Analysis issues - Risk assessment -Activities - Deliverables - Roles. (9)

### BI PROJECT PLANNING AND REQUIREMENTS

BI project: managing-Defining-Planning - Activities - Deliverables - Roles. Project Requirements Definition: General and specific requirements - Activities - Deliverables - Roles. (8)

### DATA ANALYSIS AND APPLICATION PROTOTYPING

Data Analysis: Business focused data analysis - Top-down logical data modeling -Bottom-up source data analysis - Data cleansing - Activities - Deliverables-Roles.

Prototyping: Purpose - Best practices - Types - Building successful prototypes - Application prototyping Activities - Deliverables - Roles. (9)

### DATABASE AND ETL DESIGN

Differences in database design - Logical and physical database design - Activities - Deliverables - Roles. ETL Design: Implementation strategies - Preparing for ETL process - Designing the extract programs, Transformation programs, Load programs, ETL process flow - Evaluating ETL tools - Activities - Deliverables- Roles. (9)

**TOTAL : 45**

## **TEXT BOOKS**

1. Carlo Vercellis, *"Business Intelligence: Data mining and Optimization for Decision Making"*, John Wiley and Sons, 2009. (Para- I).
2. Larissa T.Moss and Shaku Atre, *"Business Intelligence Roadmap: The Complete project life cycle for decision support applications"*, Addison Wesley, 2003. (Para II, III, IV & V).

## **REFERENCE**

1. Efraim Turban, Ramesh Sharda, DursunDelen and Janine E. Aronson, *"Business Intelligence - A Managerial Approach"*, Global Edition, Pearson, 2017

## 19MAMEL01 - SPATIAL DATA MODELLING AND ANALYSIS LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

- CO1** : *Acquire skills to carry out analysis on spatial data.*
- CO2** : *Create databases for spatial data and onscreen digitization.*
- CO3** : *Demonstrate the applications of raster and vector data.*
- CO4** : *Implement raster analysis and vector analysis.*
- CO5** : *Model the spatial variability*

### CONCEPTS

1. Rectification and Spatial Referencing of Digital Map
2. Onscreen Digitization and Database Creation
3. Projection and Re-projection of spatial data
4. Data Conversion - Vector to Raster, Raster to Vector
5. Populating Attribute data base and querying on attribute data
6. Generation of DEM: from contours, spot heights, GRID and TIN, Isometric mapping
7. Vector Analysis - Buffering, Overlay and Network analysis, flood mapping
8. Raster Analysis - Measurement - Arithmetic overlaying, Logical overlaying, Class interval selection, choropleth maps
9. Map Output - Bar charts, Pie charts and symbols
10. Map compilation
11. Modelling spatial variability
12. Weighted Theisson polygon and districting
13. Customization and scripting

**Tools : Python,QGIS,Neighborvis**

**TOTAL : 60**

### REFERENCE

1. Joel Lawhead, "*Learning Geospatial Analysis with Python*", Second Edition, Packt Publications, 2015.

## 19MAMEL02 - AUGMENTED AND VIRTUAL REALITY LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

19MAME05

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

**CO1** : Create and deploy a AR-VR application

**CO2** : Explore the physical principles of VR

**CO3** : Create a comfortable, high-performance VR application using Unity.

**CO4** : Identify, examine and develop software that reflects fundamental techniques for the design and deployment of VR experiences.

**CO5** : Develop real time applications using AR/VR techniques

### CONCEPTS TO BE COVERED

1. Simple programs on Unity for VR development, and Image blending
2. Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
3. Develop a scene in Unity that includes: i. A cube, plane and sphere, apply transformations on the 3 game objects.  
ii. Add a video and audio source
4. Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the color, material and texture of each Game object separately in the scene.
5. Create an immersive environment (living room/ battlefield/ tennis court) with only static game objects. 3D game objects can be created using Blender or use available 3D models.
6. Include animation and interaction in the immersive environment created in 3D game objects.
7. Create a virtual environment for any use case. The application must include at least 4 scenes which can be changed dynamically including good UI, animation and interaction with game objects. (e.g. VR application to visit a zoo)

### Suggested Software/Tool: Unity

**TOTAL : 60**

### REFERENCE

1. Jeff W Murray, Taylor & Francis, "Building Virtual Reality with Unity And Steamvr", 2nd Edition, 2020.

## 19MAMEL03 - NATURAL LANGUAGE PROCESSING LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

19MAME07, 19MAM65

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

**CO1** : Practice text and word representations in NLP

**CO2** : Use text segmentation, text summarization and categorization to process text data

**CO3** : Implement and evaluate different NLP applications using machine learning and deep learning methods

**CO4** : Design and develop chatbot applications and machine translations

**CO5** : Develop NLP based applications for various domains

### CONCEPTS TO BE COVERED

- Representing and computing with Text data: Simple statistics
- Accessing text corpora and lexical resources
- Processing raw text from web: regular expressions for finding patterns, tokenizing text
- Text segmentation
- Categorizing and tagging words: N-Gram
- Text classification using supervised machine learning algorithms like Naïve Bayes, Deep Neural Networks etc.)
- Speech to text, Text to Speech
- Language modelling
- Analyzing meaning of sentence
- Building chatbots/Question answering
- Machine transaction, Text summarization
- Use of transformer models

**Suggested Software : NLTK(Python)**

**TOTAL : 60**

### REFERENCES

1. Denis Rothman "Transformers for Natural Language Processing",Packt, 2021
2. Sowmya Vajjala , Bodhisattwa Majumder, Anuj Gupta "Practical Natural Language Processing", BPO, 2020.

## 19MAMEL04 - GRAPH ANALYTICS LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

**CO1** : *Implement Graph creation and detection*

**CO2** : *Implement machine learning techniques and algorithms in graph data*

**CO3** : *Use different node embedding methods for real time problems*

**CO4** : *Implement Graph Neural Networks and Implement Graph Convolution Network*

**CO5** : *Extracting data from social networks, financial transaction systems, and more and analyze it to derive patterns.*

### CONCEPTS TO BE COVERED

- Graph Creation and Analysis (Statistical) , Plotting graphs and Graph properties, Extracting features using graphs
- Node Embedding -Shallow Embedding and Random walk Embedding
- Implementation of graph algorithms-(Pathfinding & Graph Search, Centrality)
- Applications of Graph Neural Networks
- Graph Convolution Network (GCN) for graph-structured data
- Machine learning on graphs- Node Classification, Link Prediction, Clustering and Community Detection.
- Social network analysis using Graphs (Yelp Social Network Data)
- Text Analytics and NLP using graphs
- Graph analysis for credit card transaction

**Software: Python (Networkx), Neo4j, GraphX, Gephi**

**TOTAL : 60**

### REFERENCES

1. *Aldo Marzullo, Claudio Stamile, and Enrico Deusebio, Graph Machine Learning, Packt Publishing, 2021.*
2. *Mark Needham, Amy E. Hodler, Graph Algorithms: Practical Examples in Apache Spark and Neo4j, O'Reilly, 2019.*

## 19MAMEL05 - INTERNET OF THINGS LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

- CO1** : Choose the required sensor and perform input output operations for a given requirement.
- CO2** : Devise interface circuit for connecting a chosen sensor to Arduino board.
- CO3** : Develop software for Arduino board to interact with the sensor to meet requirements.
- CO4** : Develop software to interact (send/receive data) with Web/Application server located in the Internet.
- CO5** : Use data analytics tool to analyse the data collected and present the report to the end user.

### CONCEPTS TO BE COVERED

1. Familiarize with Arduino/Raspberry Pi
2. To interface LED/Buzzer and turn on/off LED
3. To interface with digital sensor like IR/LDR and push button to on/off the LED
4. To interface with DTH11 sensor and read and print temperature and humidity readings.
5. To interface Bluetooth and send sensor data to smartphone using Bluetooth.
6. Program to interact with Thingspeak Cloud
7. Program to interact with MQTT broker
8. Perform analytics on sensor data and visualize the results in mobile UI
9. Develop end-to-end intelligent IoT applications

**TOTAL : 60**

### REFERENCE

1. Pooja Baraskar, "Practical Internet of Things for Beginners: IOT Projects with Realsense, Azure, Arduino and Intel Edition", Apress, 2020

## 19MAMEL06 - CYBER SECURITY LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

**CO1** : *Perform Encryption and Decryption techniques*

**CO2** : *Implement detection and prevention process*

**CO3** : *Perform detection method against various attack mechanism*

**CO4** : *Understand the implementation of various techniques and security algorithms*

**CO5** : *Apply different tools used for secure data transmission and for creating digital signature.*

### TOPICS TO BE COVERED

1. Perform Encryption and Decryption using Substitution techniques
  - a) Caesar Cipher
  - b) Playfair Cipher
  - c) Hill Cipher
2. Perform Encryption and Decryption using Transposition techniques
  - a) Rail Fence row & Column Transformation
3. Implement Diffie-Hellman Key Exchange mechanism
4. Implement the following attacks
  - a) Dictionary Attack
  - b) Brute- Force attack
5. Calculate the message digest of a text using the SHA-1 algorithm
6. Detect ARP Spoof Attack using Scapy in Python
7. Demonstrate Intrusion Detection System using any tool
8. Implement for providing secure storage and secure data transmission
9. Implement RSA Digital Signature Scheme
10. Defeating Malware - Building Trojans, Rootkit Hunter

**TOTAL : 60**

## ONE CREDIT COURSES

### 19MAMOC01- ECONOMETRICS AND MACHINE LEARNING IN FINANCE

L	T	P	C
1	0	0	1

#### PRE-REQUISITES

Consent of the Instructor

#### ASSESSMENT : THEORY

#### COURSE OUTCOMES

**CO1** : *Understand the fundamentals of econometrics and financial markets.*

**CO2** : *Select and implement linear regression, logistic regression and random forest models as per business requirement.*

**CO3** : *Understand the techniques of fine tuning the model parameters to improve its performance.*

**CO4** : *Apply machine learning models to financial data and derive insights.*

#### ECONOMETRICS

Review of Probability and Statistics-Fundamentals of Economics

Financial Institutions, Products and Markets-Introduction to Financial Institutions-Introduction to Financial Products and Markets  
(5)

#### MACHINE LEARNING IN FINANCE

Review of R programming language-Review of machine learning

Building a multiple linear regression model

Building a logistic regression model

Validating Regression Models - Performance Diagnostics

Building a regression model to forecast losses for a trading desk

Building a logistic regression model to assess the credit quality of the borrower

Building a model using KNN, K-means and Naive Bayes classifier and understanding the testing the performance of the models

Building Prudential Life Insurance Assessment using Multinomial Logit and Random Forest.

Discussing resources for having a career in model development, validation, quantitative research and data science. (10)

**TOTAL : 15**

## 19MAMOC02 - JAVA PROGRAMMING

L	T	P	C
0	0	2	1

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

**CO1** : *Able to learn and implement classes and objects in Java.*

**CO2** : *Able to apply inheritance and create interfaces for the given requirement.*

**CO3** : *Able to handle the different kinds of exceptions arising in a Java program.*

**CO4** : *Able to use IO streams for reading and writing data in Java.*

**CO5** : *Able to write socket programs in Java to create network applications.*

### INTRODUCTION TO OBJECT ORIENTED PROGRAMMING

Object Oriented Programming - Abstraction - objects and classes - Encapsulation- Inheritance - Polymorphism.

OOP in Java -Characteristics of Java - The Java Environment - Java Source File -Structure - Compilation-Fundamental Programming Structures in Java -Objects and Classes - Strings (6)

### INHERITANCE AND INTERFACES

Inheritance - Using Super - Creating a Multilevel Hierarchy - Constructors - Method Overriding - Using Abstract Classes - Using Final with Inheritance - The Object Class

Packages and Interfaces - Packages - Access Protection - Importing Packages - Interfaces (10)

### EXCEPTION HANDLING AND I/O

Exceptions - Exception Hierarchy - Throwing and Catching Exceptions - Built-in exceptions - Creating own exceptions. Input / Output Basics - Streams - Byte streams and Character streams - Reading and Writing Console - Reading and Writing Files (8)

### SOCKET PROGRAMMING

Basic Concepts- Protocols and Terminology-Starting Network Programming in Java-Multithreading and Multiplexing. Database Connectivity: JDBC (6)

### Programming exercises based on the above concepts

**TOTAL : 30**

### REFERENCE

1. Herbert Schildt, "Java The complete reference", 11th Edition, McGraw Hill Education, 2020

# AMENDMENTS

## 19MAME14 - EXPLAINABLE AI

L	T	P	C
2	0	2	3

### PRE-REQUISITES

19MAM42, 19MAM62

### ASSESSMENT : THEORY

### COURSE OUTCOMES

Upon completion of the course the students will be able to

- CO1** : Explore the basic concepts of Interpretability and learn about simple interpretable models.
- CO2** : Recognize model-agnostic methods for interpreting black box models such as feature importance, accumulated local effects, and explaining individual predictions with Shapley values and LIME.
- CO3** : Interpret Deep Neural network models using methods like Guided backpropagation and Grad CAM.
- CO4** : Understand the interpretation of visual representation using network dissection and semantic similarity methods.
- CO5** : Select and correctly apply the interpretation method that is most suitable for a machine learning project.

### BAISCS OF INTERPRETABILITY

Introduction-DiagnosticPlus AI System-Interpretability versus Explainability-White Box Models-Interpreting Linear Regression, Decision Trees-Generalized Additive Models-Black Box Models. (6)

### INTERPRETING MODEL PROCESSING

Model Agnostic Methods: Interpreting Tree Ensembles, Random Forest- Global Interpretability. Local Interpretability: Breast Cancer Detection Diagnostic Plus Example-Exploratory Data Analysis-Interpreting Deep Neural Networks-LIME-SHAP-Anchors. (7)

### SALENCY MAPPING

Interpreting Convolution Neural Networks- Vanilla Backpropagation-Guided Backpropagation-Other Gradient Based Methods-Grad-CAM and Guided CAM. (6)

### INTERPRETING MODEL REPRESENTATIONS

Understanding Layers and Units: Visual Understanding-Network Dissection Framework-Interpreting Layers and Units. Sematic Similarity: Sentiment Analysis-Exploratory Data Analysis-Neural Word Embeddings-Interpreting Semantic Similarity. (6)

### FAIRNESS AND BIAS

Fairness Notions-Interpretability and Fairness-Mitigating Bias-Datasheets for Dataset-Path to Explainable AI. AI Fairness with Google's What-if Tool (WIT)-Building an Explainable AI Solution from Scratch. (5)

Practical exercise to be based on topics covered in theory using XAI framework or tools such as What-if , LIME, AIX360 etc. (30)

**TOTAL : 60**

### TEXT BOOKS

1. Ajay Thampi, *Interpreting AI-Building Explainable ML Systems*, Manning Publishers, 2022.
2. Denis Rothman, *Hands-On Explainable AI(XAI) with Python*, Packt Publishing, 2020  
(Practical)

### REFERENCES

1. Christoph Molnar, *Interpretable Machine Learning-A Guide for Making Black Box Models Explainable*, Second Edition, R Markdown-ebook, 2022.
2. Pradeepta Misha, *Practical Explainable AI Using Python*, A Press, 2021.

# 19MAME15 - FEDERATED LEARNING

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM42

## ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Explore the key concepts and issues behind Federated Learning

**CO2** : Gain Knowledge of the basic concepts of DML and applications of FL.

**CO3** : Analyze horizontal federated learning and its architecture

**CO4** : Interpret and get familiar with key theoretical results of Federated Learning with new research and application trends in FL.

**CO5** : Understand the significance of Federated Learning for Vision, Language, and Recommendation.

### INTRODUCTION AND BACKGROUND

Motivation- Federated Learning as a Solution- Definition-Categories of Federated Learning- Current Development in Federated Learning - Research Issues-Open - Source Projects- Standardization Efforts-Federated AI Ecosystem

Privacy-Preserving Machine of Learning- PPML and Secure ML - Threat and Security Models- Privacy Threat Models - Adversary and Security Models - Privacy Preservation Techniques-Secure Multi-Party Computation - Homomorphic Encryption- Differential Privacy (10)

### DISTRIBUTED MACHINE LEARNING

Introduction to DML - The Definition of DML - DML Platforms - Scalability-Motivated DML- Large-Scale Machine Learning, Scalability-Oriented DML Schemes- Privacy-Motivated DML, Privacy-Preserving Decision Trees, Privacy-Preserving Techniques, Privacy-Preserving DML Schemes, Privacy-Preserving Gradient Descent, Vanilla Federated Learning, Privacy-Preserving Methods (8)

### HORIZONTAL AND VERTICAL FEDERATED LEARNING

The Definition of HFL - Architecture of HFL - The Client- Server Architecture- The Peer-to-Peer Architecture- Global Model Evaluation- The Federated Averaging Algorithm- Federated Optimization- The FedAvg Algorithm- The Secured FedAvg Algorithm, -Improvement of the FedAvg Algorithm- Communication Efficiency- Client Selection

Vertical Federated Learning: The Definition of VFL, Architecture of VFL- Algorithms of VFL- Secure Federated Linear Regression, - Secure Federated Tree-Boosting (9)

### FEDERATED TRANSFER LEARNING AND DESIGN

Heterogeneous Federated Learning-Federated Transfer Learning- The FTL Framework-Additively Homomorphic Encryption- The FTL Training Process- The FTL Prediction Process- Security Analysis- Secret Sharing-Based FTL. **Incentive Mechanism Design for Federated Learning:** Paying for Contributions, Profit- Sharing Games -Reverse Auctions - A Fairness-Aware Profit Sharing Framework- Modeling Contribution- Modeling Cost- Modeling Regret- Modeling Temporal Regret- The Policy Orchestrator - Computing Payoff Weightage (9)

### FEDERATED LEARNING FOR VISION, LANGUAGE, AND RECOMMENDATION

Federated Learning for Computer Vision- Federated CV - Federated Learning for NLP- Federated NLP- Federated Learning for Recommendation Systems- Recommendation Model- Federated Recommendation System. **Federated Reinforcement Learning:** Distributed Reinforcement Learning - Asynchronous Distributed Reinforcement Learning - Synchronous Distributed Reinforcement Learning- Federated Reinforcement Learning-Background and Categorization (9)

**TOTAL : 45**

## **TEXT BOOK**

1. *Federated Learning*, Qiang Yang, Yang Liu, Yong Cheng, Yan Kang, Tianjian Chen, and Han Yu Synthesis Lectures on Artificial Intelligence and Machine Learning, Morgan & Claypool publishers, 2019. Chapters (1-9)

## **REFERENCES**

1. *Advances and Open Problems in Federated Learning*, Peter Kairouz and H. Brendan McMahan conceived, March 2021.

# 19MAME16 - GENERATIVE ADVERSARIAL NETWORKS

L	T	P	C
3	0	0	3

## PRE-REQUISITES

19MAM62

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : Explore the concept of Generative Adversarial Network

**CO2** : Understand about Unsupervised Learning with GAN

**CO3** : Describe DCGAN, Conditional GAN and Cycle GAN

**CO4** : Build Realistic Images from the Text

**CO5** : Generate images and deploying a deep model on the cloud

## GENERATIVE ADVERSARIAL NETWORK (GAN)

Introduction- Deep Neural Networks - Architecture structure basics - Basic building block - generator - Basic building block - discriminator - Basic Building Block - loss functions - Training - The work process - GAN output - Benefits of a GAN structure.

(8)

## UNSUPERVISED LEARNING WITH GAN

Automating human tasks with deep neural networks - Implementation of GAN - Challenges of GAN models - Improved training approaches and tips for GAN. **Dreaming of New Outdoor Structure using DCGAN:** Definition - A simple pseudocode example - Tools - Parsing the data - Code implementation (Generator and Discriminator) - Training - Evaluation - Adjusting parameters for better performance.

(10)

## TRANSFER IMAGE STYLE ACROSS VARIOUS DOMAINS

Bridging the gap between Supervised and unsupervised learning - Conditional GAN - The training procedure of BEGAN - Image to Image style transfer with CycleGAN. Building Realistic Images from Text: Introduction to StackGAN - Discovering cross-domain relationships with DiscoGAN - Generating handbags from edges with PyTorch - Gender transformation using PyTorch - DiscoGAN versus CycleGAN.

(9)

## GENERATE IMAGES

Transfer Learning - Large scale deep learning with Apache Spark - Generating artistic hallucinated images using DeepDream - Generating handwritten digits with VAE using TensorFlow - A real World analogy of VAE - A Comparison of two generative models GAN and VAE.

(8)

## TAKING MACHINE LEARNING TO PRODUCTION

Building an image correction system using DCGAN - Microservice architecture using containers - Various approaches to deploying deep models - serving Eras-Based deep models on Docker - Deploying a deep model on the cloud with GKE - Serverless image recognition with audio using AWS Lambda and Polly - Practical Applications of GANs : GANs in Medicine and fashion

(10)

**TOTAL : 45**

## TEXT BOOKS

1. Kuntal Ganguly, "Learning Generative Adversarial Networks: Next-generation deep learning simplified", 1 Edition, Packt Publishing Ltd., 2017, (Para II, III, IV and V).
2. Josh Kalin, "Generative Adversarial Networks Cookbook", First Edition, Packt Publishing Ltd., (Para I, II), 2018

## REFERENCES

1. *Jakub Langr and Vladimir Bok, "GANs in Action: Deep Learning with Generative Adversarial Networks", Manning Publications; First Edition, 2019.*
2. *David Foster, "Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play, First Edition, O'Reilly Media, 2019.*

## 20MSSE04 - BLOCKCHAIN TECHNOLOGIES

L	T	P	C
3	0	0	3

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : THEORY

### COURSE OUTCOMES

**CO1** : Explain the basic components of a blockchain, its operations, underlying algorithms, and essentials of trust.

**CO2** : Explain the working of Bitcoin and Ethereum blockchains.

**CO3** : Explain the role of cryptography in securing blockchain.

**CO4** : Apply the learning of solidity and develop smart contracts

**CO5** : Develop decentralized apps on Ethereum.

### INTRODUCTION

Basics of Distributed Computing - Consensus Mechanisms - Decentralization - Applications of Blockchain - Scalability and Challenges. (7)

### BITCOIN BLOCKCHAIN

Introduction - working of bitcoin - Reference Implementation - Keys and Addresses - Wallets. (10)

### BITCOIN BLOCKCHAIN MINING

Transactions - Scripting - Bitcoin Network - Mining and Consensus. (9)

### ETHEREUM BLOCKCHAIN

Basics - Ethereum Clients - Ethereum Networks - Ethereum Addresses - Wallets - Transactions - Smart Contract Security. (9)

### SMART CONTRACTS

Basics - Life Cycle of a Smart Contract - Building a Smart Contract with Solidity-Programming with Solidity - Gas Considerations. (10)

**TOTAL : 45**

### TEXT BOOKS

1. Imran Bashir, "Mastering Blockchain", Packt Publishing, First Edition, 2017. (Para I).
2. Andreas M. Antonopoulos, "Mastering Bitcoin - Programming the open Blockchain", O'Reilly, 2017. (Para II,III).
3. Andreas M. Antonopoulos Dr. Gavin Wood, "Mastering Ethereum - Building Smart Contracts and DApp", O'Reilly, 2019. Para(IV,V).

### REFERENCES

1. Lorne Lantz, Daniel Cawrey, "Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, O'Reilly, 2020.
2. Saifedean Ammous, "The Bitcoin Standard: The Decentralized Alternative to Central Banking", Wiley, 2018.

# 19MAMEL07 - GENERATIVE AI LAB

L	T	P	C
0	0	4	2

## PRE-REQUISITES

19MAM62

## ASSESSMENT : PRACTICALS

## COURSE OUTCOMES

- CO1** : *Create impressive Generative deep learning models from scratch including variational autoencoders (VAEs) and Generative Adversarial Networks (GANs)*
- CO2** : *Implement state-of-the-art architectures such as StyleGAN2, MuseGAN, pix2pix for text,image and music generation*
- CO3** : *Use diffusion models for text, image and video datasets for Generative AI applications*
- CO4** : *Store and retrieve Images, Text using Vector Database*
- CO5** : *Build real time Generative AI applications like chatbots, image,audio,video generation and synthetic dataset generation for various domains*

## CONCEPTS TO BE COVERED

- Train GANs to generate images based on your own dataset.
- Implement paired and unpaired style transfer with networks like StyleGAN.
- Use facial landmarks, auto encoders, and pix2pix GAN to create deepfakes.
- Compose music using Generative/LSTM models and the intricate MuseGAN.
- Use VAEs/C-GAN that can change facial expressions in photos.
- Use Image based diffusion models to produce new varieties of flowers
- Generate Text and other text based applications using GPT,Llama,Langchain etc..(AI chatbots)
- Applications of vector databases(Image,Text)
- Text/Image to video Generation (Modelscope.Gen-2 etc..)
- Create a own generative models using DALL.E 2, Imagen or Stable Diffusion-models

**TOTAL : 60**

**Software Used** : Python, Open Source Pretained Generative AI Models

## 19MAMEL08 - SOFTWARE TESTING LAB

L	T	P	C
0	0	4	2

### PRE-REQUISITES

Consent of the Instructor

### ASSESSMENT : PRACTICALS

### COURSE OUTCOMES

- CO1** : *Learn the fundamentals of software testing methods.*
- CO2** : *Design and develop the best test strategies in accordance to the development model*
- CO3** : *Design test cases suitable for a software development for different domains.*
- CO4** : *Apply the automation testing tools in the production environment*
- CO5** : *Develop and validate a test plan.*

### Concepts to be covered

- Unit testing - Junit
- Functional testing - Win Runner
- Synchronization Test
- Performance testing using Load Runner
- GUI checkpoint for single/multiple objects using Win Runner
- Design and development of Test Cases for Window Application
- Boundary Value Analysis of Application
- Testing load of Web Application using Load Runner
- Regression testing using Silk Test Tool
- Reliability Testing and Automation Testing using Jmeter
- Unit test cases using MLOps

**TOTAL : 60**

**Software Tools** : J Unit 5, WinRunner, Apache Jmeter, Kubeflow, MLflow

# ONE CREDIT COURSES

## 19MAMOC03 - SOFTWARE ENGINEERING

L	T	P	C
0	0	2	1

### PRE-REQUISITES

Consent of the Instructor

### COURSE OUTCOMES

- CO1** : *Understand different software life cycle models.*
- CO2** : *Identify the functional and non-functional software requirements.*
- CO3** : *Apply systematic methodologies for software design and deployment.*
- CO4** : *Recognize various testing approaches and maintenance related issues.*
- CO5** : *Plan project schedule, and estimate project cost and effort required.*

### SOFTWARE PROCESS AND AGILE DEVELOPMENT

Introduction to Software Engineering-Software Process-Software Development Life Cycle Models --Agile Process-Extreme Programming. (2)

### REQUIREMENTS ANALYSIS AND SPECIFICATION

Functional and Non-Functional-User Requirements-System and Software Requirements Document-Requirement Engineering Process-Requirements Elicitation and Analysis. (3)

### SOFTWARE DESIGN

Design Process-Design Concepts-Design Model-Architectural Design and Styles-User Interface Design: Interface Analysis-Interface Design

### TESTING AND MAINTENANCE

Software Testing Fundamentals-White Box Testing- Basis Path Testing-Control Structure Testing-Black Box Testing- Acceptance Testing - Regression Testing-Unit Testing- Integration Testing-Validation Testing- System Testing & Debugging. (5)

### PROJECT MANAGEMENT

Software Project Management: Estimation- LOC- Function Point Based Estimation- Make/Buy Decision COCOMO I & II Model- Project Scheduling- Project Plan-Planning Process- Risk Identification and Management-Case Tools. (5)

### PRACTICALS

(15)

**TOTAL : 30**

### REFERENCE

1. Roger S. Pressman, *Software Engineering - A Practitioners Approach, Seventh Edition, Mc Graw-Hill International Edition, 2020.*

## 19MAMOC04 - MACHINE LEARNING OPERATIONS LAB

L	T	P	C
0	0	2	1

### PRE-REQUISITES

Consent of the Instructor

### COURSE OUTCOMES

- CO1** : *Understand the fundamentals of Machine Learning Operations(MLOPs) and AI pair programming.*
- CO2** : *Select and implement web applications and Command line tools for Machine Learning model Interaction.*
- CO3** : *Design MLOps pipeline and deploy ML models on cloud.*
- CO4** : *Deploy Large Language Models and Containerized models*

### CONCEPTS TO BE COVERED

1. Build Python script to automate data pre-processing and feature extraction for machine learning models.
2. Develop a real-world ML/AI solution using AI pair programming and GitHub Copilot, showcasing the ability to collaborate with AI.
3. Create web applications and command-line tools for ML model interaction using Gradio library, Hugging Face, and the Click framework package.
4. Implement GPU-accelerated ML tasks using Rust language for improved performance and efficiency.
5. Train, optimizing, and deploying ML models on cloud such as Amazon SageMaker/Azure ML/Google Cloud Platform for cloud-based MLOps.
6. Design a full MLOps pipeline with MLflow, managing projects, models, and tracking system features.
7. Containerize models using the ONNX format with Hugging Face.

**Software/Tools** : GitHub Copilot, Hugging Face, Any Cloud Platform.

**TOTAL : 30**

# 19MAMOC05 - INNOVATION, STARTUPS AND ENTREPRENEURSHIP

L	T	P	C
1	0	0	1

## PRE-REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OUTCOMES

**CO1** : *Understand the concept development*

**CO2** : *Familiarize the startup opportunities and startup equation*

**CO3** : *Identify new venture creation opportunities, its resources, and Requirements*

**CO4** : *Develop entrepreneurial mindset and new trends in entrepreneurship*

**CO5** : *Learn the strategic perspectives in entrepreneurship*

### Introduction to Entrepreneurship

Definition of entrepreneurship and its significance.

Characteristics and traits of successful entrepreneurs.

Overview of the start-up ecosystem and the entrepreneurial process.

### Identifying Business Opportunities

Understanding market trends and opportunities.

Conducting market research and feasibility analysis.

Idea generation and evaluation.

### Business Planning and Strategy

Creating a business plan: key components and importance.

Crafting a unique value proposition.

Developing a competitive strategy.

### Legal and Financial Considerations

Business registration and legal structures.

Financial management and budgeting.

Sources of funding and fundraising strategies.

### Marketing and Sales Strategies

Market segmentation and targeting.

Branding and positioning.

Sales techniques and customer acquisition.

### Product Development and Innovation

Prototyping and minimum viable product (MVP) development.

Lean start-up principles and agile methodologies.

Continuous innovation and improvement.

### Building a Team and Leadership

Hiring and team-building.

Effective leadership and management skills.

Creating a positive and productive work culture.

**Managing Risks and Challenges**

Identifying and mitigating business risks.

Dealing with uncertainty and failure.

Resilience and adaptability in entrepreneurship.

**Scaling and Growth Strategies**

Scaling a start-up: challenges and opportunities.

Expansion strategies and internationalization.

Managing growth and maintaining organizational culture.

**Social Entrepreneurship and Sustainability**

Introduction to social entrepreneurship-

Balancing profit and purpose.

Sustainable business practices.

**Pitching and Investor Presentations**

Crafting a compelling pitch deck.

Presenting to investors and stakeholders.

Negotiation and deal-making.

**Entrepreneurship in the Digital Age**

Leveraging technology for business growth.

E-commerce and digital marketing strategies.

Emerging trends in entrepreneurship.

**Assessment :**

Entrepreneurial project : students to develop a business plan or pitch presentation for a start-up idea.

**TOTAL : 15**

## LIST OF NPTEL / SWAYAM COURSES

### 19MAMON01 - ECONOMICS OF BANKING AND FINANCE MARKETS

#### INTRODUCTION TO CYBER CRIME

The course aims at providing adequate exposure to the basic concepts and policy issues related to the working of the financial markets nationally and globally. The course will cover basic economic theories related to banking and finance markets, and then will apply those to understand the working of both national and global monetary and other related economic variables. The course will follow a macroeconomic perspective and will discuss recent finance market developments and controversies. The course aim to develop the learning skills of the students in a way that they can apply their knowledge not only at the academic level but also at the managerial and leadership level in the field of financial sector.

#### COURSE LAYOUT

1. An overview of the financial system; debt (bond) markets
2. Debt (bond) markets; interest rate determination
3. Equity markets; basics of banking
4. Banking sector
5. Asymmetric information and the rationale for regulations of finance markets
6. Asymmetric information; Conflicts of interest and rationale for regulations
7. Rationale for regulations; financial crisis
8. Financial crisis; central banking
9. Central banking
10. Central banking and monetary policy tools
11. Effectiveness of policy
12. Monetary policy tactics and strategies

#### REFERENCES

1. *Mishkin, Frederic S., The Economics of Money, Banking and Financial Markets (AddisonWesley) Ninth Edition, 2010*
2. *Baye, Michael R., & D.W. Jansen, Money, Banking & Financial Markets, An Economics Approach (A.I.T.B.S.), Indian Edition, 1999.*
3. *Froyen, Richard T. Macroeconomics: Theory and Policies.2009*
1. *Websites of Regulatory and Promotional institutions: RBI ([www.rbi.org](http://www.rbi.org)); IMF data ([www.imf.org/en/Data](http://www.imf.org/en/Data)); FRED (<http://research.stlouisfed.org/fred2>); RBI: Handbook of Statistics On Indian Economy*
2. *Economic Dailies: Economic times, Business standard, Financial express, Hindu business line, The Wall Street Journal ([www.wsj.com](http://www.wsj.com)), Financial Times ([www.ft.com](http://www.ft.com)), Bloomberg ([www.bloomberg.com](http://www.bloomberg.com)), and The Economist ([www.economist.com](http://www.economist.com))*

# 19MAMON02 - INTRODUCTION TO INDUSTRY 4.0 AND INDUSTRIAL INTERNET OF THINGS

## ABOUT THE COURSE

Industry 4.0 concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Technologies such as Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics are considered to be the different drivers necessary for the transformation. Industrial Internet of Things (IIoT) is an application of IoT in industries to modify the various existing industrial systems. IIoT links the automation system with enterprise, planning and product lifecycle. This course has been organized into the following modules:

## PRE-REQUISITES

Basic knowledge of computer and internet

## Course layout

1. Introduction: Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II
2. Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories
3. Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis
4. Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes-Part I, Part II, Industrial Sensing & Actuation, Industrial Internet Systems.
5. IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models-Part I, Part II, IIoT Reference Architecture-Part I, Part II.
6. Industrial IoT- Layers: IIoT Sensing-Part I, Part II, IIoT Processing-Part I, Part II, IIoT Communication-Part I.
7. Industrial IoT- Layers: IIoT Communication-Part II, Part III, IIoT Networking-Part I, Part II, Part III.
8. Industrial IoT: Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science - Part I, Part II, R and Julia Programming, Data Management with Hadoop.
9. Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT-Part I, Part II, Data Center Networks, Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT-Part I, Part II.
10. Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT-Part I, Part II, Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry.
11. Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management.
12. Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies :

Case study - I : Milk Processing and Packaging Industries

Case study - II : Manufacturing Industries - Part I

Case study - III : Manufacturing Industries - Part II

Case study - IV : Student Projects - Part I

Case study - V : Student Projects - Part II

Case study - VI : Virtual Reality Lab

Case study - VII : Steel Technology Lab

## REFERENCES

- 1) S. Misra, A. Mukherjee, and A. Roy, 2020. *Introduction to IoT*. Cambridge University Press.
- 2) S. Misra, C. Roy, and A. Mukherjee, 2020. *Introduction to Industrial Internet of Things and Industry 4.0*. CRC Press.

# 19MAMON03 - ETHICAL HACKING

## ABOUT THE COURSE

Ethical hacking is a subject that has become very important in present-day context, and can help individuals and organizations to adopt safe practices and usage of their IT infrastructure. Starting from the basic topics like networking, network security and cryptography, the course will cover various attacks and vulnerabilities and ways to secure them. There will be hands-on demonstrations that will be helpful to the participants. The participants are encouraged to try and replicate the demonstration experiments that will be discussed as part of the course.

## PRE-REQUISITES

Basic concepts in programming and networking

### Course layout

1. Introduction to ethical hacking. Fundamentals of computer networking. TCP/IP protocol stack.
2. IP addressing and routing. TCP and UDP. IP subnets.
3. Routing protocols. IP version 6.
4. Installation of attacker and victim system. Information gathering using advanced google search, archive.org, netcraft, whois, host, dig, dnsenum and NMAP tool.
5. Vulnerability scanning using NMAP and Nessus. Creating a secure hacking environment. System Hacking: password cracking, privilege escalation, application execution. Malware and Virus. ARP spoofing and MAC attack.
6. Introduction to cryptography, private-key encryption, public-key encryption.
7. Cryptographic hash functions, digital signature and certificate, applications.
8. Steganography, biometric authentication, network-based attacks, DNS and Email security.
9. Packet sniffing using wireshark and burpsuite, password attack using burp suite. Social engineering attacks and Denial of service attacks.
10. Elements of hardware security: side-channel attacks, physical inclinable functions, hardware trojans.
11. Different types of attacks using Metasploit framework: password cracking, privilege escalation, remote code execution, etc. Attack on web servers: password attack, SQL injection, cross site scripting.
12. Case studies: various attacks scenarios and their remedies.

## REFERENCES

*Data and Computer Communications -- W. Stallings.*

*Data Communication and Networking -- B. A. Forouzan*

*TCP/IP Protocol Suite -- B. A. Forouzan*

*UNIX Network Programming -- W. R. Stallings*

*Introduction to Computer Networks and Cybersecurity -- C-H. Wu and J. D. Irwin*

*Cryptography and Network Security: Principles and Practice -- W. Stallings*

# 19MAMON04 - AFFECTIVE COMPUTING

## ABOUT THE COURSE

Affective Computing focuses on enabling the machines with emotion recognition and adaptive interaction. It lies in the intersection of Computer Science, design and human psychology. This course will overview the emotion theory, computational modelling of emotions, analysis of emotions using different modalities (such as voice, facial expressions, physiological signals etc) and related machine learning and/or signal processing techniques. We will also discuss ethical, legal and social implications of affective computing particularly in relation to Human-Machine Interaction.

## PREREQUISITES

### Mandatory Prerequisites

Programming, Artificial Intelligence, Machine Learning

### Desirable Prerequisites

Human-Computer Interaction, Deep Learning

### Course layout

1. Fundamentals of Affective Computing
2. Emotion Theory and Emotional Design
3. Experimental Design: Affect Elicitation; Research and Development Tools
4. Emotions in Facial Expressions
5. Emotions in Voice
6. Emotions in Text
7. Emotions in Physiological Signals
8. Multimodal Emotion Recognition
9. Emotional Empathy in Agents/Machines/Robots
10. Online and Adaptive Recognition of Emotions: Challenges and Opportunities
11. Case Study: Updated from Time to Time
12. Ethical Issues: Ethical, legal and Social Implications of Affective Computing

## REFERENCES

1. Affective Computing. MIT Press
2. The Oxford Handbook of Affective Computing. Oxford University Press
3. The Encyclopaedia of Human-Computer Interaction, 2nd Ed.
4. Interaction Design: Beyond Human-Computer Interaction. 2019. (5th Edition) by Jenny Preece, Helen Sharp, Yvonne Rogers (Wiley)

## 19MAME23-LARGE LANGUAGE MODELS

L	T	P	C
3	0	0	3

### PRE-REQUISITES

19MAM51, 19MAM62

### ASSESSMENT: THEORY

### COURSE OUTCOMES

**CO1:** Familiarize with Natural Language Programming (NLP) models and their progress over time.

**CO2:** Learn about the various transformer models and apply it in Large Language Models (LLMs)

**CO3:** Explore the different LLM architectures and use them in building AI applications.

**CO4:** Understand the concepts of prompt engineering and how prompt engineering helps in efficient use of LLMs.

**CO5:** Examine and leverage the power of LLMs in building applications across domains

### NLP FOR LLMs (12)

Introduction to NLP– Text Extraction and Clean up – Pre-processing – Feature Engineering – Modelling – Evaluation – Post Modelling Phases – Vector space models – Basic Vectorization approaches – Distributed representations – Using Neural Embedding for Text Classification – Deep Learning for Text Classification – Introduction to Natural Language Understanding.

### TRANSFORMERS (12)

Basics of Transformers – Optimizing NLP with Transformers - Architecture of Transformers - The rise of transformers – Transformers and Pretrained Language Models.

### LARGE LANGUAGE MODELS (11)

The Architecture of BERT – Fine tuning BERT – RoBERTa – Pretraining RoBERTa Model from Scratch – Superhuman Transformers with GPT3 Engines – Fine Tuning GPT3.

### PROMPT ENGINEERING (5)

Fundamentals of Prompt Engineering – Techniques for Effective Prompt Engineering – Best Practices of Prompt Engineering – Advanced Prompt Engineering Strategies.

### CURRENT TRENDS (5)

Machine Translation – Question Answering and Information Retrieval – Chatbot and Dialogue Systems – Automatic Speech Recognition – Text to Speech

**TOTAL HOURS: 45**

## TEXT BOOKS

1. Bodhisattwa, Sowmya and Anuj, "Practical Natural Language Processing", 1<sup>st</sup> Edition, 2020. (Para-I)
2. Denis Rothman, "Transformers for Natural Language Processing", 2<sup>nd</sup> Edition, 2022, Pakt Publishing (Para-II& III)
3. S. Ekin, "Prompt Engineering for Chat GPT: A Quick Guide to Techniques, Tips and Best Practices", 2023(online). (Para-IV)
4. Jurafsky and Martin, "Speech and Language Processing", Third Edition (2023). (Para-V)