Artificial Intelligence and Data Science (AI &DS)

Bachelor of Technology

Schema& Syllabus

[Effective from 2022 Admitted students and onward]

SMIT SIKKIM MANIPAL UNIVERSITY

SIKKIM MANIPAL INSTITUTE OF TECHNOLOGY

SMIT ||B. TECH ||Schema & Syllabus || Artificial Intelligence and Data Science (AI &DS)

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SMU SIKKIM MANIPAL UNIVERSITY

Established under Govt.of Sikkim, Act 9 of 1995, recognised under 2(f) of the UGC Act, 1956

Vision, Mission and Objective of University

VISION

Global Leadership in Human Development, Excellence in Education and Healthcare.

MISSION

Develop professionals of excellent technical calibre in the field of Health Sciences, Engineering, Management and Social Sciences with a humane approach capable of shouldering the responsibility of building the nation and be globally competent.

OBJECTIVES

- To support, promote and undertake the advancement of academics
- To promote the use of ICT and modern education technologies
- To encourage research, creation and dissemination of knowledge.
- To facilitate extension and community service.
- To empower people of Sikkim and contribute to human development in Northeast.
- To create environmental and social responsibilities among students and employees.
- To ensure steady growth of the University.

SIKKIM MANIPAL UNIVERSITY
SIKKIM MANIPAL INSTITUTE OF TECHNOLOGY

Vision, Mission and Objective of Institute

VISION

To achieve eminence in the field of quality technological education and research.

MISSION

To develop SMIT into an Institution of Excellence capable of producing competent techno managers who can contribute effectively to the advancement of the society.

OBJECTIVES

- To provide wholesome education to meet the intellectual aspirations of the students.
- To equip students with techno-managerial skills to enable them to take their assigned role in the industry.
- To inculcate essential ethics and values to meet the spiritual needs to the students.
- To provide a sound institutional environment nurturing emotional strength, healthy mind, body and resilience amongst the students.

Vision, Mission and PEO of the Department

VISION

To achieve excellence in quality technological education and research for making frontline innovators, researchers and entrepreneurs in the domain of Artificial Intelligence & Data Science.

MISSION

To develop the department as a Centre of excellence in Artificial Intelligence and Big Data in line with the megatrend of Industry 4 impacting virtually every industry

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

- To empower students with skills and employability to solve real life problems.
- To inculcate professional ethics in students and prepare them to become professionals.
- To enhance technical skills and enthusiasm among students to carry out higher studies and research.
- To motivate students for Cutting Edge education and research. ·
- To encourage students for becoming future entrepreneur and provide them an ecosystem for the same.

FIRST YEAR B. TECH CURRICULUM 2022 (Common to all branches)

(Applicable to students admitted during 2022 and later)

Semester	GROUP A (FIRST SEMESTER) **PHYSICS GROUP**						GROUP B (FIRST SEMESTER **CHEMISTRY GROUP**					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
I	MA10101A	Engineering Mathematics–I	3	1	0	4	MA10101A	Engineering Mathematics–I	3	1	0	4
	CE10101A	Elements of Civil Engineering	3	0	0	3	ME10102A	Element of Mechanical Engineering	3	0	0	3
	PH10101A	Engineering Physics	3	1	0	4	CH10101A	Engineering Chemistry	3	1	0	4
	EC10101A	Basic Electronics	3	0	0	3	EE10101A	Element of Electrical engineering	3	0	0	3
	BA10101A	Communication Skills	2	0	0	2	CS10101A	Computer Programming in C	3	1	0	4
	ME10101A	Engineering Graphics	1	0	2	2	CH11001A *	Environmental Science*	2	0	0	0
	BP11001A **	Constitution of India	2	0	0	0						
	ME10401A	Workshop Practice	0	0	2	1	CS10401A	Computer Programming Lab	0	0	2	1
	PH10401A	Engineering Physics Lab	0	0	2	1	CH10401A	Engineering Chemistry Lab	0	0	2	1
	GN10401A	Experiential Learning Lab-I/NCC	0	0	2	1	GN10402A	Experiential Learning Lab-II/NCC	0	0	2	1
	** Optional audit course		17	2	8	21			17	3	6	21
	Total Contact Hours (L + T + P)		27				Total Contact Hours (L + T + P)		26			
	***Mandatory audit course**						***Mandatory audit course**					
II	GROUP A (SECOND SEMESTER)						GROUP B (SECOND SEMESTER)					
	MA10102A	Engineering Mathematics–II	3	1	0	4	MA10102A	Engineering Mathematics–II	3	1	0	4
	ME10102A	Element of Mechanical Engineering	3	0	0	3	CE10101A	Elements of Civil Engineering	3	0	0	3
	CH10101A	Engineering Chemistry	3	1	0	4	PH10101A	Engineering Physics	3	1	0	4
	EE10101A	Element of Electrical engineering	3	0	0	3	EC10101A	Basic Electronics	3	0	0	3
	CS10101A	Computer Programming in C	3	1	0	4	BA10101A	Communication Skills	2	0	0	2
	CH11001A *	Environmental Science*	2	0	0	0	ME10101A	Engineering Graphics	1	0	2	2
							BP11001A **	Constitution of India	2	0	0	0
	CS10401A	Computer Programming Lab	0	0	2	1	ME10401A	Workshop Practice	0	0	2	1
	CH10401A	Engineering Chemistry Lab	0	0	2	1	PH10401A	Engineering Physics Lab	0	0	2	1
	GN10402A	Experiential Learning Lab-II/NCC	0	0	2	1	GN10401A	Experiential Learning Lab-I/NCC	0	0	2	1
	***Mandatory audit course**		17	3	6	21	** Optional audit course		17	2	8	21
	Total Contact Hours (L + T + P)		26				Total Contact Hours (L + T + P)		27			

Note: UHV–I has been introduced under Mandatory Induction Program.

SECOND YEAR B. TECH AI & DS CURRICULUM 2022

Semester	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
II	MA10103A	Engineering Mathematics – III (Probability & Statistics)	2	1	0	3	MA10104A	Engineering Mathematics – IV (Discrete Mathematics)	2	1	0	3
	AD10101A	Digital Systems and Computer Organization	3	1	0	4	AD10106A	Design & Analysis of Algorithms	3	1	0	4
	AD10102A	Data Science	3	1	0	4	AD10107A	Database Management Systems	3	0	0	3
	AD10103A	Data Structures	3	0	0	3	AD10108A	Artificial Intelligence	3	0	0	3
	AD10104A	Object Oriented Programming using Python	3	0	0	3	AD103XXA	Program Elective-1(+MOOC Based)	3	0	0	3
	AD10105A	Operating Systems	3	0	0	3	AD102XXA	Open Elective-1(+ MOOC Based)/NCC	3	0	0	3
							GN10101A	Universal human values-II: understanding Harmony and ethical human conduct	3	0	0	3
	AD10401A	Data Structures & OOPs using Python Lab	0	0	2	1	AD10403A	Artificial Intelligence Lab	0	0	2	1
	AD10402A	Data ScienceLab	0	0	2	1	AD10404A	Database Management Systems Lab	0	0	2	1
	AD10501A	Project Based Learning- I	0	0	2	1	AD10502A	Project Based Learning- II	0	0	2	1
			17	3	6	**23**			20	2	6	**25**
	Total Contact Hours (L + T + P)		26				Total Contact Hours (L + T + P) + OE		25+ 3 = 28			

SECOND YEAR B. TECH AI & DS CURRICULUM 2022

III	FIFTH SEMESTER						SIXTH SEMESTER					
	GN10103A	Professional communication and technical writing	1	0	0	1	BA 10146A	Industrial Management	2	0	0	2
	AD10109A	Formal Language & Automata Theory	3	0	0	3	AD10112A	Deep Learning	3	0	0	3
	AD10110A	Big Data Analytics	3	0	0	3	AD10113A	Text Analytics and Natural Language Processing	3	0	0	3
	AD10111A	Machine Learning	3	0	0	3	AD10114A	Data Communications and Networks	3	0	0	3
	AD103XXA	Program Elective-2(+MOOC Based)	3	0	0	3	AD103XXA	Program Elective-3 (+MOOC Based)	3	0	0	3
	AD102XXA	Open Elective-2 (+MOOC Based)/NCC	3	0	0	3	AD103XXA	Program Elective-4 ((+MOOC Based)	3	0	0	3
	GN10102A	Behavior Management and Leadership (Capsule Course/Certificate course)	3	0	0	3	AD102XXA	Open Elective-3(+MOOC Based)/NCC	3	0	0	3
	AD10405A	Big Data Analytics Lab	0	0	2	1	GN11001A	Quantitative aptitude and logical reasoning				
	AD10406A	Machine Learning Lab	0	0	2	1	AD10407A	Deep Learning - Lab	0	0	2	1
	AD10503A	Project Based Learning- III	0	0	2	1	AD10408A	Text Analytics and NLP Lab	0	0	2	1
	AD10901A	Industrial Training-I	0	0	2	1	AD10504A	Mini Project	0	0	4	2
			19	0	8	**23**	**** Optional Audit Course**		20	0	8	**24**
	Total Contact Hours (L + T + P) + OE		24 + 3 = 27				Total Contact Hours (L + T + P) + OE		25 + 3 = 28			
IV	SEVENTH SEMESTER						EIGHTH SEMESTER					
	AD102XXA	Open Elective-4((+MOOC Based)	3	0	0	3						
	AD103XXA	Program Elective-5 ((+MOOC Based)	3	0	0	3						
	AD10601A	Research based Project / Industrial Project -Phase-I	0	0	14	7	AD10602A	Research based Project / Industrial Project -Phase-II	0	0	24	12
	AD10902A	Industrial Training-II	0	0	2	1						
			6	0	16				0	0	24	**12**
	Total Contact Hours (L + T + P)+OE		19+3=22				Total Contact Hours (L + T + P)		24			

B Tech in AI & DS - 121 Credit

List of Program Elective

Subject Code	Program Elective-I (4th Semester)
AD10301A	Analog Electronics and Integrated Circuits
AD10302A	Digital Signal Processing
AD10303A	Programming in Java
AD10304A	ARM controller
	Program Elective-II (5th Semester)
AD10305A	Digital Image Processing
AD10306A	Compiler Design
AD10307A	AI for Internet of Things (IoT)
AD10308A	Speech Processing
	Program Elective-III (6th Semester)
AD10309A	Cloud Computing
AD10310A	Remote Sensing & GIS
AD10311A	Augmented and Virtual Reality
AD10312A	Parallel and Distributed Algorithms
AD10313A	Social Network Analytics
AD10314A	Block Chain Technologies
AD10315A	High Performance Computing
AD10316A	Bio-Inspired Computing
	Program Elective-V (7th Semester)
AD10317A	Quantum Computing
AD10318A	Machine learning in VLSI Design
AD10319A	Cryptography and Network Security
AD10320A	Reinforcement Learning

List of Open Elective

Subject Code	Open Electives
AD10201A	**Open Elective (4th Semester):** Introduction to Python Programming
AD10202A	**Open Elective (5th Semester):** Data Analytics using Python
AD10203A	**Open Elective (6th Semester):** Introduction to Machine Learning
AD10204A	**Open Elective (7th Semester):** Biometric Technology

List of Honours Specialization

** HONOURS SPECIALIZATION:		Credits (20)
I. AI in Healthcare:		
AD10321A	Artificial Intelligence for Health and Medicine	3
AD10322A	Bioinformatics	3
AD10323A	Healthcare Informatics	3
AD10324A	Artificial Intelligence in Medical Imaging	3
AD10603A	Project Work	6
AD10701A	Seminar	2
II. Intelligent Robotics &Automation		
AD10325A	Introduction to Robotics&Programming	3
AD10326A	Human Machine Interaction	3
AD10327A	Industrial Automation and Control	3
AD10328A	Game Theory	3
AD10604A	Project Work	6
AD10702A	Seminar	2
III. Infrastructure and Big Data Management		
AD10329A	Parallel and Distributed Computer Architecture	3
AD10330A	Cloud Computing architecture and services	3
AD10331A	Big Data algorithms for large scale data processing	3
AD10332A	Digital Marketing	3
AD10605A	Project Work	6
AD10703A	Seminar	2
IV. Computer Vision and Speech Technology		
AD10333A	Introduction to Speech Disorders	3
AD10334A	Biometric Technology	3
AD10335A	Automatic Speech Recognition	3
AD10336A	Deep Learning for Computer Vision	3
AD10606A	Project Work	6
AD10704A	Seminar	2

***Industrial Trainings will be conducted during the summer vacations after IV and VI Semester and evaluated in V and VII Semester respectively**

Total Credit: 42+23+25+23+24+14+12=42+121=163

Industrial Training:

1. Students have to undergo an internship (Industrial Training I, AD10901A) of minimum 2 weeks from an industry of repute during the summer break between 4th semester and 5th semester.
2. Students have to undergo an internship (Industrial Training II, AD10902A) of minimum 4 weeks from an industry of repute during the summer break between 6th semester and 7th semester
3. Students have to submit a completion certificate and present PPT related to training imparted at the industry.
4. For industrial training/ viva-voce/ seminar it will be evaluated out of 100 at the end of the semester.

Mini Project:

Sl. No.	Subject Code	Internal Marks	External Marks	Credits
1	AD10504A	50	50	2

Research based Project/ Industrial Project -Phase-I &II:

Sl. No.	Subject Code	Internal Marks	Seminar/Viva	External Marks	Duration of Project	Credits
1	AD10601A	50	50	50	14 hours/ weeks	7
2	AD10602A	50	50	50	24 hours/weeks	12

** Project Evaluation: 1. One interim evaluation to be followed [Candidate has to present PPT/demonstration]. 2. Final Evaluation with PPT presentation/demonstration to be followed at the end of session

PROGRAM OUTCOMES (PO)

Engineering Graduates will be able to:

PO 1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO 6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO 9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO 1	The ability to understand, analyses, design and demonstrate the knowledge of human cognition, Artificial Intelligence, Machine Learning and data engineering, electronics and communication engineering in terms of real-world problems to meet the challenges of the future in multidisciplinary domain.
PSO 2	To provide a concrete foundation and enrich their abilities to qualify for Employment, Higher studies and research works in Artificial Intelligence and Data science with ethical values

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Core Courses: Semester III

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MA10103A **Credit: 3 (L-2, T-1, P-0)**

Engineering Mathematics III (Probability and Statistics)

Questions to be set: 05 (All Compulsory)

Course Objectives: The primary objective of this course is to equip the students with strong mathematical foundations on random experiments. This course will lay the foundations on probability theory which plays a crucial role for students, professionals in data science as well as in artificial intelligence. The theory of sampling is the basic building block of statistics. Inference theory has enormous applications for a data scientist, a solid foundation will be immensely beneficial for those who are interested in classifying data. Test of hypothesis is an integral area for students, professionals and researchers working in data science.

Pre-requisites: Calculus, Linear Algebra, Counting techniques, Differential equations.

Course Outcomes (CO):

Upon successful completion of the course, students will be able to:

CO1: Identify random experiments, classify them into discrete and continuous cases.

CO2: Apply counting technique to solve problems.

CO3: Use calculus and geometry to arrive at a solution.

CO4: Analyze the data based on some known characteristics

CO5: Critically analyze the real-world problems that appear randomly.

Module	Topics	Hrs	CO
Module 1: Basic Probability, Random Variables and Probability Distributions	Random Experiments, Sample Spaces, Events, The Concept of Probability, The Axioms of Probability, Conditional Probability, Independent Events, Bayes' Theorem, Random Variables: Discrete and continuous Distribution Functions. Joint Distributions, Independent Random Variables, Functions of Random Variables, Conditional Distributions	9	1

Module 2: Mathematical Expectation and Special Probability Distributions	Mathematical Expectation: Discrete and Continuous cases. Moments for Joint Distributions: Covariance, Correlation Coefficient, Conditional Expectation, Conditional Variance, Chebyshev's Inequality, Law of Large Numbers, Other Measures of Central Tendency, Percentiles, Other Measures of Dispersion, Skewness and Kurtosis The Binomial, Poisson, Geometric, Hypergeometric, and Multinomial Distributions: their properties and problems. Normal, Gamma, Exponential, Chi-squared Distributions: Bivariate Normal Distribution,	9	2
Module 3: Descriptive Statistics:	Describing Datasets: Frequency Table and Graphs, Relative Frequency Table and Graphs, Grouped Data, Histograms, Ogives, Stem and leaf plot. Summarizing Datasets: Population and Sample, Statistical Inference, Sampling Mean, Sampling Median, Sampling Mode, Sample Variance, Sample Standard deviation, Sample Percentiles and Box Plots. Normal Datasets, Paired Datasets, Scatter Plot, Sample Correlation Coefficient	6	3
Module 4: Parameter Estimation	Parameter Estimation: Point Estimate-Maximum Likelihood Estimators; Interval Estimate- Confidence Interval for Normal Mean When the variance is unknown, Confidence Interval for Variance of Normal Distribution	7	4
Module 5: Test of Hypotheses and Significances	Statistical Hypotheses, Null Hypothesis, Type I and Type II Errors , Level of Significance, Test involving Normal Distribution: One tailed and two tailed test, P-value, Tests of significance for Large Samples, Special Tests of Significance for Small Samples, Tests Concerning the Mean of Normal Population: Case of known variance and Case of unknown variance-The Chi-Square Test for Goodness of Fit.	7	5

Textbook:

1. Murray R. Spiegel, John J. Schiller, and R. Alu Srinivasan (2012). *Probability and Statistics* (4th ed.), Schaum's Outline Series, McGraw Hill.
2. Sheldon M. Ross (2014). *Introduction to Probability and Statistics for Engineers and Scientists* (5th ed.). Academic Press.

3. Johnson, R.A., Miller, I and Freund J.Miller and Freund's (2015). *Probability and Statistics for Engineers* (8th ed.). Pearson Education, Asia.
4. Papoulis, A. and Unnikrishnapillai, S. (2010). *Probability, Random Variables, and Stochastic Processes* (4th ed.). McGraw Hill Education, India
5. Milton. J. S. and Arnold. J.C. (2007*). Introduction to Probability and Statistics* (4th ed.). Tata McGraw Hill.

Reference Book

1. Kishor. S. Trivedi (2013). *Probability & Statistics with Reliability, Queuing and Computer Science Applications* (2nd ed.). Wiley.
2. Arnold O.. Allen (2014). *Probability, Statistics & Queuing Theory with Computer Science Applications.*Academic Press.

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AD10101A **Credit: 4 (L-3, T-1, P-0)**

Digital Systems and Computer Organization

Questions to be set: 05 (All Compulsory)

Course Objectives: To provide basic knowledge in digital electronics and internal architecture of a computer.

Pre-requisites: Knowledge of Number system and logic gates

Course Outcomes(CO):

Upon successful completion of the course, students should be able to

CO 1: Describe various combinational logic circuits.

CO 2: Describe varioussequential logic circuits.

CO 3: Explain the basic computer organization.

CO 4: ReframeInput-Output Organization & Central Processing Unit in computers.

CO 5: Explain Memory and parallel processing of computer system.

Module	Topics	Hrs	CO
Module 1: Basic Logic Gates and Combinational Circuits	Boolean Algebra: De-Morgan's Theorem, Simplification of Logic Circuits, Combinational Circuits: Introduction to K-map, Half and Full Adder Circuit, Parallel Adder, Multiplexer, De multiplexer, Decoder, Encoders, Comparators, 7-Segment Decoder, and current trends in digital electronics (Reversible logic)	5	1
Module 2: Sequential Circuits	Latches and Flip-Flops, State Diagram and State Tables, Analysis of Asynchronous Sequential Circuits, Analysis of Synchronous Sequential Circuits, Design of Sequential Logic Circuit, Asynchronous and Synchronous Counter and Shift Register.	5	2
Module 3: Basic Computer Organization & Arithmetic	Instruction codes, Computer instructions, Timing & control, Instruction Cycles, Memory reference instruction, Input/Output & Interrupts, Complete computer description & design of basic computer, Addition & subtraction, Multiplication Algorithms, Division algorithms.	8	3
Module 4: Input-Output	Peripheral devices, I/O interface, Data transfer schemes, Program control, Interrupt, DMA transfer, I/O processor. Hardwired & Micro programmed	9	4

Organization & Central Processing Unit	control unit. General register organization, Stack organization, Instruction format, Data transfer & manipulation, Program control, RISC, CISC		
Module 5: Memory Unit & Parallel Processing	Memory hierarchy, Processor vs. memory speed, High-speed memories, Cache memory, Associative memory, Interleave, Virtual memory, Memory management. Introduction to Parallel Processing: Pipelining, Characteristics of multiprocessors, Interconnection structures, Interprocessor arbitration, Interprocessor communication & synchronization	9	5

Text Books:

1. Douglas Comer. (2019), "Essentials of Computer Architecture", (2e ed), CRC Press

2. M. Morris Mano, (2017), "Computer System Architecture", (3rd ed), Pearson.

3. William J. Fletcher, (1997), "An Engineering approach to Digital Design", (1st ed), PHI.

Reference Books:

1. Joseph D. Dumas II,(2016), "Computer Architecture: Fundamentals and Principles of Computer Design", (2nd ed), CRC Publication.

2. C. H. Roth, (1998), "Digital System Design using VHDL", (4th ed), PWS publication.

AD10102A **Credit: 4 (L-3, T-1, P-0)**

Data Science

Questions to be set: 05 (All Compulsory)

Course Objectives: The course objective is to provide fundamentals knowledge of Data Science, Data Cleaning, and Statistical Inference. Visualization, supporting tools for implementation.

Pre-requisites: Basic statistical knowledge.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Perform data manipulation using python.

CO 2 Apply exploratory data analysis for summarizing the sample distribution.

CO 3 Analyze data using data visualization tools.

CO 4: Explain the concept of Estimation and Hypothesis.

CO 5: Apply SciKit Learn tool for machine learning tasks.

Module	**Topics**	**Hrs**	**CO**
Module 1: Introduction to Data Science and Toolboxes for Data Scientist	Introduction, Why Python? *Fundamental Python Libraries for Data Scientists*: Math: Numpy, SciPy; Data Mining: BeautifulSoup, Scrapy; Data Exploration and Visualization: Pandas, Matplotlib, Plotly, Seaborn; Machine Learning: Scikit Learn, PyCaret, TensorFlow, Keras, PyTorch , *Data Science Ecosystem Installation*, *Integrated Development Environments (IDE) for python*: Jupyter notebook, Pycharm, Spyder ,*Get Started with Python for Data Scientists:* Reading, Selecting Data, Filtering Data, Filtering Missing Values, Manipulating Data, Sorting, Grouping Data, Rearranging Data, Ranking Data, Plotting.	9	1
Module 2: Descriptive Statistics	Introduction, Data Preparation: Obtaining the data, Parsing the data, Cleaning the data, Building data structures;Exploratory Data Analysis: Summarizing the Data, Data Distributions, Outlier Treatment, Measuring Asymmetry, Continuous Distribution, Kernel Density; Estimation: Sample and Estimated	9	2

	Mean, Variance and Standard Scores, Covariance, and Pearson's and Spearman's Rank Correlation		
Module 3: Data Visualization Techniques	*Basic Charting and Fundamentals*: Matplotlib Architecture, Basic Plotting with Matplotlib, Scatterplots, Line Plots, Bar Charts, Dejunkifying a Plot , Subplots, Histograms, Box Plots, Heatmaps, Animation, Interactivity ; Plotting with Pandas and seaborn	6	3
Module 4: Statistical Inference	Introduction, Measuring the Variability in Estimates: Point Estimates, Confidence Intervals or set estimates; Hypothesis Testing	9	4
Module 5: Model Development and Evaluation	*Fundamentals of Machine Learning - Intro to SciKit Learn:* Introduction, Key Concepts in Machine Learning, Python Tools for Machine Learning, An Example Machine Learning Problem, Model Evaluation: Confusion Matrices & Basic Evaluation Metrics, Precision-recall and ROC curves	9	5

Text Books:

1. Laura Igual and Santi Seguí (2017). *Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications*, Springer
2. Jesús Rogel-Salazar ,(2014). *Data Science and Analytics with Python* (1st ed). CRC Press.
3. David Dietrich, et.al.(2015). *Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data*. John Wiley & Sons.
4. João Moreira, Andre Carvalho, Tomás Horvath (2018). *A General Introduction to Data Analytics* (3rd ed). Wiley.
5. Rao, R. Nageswara , (2018). *Core python programming* (1st ed). Dreamtech press publication.

Reference Books:

1. Grus, Joel (2019). *Data science from scratch: first principles with python* (1st ed). O'Reilly
2. Vincent Granville (2014). *Developing Analytic Talent: Becoming a Data Scientist* (1st ed). Wiley publishers.
3. Jojo Moolayil, (2016). *Smarter Decisions: The Intersection of IoT and Data Science* (3rd ed). PACKT
4. David Dietrich, Barry Heller, and Beibei Yang (2015). *Doing Data Science* (1st ed). O'Reilly.

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AD10103A **Credit: 3 (L-3, T-0, P-0)**

Data Structures

Questions to be set: 05 (All Compulsory)

Course Objectives: To provide knowledge of basic elements of data structure like Pointers, Recursion, Stacks, queue Linked lists representations and there application.

Pre-requisites: Basic knowledge in data and programming skills.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Describe basic idea of data structure and write programs for Pointer

CO 2: Sketch recursive programs and calculate their efficiency.

CO 3: Describe basic idea of Stacks & queues and write programs for Stacks & queues.

CO 4: Explain basic idea of Linked lists and write code for Linked lists

CO 5: Sketchthe Binary trees and write programs for Binary trees.

Module	Topics	Hrs	CO
Module 1: Introduction	Introduction of data structure, Pointers and Pointer Application, Accessing variables through pointers, pointers to pointers, pointer arithmetic and arrays, pointers, and functions,	7	1
Module 2: Recursion	definition, recursive programs, efficiency of recursion	7	2
Module 3: Stacks & queues	evaluation of expressions, multiple stacks and queues and their application	7	3
Module 4: Linked lists representations	Singly, doubly, header node, circular along with the applications,	7	4
Module 5:	representation, recursive/ non recursive in-order, preorder and post order tree	8	5

Trees-Binary trees	traversal, level order traversal, Binary search tree, creation, insertion deletion operations on binary search tree, Additional Binary Tree Operations, Threaded Binary Tree and applications and Introduction to the concepts of Optimal Binary Search Trees.		

Text Books:

1. Narsimha Karumanchi ,(2022) "Data Structures and Algorithms Made Easy" (3rd ed) Careermonk Publications.

2. Thomas H. Cormen , (2009) "Introduction to Algorithms", (3rd ed) The MITPress Cambridge, Massachusetts London, England,

3. Robert Sedgewick , Kevin Wayne ,(2021) "Algorithms" (4th ed), Pearson.

4. Udi Manber , (1989) "Introduction to Algorithms: A Creative Approach",(1st ed) **Pearson.**

5. Bradley N. Miller and David L. Ranum (2022), "Problem-Solving with Algorithms and Data Structures using Python", (2nd ed), Franklin, Beedle & Associates.

Reference Books:

1. Steve S. Skiena ,(2008) "The Algorithm Design Manual" (2nd ed) springer.

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AD10104A **Credit: 3 (L-3, T-0, P-0)**

Object Oriented Programming using Python

Questions to be set: 05 (All Compulsory)

Course Objectives: To provide knowledge regarding the OOPs programming like basics of Python along with the technique for handling I/O, packagingand basic GUI.

Pre-requisites: Basic programming skills

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Acquire programming skills in core Python.

CO 2: Acquire Object-oriented programming skills in Python.

CO 3: Develop the skill of designing graphical-user interfaces (GUI) in Python.

CO 4: Develop the ability to write database applications in python

CO 5: Acquire Python programming skills to move into specific branches - Internet of Things (IoT), DataScience, Machine Learning (ML), Artificial Intelligence (AI) etc.

Module	**Topics**	**Hrs**	**CO**
Module 1: Introduction to python and object oriented concepts	Introduction to Python: Features of Python, Data types, Operators, Input and output, Control Statements. Introduction to Object Oriented Concepts: Features of Object-oriented programming system (OOPS) – Classes and Objects, Encapsulation, Abstraction, Inheritance, Polymorphism.	8	1
Module 2: Python classes and objects	Classes and Objects: Creating a class, The Self variable, Constructor, Types of Variable, Namespaces, Types of Methods, Inheritance and Polymorphism – Constructors in inheritance, the super () method, types of inheritance, polymorphism, abstract classes and interfaces.	8	2

Module 3: Strings and functions	Strings: Creating strings and basic operations on strings, string-testing methods. Functions: Defining a function, Calling a function, returning multiple values from a function, functions are first class objects, formal and actual arguments, positional arguments, recursive functions.	4	3
Module 4: Exception handling	Exception: Errors in a Python program, exceptions, exception handling, types of exceptions, the except block, the assert statement, user-defined exceptions.	7	4
Module 5: Graphical user interface	GUI in Python: The root window, fonts and colors, working with containers, Canvas, Frames, Widgets – Button widget, Label widget, message widget, text widget, radio button widget, entry widget.	8	5

Text Books:

1. R Nageswara Rao (2017). *Core Python Programming* (2nd edition), Dreamtech press.
2. Dusty Philips (2015), "Python Object Oriented Programming", (2nd ed) PACKT Publishing.

Reference Books:

1. Mark Lutz (2013) "Programming Python", (5th ed) O'Reilly
2. Michael Goldwasser, David Letscher, (2007) "Object Oriented Programming in Python", (1st ed) Prentice Hall.

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AD10105A **Credit: 3 (L-3, T-0, P-0)**

OPERATING SYSTEMS

Questions to be set: 05 (All Compulsory)

Course Objectives: To provide knowledge regarding the operating system architecture, services, scheduling and related algorithms.

Pre-requisites: Basic computer architecture.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain basic idea of System Structure and Services.

CO 2: Describe the Process Management of an operating system.

CO 3: ConcludeProcess Management of an operating system.

CO 4: Explain basic idea of I/O management & Disk scheduling in an operating system.

CO 5: Correlate Inter Process Communication,Multi-Processor Virtualization Concepts.

Module	Topics	Hrs	CO
Module 1: Introduction	Introduction to operating system, Operating System Structure,Operations, Goals .Interaction of O. S.& hardware architecture, System calls, Batch, multiprogramming. Multitasking, time sharing, parallel, distributed operating system.Basics of Network Operating System, System and Real Time Operating System.	9	1
Module 2: Process Management	Process Concept, Process states, Process control, Threads, Uni-processor Scheduling: Types of scheduling: Preemptive, Non preemptive, Scheduling algorithms: FCFS, SJF, RR, Priority, Thread Scheduling, Real Time Scheduling. System calls like ps, fork, join, exec family, wait., Overview, Linux scheduling	6	2
Module 3: Memory Management	Memory Management requirements, Memory partitioning: Fixed and Variable Partitioning, Memory Allocation: Allocation Strategies (First Fit, Best Fit, and Worst Fit), Fragmentation, Swapping, and Paging. Segmentation, Demand paging Virtual Memory: Concepts, management of VM, Page Replacement Policies (FIFO, LRU, Optimal, Other Strategies), Thrashing.	7	3

Module 4: I/O management & Disk scheduling:	I/O Devices, Organization of I/O functions, Operating System Design issues, I/O Buffering, Disk Scheduling (FCFS, SCAN, C-SCAN, SSTF), RAID, Disk Cache. Thrashing, Disk Scheduling, Swap-Space Management, System Model, Deadlock: Deadlock prevention, Avoidance, Detection, Recovery, File Concept, Protection.	7	4
Module 5: Inter Process Communication,Multi-Processor Virtualization Concepts	Basic Concepts of Concurrency, Cooperating process, Advantage of Cooperating process, Bounded-Buffer Shared-Memory Solution, Inter-process Communication (IPC), Basic Concepts of Inter-process Communication and Synchronization,Virtual machines; supporting multiple operating systems simultaneously on a single hardware platform; running one 815operating system on top of another. Reducing the software engineering effort of developing operating systems for new hardware architectures. True or pure virtualization Para virtualization; optimizing performance of virtualization system; hypervisor call interface.	7	5

Text Books:

1. Avi Silberschatz, Peter Baer Galvin, Greg Gagne (2018)"Operating System Concepts"(10th ed) John Wiley & Sons
2. Charles Crowley, (1996), "Operating Systems: A Design-Oriented Approach" (1st ed) McGraw-Hill Science.
3. Andrew S. Tanenbaum, (2015), "Modern Operating Systems" (4th ed), Pearson.

Reference Books:

1. William Stallings (2018), "Operating systems internals and design principles" (9th ed) Pearson.

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AD10401A **Credit: 1(L-0,T-0,P-2)**

Data Structures & OOPs using Python Lab

Minimum Experiment to be done: 12

Course Objectives: Provide knowledge of python code used in data structure and object-oriented programming.

Pre-requisites: Basic knowledge of data structure and python.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Write the program for Array and Linked list, Stack and tree ADT using Python

CO 2: Sketch the program for Heaps, graph, search, and shorting using Python.

CO 3: Write the program for Dynamic array and class using Python.

CO 4: Reframe Generic class and Exception Handling using Python.

CO 5: Write the program Sketch Multithreading and GUI using Python.

List of Experiments:

Module	Name of Experiments	Hours	CO
Module: 1	Experiment 1: Basics of Python language	3	1
	Experiment 2: Implementation of Array and Linked list, Stack ADT using Python	3	1
	Experiment 3: Implementation and operation of Binary trees using Python.	3	1
	Experiment 4: Implementation of Binary Search Trees & AVL Trees using Python.	3	1
Module:2	Experiment 5: Implementation of Heaps using Priority Queues using Python.	3	2
	Experiment 6: Graph representation and Traversal algorithms using Python.	3	2
	Experiment 7: Implementation of searching and sorting algorithms using Python.	3	2
Module:3	Experiment 8: Write programs Based Upon 1-D, 2-D and Dynamic Arrays using Python.	3	3
	Experiment 9: Write python codes for Abstract Class, Inner and Outer Class using Python.	3	3
	Experiment 10: Write python codes for Generic Classes using Array Lists and Linked	3	4

	Lists.		
Module:4	Experiment 11: Write python code for Exception Handling.	3	4
	Experiment 12: Write python code for Multithreading, Synchronization, and Event Handling.	3	5
Module:5	Experiment 13:Write python code of GUI Programming for Action Listener & Swing Package.	3	5
	Experiment 14: Build a TensorFlow model to recognize handwritten digits using the MNIST data set.	3	5
	Experiments 15: Design and develop a model with TensorFlow Lite for Microcontrollers.	3	5
	Experiment 16: Design and develop model for Binary Classification for Movie Reviews by using Keras.	3	5

Text Books:

1. Reema Thareja, (2017), "Python Programming" (3rd ed) Oxford university press.

Reference Books:

1. Steven S. Skiena ,(2008), "The Algorithm Design Manual" (2nd ed) Springer.

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AD10402A **Credit: 1(L-0,T-0,P-2)**

Data Science Lab

Minimum Experiment to be done: 12

Course Objectives: To provide hands-on exposure to python programming for Data Science

Pre-requisites: Basics knowledge of statics and programming.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Execute basic python programming for Array, Data frame, Matrix, vector, list and factors.

CO 2: Use statistical methods to analyze the data with python.

CO 3: Evaluate distribution and correlation of using python.

CO 4: Develop models for the regression and decision trees and evaluate them by using python.

CO 5: Write the program for different classifiers & Clustering algorithms and evaluate its performance using python.

List of Experiments:

Module	Name of Experiments	Hours	CO
Module: 1	Experiment 1: Installation of Python software and basics of python programming.	3	1
	Experiment 2: Write a python program to take input from the user (name and age) and display the values.	3	1
	Experiment 3: Write a python program for Array, Data frame, Matrix, vector, list and factors.	3	1
	Experiment 4: Write a python program for making different charts and graphs.	3	1
Module:2	Experiment 5: Write a python program for computing statistical parameters such as Mean, Median, Mode, etc.	3	2
	Experiment 6: a) Write a python script to find basic descriptive statistics using summary, str, quartile function on mtcars & cars datasets. b) Write a python program to find a subset of a dataset by using subset (), aggregate () functions on the iris dataset.	3	2
	Experiment 7: Reading several types of data sets (.txt, .csv) from the web and disk and writing in a file in a specific disk location. Reading Excel datasheet, XML dataset in Python.	3	2

Model: 3	Experiment 8: Write a python program to find the data distributions using a box and scatter plot. Find the outliers using a plot, plot the histogram, bar chart, and pie chart on sample data.	3	3
	Experiment 9: Write a python program for evaluating and visualizing correlation among categorical variables for the iris dataset. Perform Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data.	3	2
Model:4	Experiment 10: Write a python programme for linear and multiple regression for a specific data set.	3	4
	Experiment 11: Write a python programme for a decision tree and random forest for a specific data set.	3	4
Model:5	Experiment 12: Install the relevant package for classification and write the program for different classifiers and list the performances for a specific dataset.	3	5
	Experiment 13: Write a python programming for clustering algorithms and visualize the result through a plot.	3	5

Textbooks:

1. João Moreira, Andre Carvalho, Tomás Horvath, (2019). *A General Introduction to Data Analytics (*1st ed), John Wiley & Sons Inc
2. Reema Thareja (2017). *Python Programming* (3rd ed). Oxford University Press.
3. Jesús Rogel-Salazar (2014).*Data Science and Analytics with Python* (1st ed). CRC Press.
4. David Dietrich, et.al.(2015). *Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data,* John Wiley & Sons.
5. João Moreira, Andre Carvalho, Tomás Horvath, (2018). *A General Introduction to Data Analytics* (3rd ed), Wiley.
6. Rao, R. Nageswara, (2018). *Core python programming (*1st ed). Dream tech Press publication.

Reference Books:

1. Grus, Joel (2019). *Data science from scratch: first principles with python* (1st ed), O'Reilly
2. Vincent Granville (2014). *Developing Analytic Talent: Becoming a Data Scientist*(1st ed). Wiley publishers.
3. Jojo Moolayil, (2016). *Smarter Decisions: The Intersection of IoT and Data Science* (3rd ed). PACKT,
4. David Dietrich, Barry Heller, Beibei Yang, (2015). *Doing Data Science* (1st ed). O'Reilly,

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Core Courses: Semester – IV

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MA10104A **Credit: 3 (L-2, T-1, P-0)**

Engineering Mathematics IV (Discrete Mathematics)

Questions to be set: 05 (All Compulsory)

Course Objectives: The objective of this course is to familiarize the students on numerous counting techniques and abstract structures which appear frequently in many areas such as Algorithm analysis, data structures, database management system. Discrete mathematics plays a crucial role in enabling students of computer science, data scientists to tackle these problems. Graph theory has tremendous application in Computer Networks, Switching which are integral part of a Data Scientist. Group theory has enormous applications coding theory and related areas which will be very handy for students, professionals and researchers working in this area.

Pre-requisites: Set theory, Permutations and Combinations, Relations, Functions.

Course Outcomes (CO):

Upon successful completion of the course, students will be able to:

CO1: Solve problems using Counting Principles, Relations, Functions, Recursion and Generating Functions.

CO2: Apply concepts of Group theory to model real-world problems.

CO3: Analyze the use of graphs in engineering applications.

CO4: Solve problems using Permutation and Combination, Ordering.

CO5: Evaluate problems related to mathematical logic. Extend the concepts of Predicate Calculus in Data Sciences.

Module	Topics	Hrs	CO
Module 1: Set theory	Set theory: Principle of inclusion and exclusion, Partitions and Compositions, Relations, and functions, Pigeonhole Principle,	8	1
Module 2: Group Theory	Group Theory: Groups, subgroups, permutation group with simple examples. Cosets, normal subgroup, Burnside's theorem (statement only) and its simple	8	2

	applications, codes and group codes.		
Module 3: Graphs	Graphs, Digraphs, Walk, Path, Cycles, Connectedness, Tree, Computer representation of relation, relation digraph, and graphs, transitive closer and Warshall's Algorithm.	8	3
Module 4: Elementary configurations	Recurrence Relations, Generating functions. Permutations and Combinations, Lexicographical and Fike's orderings of permutations. Algorithms for Lexicographical, Reverse Lexicographical and Fike's ordering of permutation.	8	1,4
Module 5: Predicate calculus	Predicate calculus: Connectives, Well-formed formula (WFF), Quantification, examples and properties of WFF into Causal form. Resolution and refutation, answer extraction and simple examples. Techniques of Proofs.	8	5

Text books:

1. Jean-Paul Tremblay and Manohar, R (2017). *Discrete Mathematical Structures with application to Computer Science*, McGraw Hill.
2. C.L. Liu and D. Mahapatra (2017). *Elements of Discrete Mathematics: A Computer Oriented Approach* (4th ed.). McGraw Hill.
3. Narasingh Deo (2017). *Graph theory with applications to Computer Science*. Dover Publications

References:

1. B. Kolman, R.C. Busby & S. Ross (2015). *Discrete Mathematical Structures* (6^{th} ed.). Pearson
2. N. J. Nielson (1993). *Principles of Artificial Intelligence*; Morgan Kaufmann Publishers

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AD10106A **Credit: 4 (L-3, T-1, P-0)**

Design & Analysis of Algorithms

Questions to be set: 05 (All Compulsory)

Course Objectives: To provide knowledge regarding the different algorithms and their analysis. Also the mathematical approach of such algorithms along with problem solving will also be discussed.

Pre-requisites: Basic idea of algorithm and its structure.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain the basics of algorithm and numerically analyze the performance of Non-recursive and Recursive Algorithms.

CO 2: Define different Searching and Sorting methods used in different algorithms.

CO 3: Co-relate several types of tradeoffs.

CO 4: Write different Dynamic Programming.

CO 5: Explain the Backtracking process used in design and analysis of algorithm.

Module	**Topics**	**Hrs**	**CO**
Module 1: Introduction	Fundamentals of Algorithms, Important Problem Types, Analysis of algorithm efficiency. Analysis Framework: Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non recursive and Recursive Algorithms. Brute force Techniques, Divide and Conquer, Decrease and Conquer	9	1
Module 2: Searching and Sorting	Depth First Search, Breadth First Search, Topological Sorting, Insertion Sort	9	2
Module 3: Transform and Conquer	Presorting, BST, Heapsort. Space and Time tradeoffs: Input Enhancement in String Matching	9	3
Module 4: Dynamic Programming	Warshall's and Floyd's Algorithms, The Knapsack Problem. Greedy Techniques: Prim's, Kruskal's and Dijkstra's Algorithm, Huffman Trees. Coping with limitations of algorithmic power, P, NP, and NP-complete Problems	9	4

Module 5: Backtracking	n–Queens problem, Hamiltonian Circuit Problem, Subset–Sum Problem. Branch and Bound: Assignment Problem, Knapsack Problem, TSP	9	5

Text Books:

1. Anany Levitin,(2011) " Introduction to the Design and Analysis of Algorithms", (3rd ed), Pearson Education
2. Ellis Horowitz and Sartaj Sahni,(2007), "Computer Algorithms/C++", (2nd ed), University Press.

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, (2006), "Introduction to Algorithms", (2nd ed), PHI

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AD10107A **Credit: 3 (L-3, T-0, P-0)**

Database Management Systems

Questions to be set: 05 (All Compulsory)

Course Objectives: Students will be able to learn about maintaining and handling various Data and applying them with different methods and strategies.

Pre-requisites: Basic idea about Data Structure.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain the basics of database management system.

CO 2: Define SQL and specified database.

CO 3: Explain and design NoSQL Databases.

CO 4: Describe and design Relational Database.

CO 5: Co-relate the Query Optimization, Transactions, and design Recovery System.

Module	**Topics**	**Hrs**	**CO**
Module 1: Introduction	Database System Applications, View of data, Database languages, Database users and Administrator. Introduction to Relational Model: database schema, keys, schema diagrams, Relational Query Languages, Relational Operations	5	1
Module 2: SQL and database design	SQL: Data Definition, Basic structure of SQL queries, Basic operations, Set operations, Null values, Aggregate Functions, Nested subqueries, Modification of the database. Intermediate SQL: Join expressions, Views, Transactions, Integrity Constraints, SQL Data types and schemas, Authorization, Advanced SQL-PL/SQL, Cursors, Functions, Procedures, Triggers, recursive queries, advanced aggregation features. Database Design and Entity-Relationship Model**:** Design Process, ER Model, Reduction to Relational schema	8	2

Module 3: NoSQL Databases	Introduction, Overview, and History of NoSQL Databases: The Definition of the Four Types of NoSQL Databases Column-oriented NoSQL: Column-oriented NoSQL databases using Apache HBASE and NoSQL Key/Value databases using MongoDB	7	3
Module 4: Relational Database Design	Functional dependencies, Normal forms, Closure, Canonical cover, Lossless joins, dependency preserving decomposition, Storage and File structure, Indexing & Hashing. Query Processing, Overview, Measure of query cost, selection, Join operation, sorting, Evaluation of expressions.	8	4
Module 5: Query Optimization, Transactions, and Recovery System	Query Optimization: Overview, Estimating statistics of expression results, Materialized Views. Transactions: Concepts, Simple transaction model, Transaction atomicity and durability, based protocols, Deadlock Handling, Multiple granularity, Timestamp-based Protocols, Validation-based Protocols. **1.** Recovery System: Failure classification, Storage, Recovery algorithm, Buffer Management	8	5

Text Books:

1. Abraham Silberschatz, Henry Korth, S. Sudarshan (2010). *Database System Concepts* (6th ed.). McGraw Hill.
2. Ramez Elmasri and Shamkant Navathe (2010). *Fundamentals of Database System* (6th ed.). Addison Wesley Publications Co.
3. R. Ramakrishnan and J. Gehrke (2014). *Database Management System* (3rd ed). McGraw Hill Publisher.

Reference Books:-

1. Ivan Bayross, (2010). *SQL, PL/SQL-The Programming Language of Oracle* (4th ed). BPB Publications.
2. Shashank Tiwari, (2011). *Professional NoSQL*. Wiley.

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AD10108A **Credit: 3 (L-3, T-0, P-0)**

Artificial Intelligence

Questions to be set: 05 (All Compulsory)

Course Objectives: To provide knowledge regarding the basic principles of Artificial Intelligence, learn and design intelligent agents. This course also focus on the basic areas of Artificial Intelligence including problem solving, knowledge representation, reasoning, decision making, planning, perception and action.

Pre-requisites: Basic knowledge in sensors, actuator and systems.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain the basics of artificial intelligence.

CO 2: Describe different models for Agent & environment used in AI.

CO 3: Co-relate among the Knowledge and key words for Reasoning used in AI based model.

CO 4: Reframe Expert system implement in AI.

CO 5: Explain the Applications, Modern Trends, and future of Artificial intelligence

Module	**Topics**	**Hrs**	**CO**
Module 1: Introduction to artificial intelligence	Introduction, the History of AI, Objectives, Components, Contributes, different Programming Languages. task domain of AI. It also describes Applications and Research Area of AI	4	1
Module 2: Agent & environment	Introduction,what are Agent and Environment? , Agent Terminology, The Structure of Intelligent Agents -, Different Types of Agents,Simple Reflex Agents, Model Based Reflex Agents,Utility Based Agents, Learning agent, PAGE Descriptor of Intelligent agent, PEAS Descriptor of Intelligent agent,The Nature of Environments, Properties of Environment, Intelligent Agent applications, Game Theory.	9	2
Module 3: Knowledge ,Reasoning, representation	Introduction of knowledge, Different types of knowledge, knowledge representation , The knowledge cycle, Basic Knowledge base system,definition of reasoning, Different types of reasoning , The Wumpus World, What is Proportional logic , Syntax, Semantics , Advantages of Proportional Logic , Limitations of Proportional logic	9	3

	,Applications , What is Predicate Logic? , How predicate logic used in AI, Advantages of Predicate Logic, Limitations of Predicate Logic, Applications of Predicate Logic , Difference between Proportional logic and Predicate Logic		
Module 4: Expert system	Introduction of Expert Systems, Characteristics of Expert Systems, Capabilities of Expert Systems , Components of Expert Systems , Knowledge Base , Inference Engine , User Interface, Requirements of Efficient ES User Interface, Expert System Technology , Development of Expert Systems: General Steps, Benefits of Expert Systems , Expert Systems Limitations ,Applications of Expert System	9	4
Module 5: Applications, Modern Trends and future of Artificial intelligence	Introduction, Applications of Artificial intelligence, Latest trends of Artificial intelligence, Ethics and risk for developing Artificial Intelligence, Future Trends of Artificial Intelligence	5	5

Textbooks:

1. Nilakshi Jain(2019), "Artificial Intelligence, making a system intelligent", (1st ed), Wiley.
2. Russell S., and Norvig P(2010), Artificial Intelligence: A Modern Approach (3rd ed), Pearson.
3. Marvin Minsky(1998), "Society of Mind"(1st ed). Simon & Schuster.

Reference Books:

4. Rich E., Knight K., Nair S.B.(2008), Artificial Intelligence (3e), Tata McGraw Hill, 2008.
5. Grigoris Antoniou, Paul Groth, Frank van Harmelen and Rinke Hoekstra, (2012) "A Semantic Web Primer", MIT Press.

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Sub Code: GN10101A **[2-1-0-3]**

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY and ETHICAL HUMAN CONDUCT

Course Objectives:

This introductory course input is intended:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all humanbeings.
2. To facilitate the development of a Holistic perspective among students towards life and professionaswellastowardshappinessandprosperitybasedonacorrectunderstandingof the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a naturalway.
3. TohighlightplausibleimplicationsofsuchaHolisticunderstandingintermsofethicalhuman conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction withNature.

Thus, this course is intended to provide a much needed orientational input in value education to the young enquiring minds.

Pre-requisites: None. However, it is desired that students may have gone through UHV-I: Universal Human Values-Introduction

Course Outcome (CO):

1. Students are expected to understand self-exploration and Basic Human Aspirations.
2. To understand harmony in themselves (Human being).
3. To become more aware of their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
4. They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hopedthattheywouldbeabletoapplywhattheyhavelearnttotheirownselfindifferentday-to-day settings in real life, at least a beginning would be made in thisdirection.

Therefore, the course and further follow up is expected to positively impact common graduate attributes like:

1) Holistic vision oflife
2) Socially responsiblebehaviour

3) Environmentally responsiblework
4) Ethical humanconduct
5) Having Competence and Capabilities for Maintaining Health andHygiene
6) Appreciation and aspiration for excellence (merit) and gratitude forall

Module 1 –Introduction to Value Education (9 Hrs)

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
Lecture 2: Understanding Value Education

Tutorial 1: PracticeSession *PS1 Sharing aboutOneself*

Lecture 3: Self-exploration as the Process for Value Education
Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations
Tutorial 2: Practice SessionPS*2 Exploring HumanConsciousness*

Lecture 5: Happiness and Prosperity – CurrentScenario

Lecture 6: Method to Fulfil the Basic HumanAspirations
Tutorial 3: PracticeSessionPS*3 Exploring Natural Acceptance*

Module 2 – Harmony in the Human Being (9 Hrs)

Lecture 7: Understanding Human being as the Co-existence of the Self and the Body
Lecture 8: Distinguishing between the Needs of the Self and the Body
Tutorial 4: Practice Session PS*4 Exploring the difference of Needs of Self and Body*
Lecture 9: The Body as an Instrument of the Self
Lecture 10: Understanding Harmony in the Self
Tutorial 5: Practice Session PS*5 Exploring Sources of Imagination in the Self*
Lecture 11: Harmony of the Self with the Body
Lecture 12: Programme to ensure self-regulation and Health

Tutorial 6: Practice Session PS*6 Exploring Harmony of Self with the Body*

Module 3 – Harmony in the Family and Society (9 Hrs)

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction
Lecture 14: 'Trust' – the Foundational Value in Relationship
Tutorial 7: Practice Session PS*7 Exploring the Feeling of Trust*
Lecture 15: 'Respect' – as the Right Evaluation
Tutorial 8: Practice Session PS*8 Exploring the Feeling of Respect*
Lecture 16: Other Feelings, Justice in Human-to-Human Relationship
Lecture 17: Understanding Harmony in the Society
Lecture 18: Vision for the Universal Human Order
Tutorial 9: Practice Session PS*9 Exploring Systems to fulfil Human Goal*

Module 4 – Harmony in the Nature/Existence (6 Hrs)

Lecture 19: Understanding Harmony in the Nature
Lecture 20: Interconnectedness, self-regulation, and Mutual Fulfilment among the Four Orders of Nature
Tutorial 10: Practice Session PS*10 Exploring the Four Orders of Nature*
Lecture 21: Realizing Existence as Co-existence at All Levels
Lecture 22: The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session PS*11 Exploring Co-existence in Existence*

Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics (9 Hrs)

Lecture 23: Natural Acceptance of Human Values
Lecture 24: Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS*12 Exploring Ethical Human Conduct*
Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS*13 Exploring Humanistic Models in Education*

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies

Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS*14 Exploring Steps of Transition towards Universal Human Order*

Content for Practice Sessions (Tutorials)

Inordertoconnectthecontentoftheproposalswithpractice(living),14practicesessionshavebeen designed. The full set of practice sessions is available in the Teacher's Manual as well as the website.

Practice Sessions for Module 1 – Introduction to Value Education

PS1 Sharing aboutOneself

PS2 Exploring Human Consciousness

PS3 Exploring NaturalAcceptance

Practice Sessions for Module 2 – Harmony in the Human Being

PS4 Exploring the difference of Needs of Self and Body

PS5 Exploring Sources of Imagination in theSelf

PS6 Exploring Harmony of Self with theBody

Practice Sessions for Module 3 – Harmony in the Family and Society

PS7 Exploring the Feeling of Trust PS8 Exploring the Feeling ofRespect

PS9 Exploring Systems to fulfil HumanGoal

Practice Sessions for Module 4 – Harmony in the Nature (Existence)

PS10 Exploring the Four Orders of Nature

PS11 Exploring Co-existence in Existence

Practice Sessions for Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics

PS12 Exploring Ethical Human Conduct

PS13 Exploring Humanistic Models in Education

PS14 Exploring Steps of Transition towards Universal Human Order

Text Book

A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1

The Teacher'sManual

Teachers' Manual for *A Foundation Course in Human Values and Professional Ethics*, RRGaur,RAsthana,GPBagaria,2ndRevisedEdition,ExcelBooks,NewDelhi,2019. ISBN978-93-87034-53-2

Reference Books

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak,1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi,2004.
3. The Story of Stuff(Book).
4. The Story of My Experiments with Truth - by Mohandas KaramchandGandhi
5. Small is Beautiful - E. FSchumacher.
6. Slow is Beautiful - CecileAndrews
7. Economy of Permanence - J CKumarappa
8. Bharat Mein Angreji Raj – PanditSunderlal
9. Rediscovering India - byDharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K.Gandhi
11. India Wins Freedom - Maulana Abdul KalamAzad
12. Vivekananda - Romain Rolland(English)
13. Gandhi - Romain Rolland(English)

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AD10403A **Credit: 1(L-0,T-0,P-2)**

Artificial Intelligence Lab

Minimum Experiment to be done: 12

Course Objectives: The objective of this course is to introduce hands-on exposure to AI-related concepts and their applications. AI provides the system with the ability to automatically learn and improve from experience.

Pre-requisites: Basic knowledge of programming skills and basic design of sensors, actuators & system.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: To Understand the concept of Artificial intelligence.

CO 2: To apply various search algorithms of artificial intelligence.

CO 3: To apply knowledge representation and reasoning techniques.

CO 4: To understand & apply several types of AI based models.

CO 5: To understand the design principles of different expert systems.

List of Experiments:

Module	Name of Experiments	Hours	CO
Module:1	**Experiment 0:** Installation of gnu-prolog, Study of Prolog (gnu-prolog), its facts, and rules.	3	1
	Experiment 1: Write simple facts for the statements and query it.	3	1
	Experiment 2: Write a program in prolog to implement simple arithmetic	3	1
Module:2	**Experiment 3:** Write prolog program for Family-tree.	3	2
	Experiment 4: Write prolog codes for predicates, one converts centigrade temperatures to Fahrenheit, the other checks if a temperature is below freezing.	3	2
	Experiment 5: Write prolog programs for computation of recursive functions like factorial Fibonacci numbers, etc.	3	2
Module:3	**Experiment 6:** Write prolog program to implement a Tic-Tac-Toe game.	3	3
	Experiment 7: Write prolog program to solve 5-queens problem.	3	3
	Experiment 8: Write prolog program in prolog to solve 8 Puzzle problems	3	3
	Experiment 9: Write prolog Program for water jug problem.	3	3

Module:4	**Experiment 10:** Write prolog program for travelling Salesman program.	3	4
	Experiment 11: Write prolog Program for Monkey-banana Problem.	3	4
	Experiment 12: Write a python program to implement simple Chatbot.	3	4
Module:5	**Experiment 13:** Case study of standard AI programs like Mycin and AI Shell	3	5
	Experiment 14: Write a program in turbo prolog for medical diagnosis.	3	5
	Experiment 15: Write a python program to POS (Parts of Speech) tagging for the given sentence using NLTK.	3	5
	Experiment 16: Write a python program for Text Classification for the given sentence using NLTK.	3	5
	Experiment 17: Experiment on Face Mask Detection System Using AI and Nvidia Jetson Board.	3	5
	Experiment 18: Deploying different AI-based expert systems using NVIDIA Jetson	3	5
	Experiment 19: Experiment on OpenVINO™ for solving a variety of AI tasks like image recognition.	3	5
	Experiment 20: Experiment on OpenVINO™ for solving a variety of AI tasks like NLP.	3	5

Textbooks:

1. Russell S., and Norvig P.(2010), "Artificial Intelligence A Modern Approach" (3rd ed), Pearson.
2. A D McGettric , J van Leeuwe ,(2008) "Prolog programming for artificial intelligence" (3rd ed) Addison-wesley publishing house.

Reference Books:

1. Rich E., Knight K., Nair S.B.(2008), "Artificial Intelligence" (3rd ed), Tata McGraw Hill.

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AD10404A **Credit: 1(L-0,T-0,P-2)**

Database Management Systems Lab

Minimum Experiment to be done: 12

Course Objectives: To provide knowledge regarding the maintaining and handling various Data and the process for applying the different methods and strategies on the data.

Pre-requisites: Basic idea about Data Structure.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Develop E-R diagram and convert entities and relationships.

CO 2: Write relational algebra queries and analyzing database.

CO 3: Co-relate among Altering, creating and performing a Table

CO 4: Describe a PL/SQL procedure.

CO 5: Write program on NoSQL. MongoDB, MsAccess.

List of Experiments:

Module	Name of Experiments	Hours	CO
Module:1	**Experiment 1:**Draw E-R diagram and convert entities and relationships to relation table for a given scenario. a. Two assignments shall be carried out i.e. consider two different scenarios (eg. bank, college)	3	1
Module:2	**Experiment 2:**Write relational algebra queries for a given set of relations	3	2
	Experiment 3: Perform the following: a. Viewing all databases, creating a Database, viewing all Tables in a Database, Creating Tables (With and Without Constraints), Inserting/Updating/Deleting Records in a Table, Saving (Commit) and Undoing (rollback)	3	2
Module:3	**Experiment 4:**Perform the following: a. Altering a Table, Dropping/Truncating/Renaming Tables, backing up / Restoring a Database.	3	3
	Experiment 5: For a given set of relation schemes, create tables and perform the following Simple Queries, Simple Queries with Aggregate functions, Queries with Aggregate functions (group by and having clause), Queries involving- Date Functions, String	3	3

	Functions, Math Functions Join Queries- Inner Join, Outer Join Subqueries- With IN clause, With EXISTS clause.		
	Experiment 6 For a given set of relation tables perform the following a. Creating Views (with and without check option), Dropping views, Selecting from a view.	3	3
Module:4	**Experiment 7:**Write a Pl/SQL program using FOR loop to insert ten rows into a database table.	3	4
	Experiment 8: Given the table EMPLOYEE (Emp No, Name, Salary, Designation, Dept ID) write a cursor to select the five highest paid employees from the table.	3	4
	Experiment 9: Illustrate how you can embed PL/SQL in a high-level host language such as C/Java And demonstrates how a banking debit transaction might be done.	3	4
	Experiment 10: Given an integer i, write a PL/SQL procedure to insert the tuple (i, 'xxx') into a given relation.	3	4
Module:5	**Experiment 11:**Experiments on NoSQL.	3	5
	Experiment 12: Experiments on MongoDB, MsAccess	3	5

Text Books:

1. Abraham Silberschatz, Henry Korth, S. Sudarshan,(2010) " Database System Concepts", (6th Ed), McGraw Hill,
2. Ramez Elmasri, Shamkant Navathe, (2010), "Fundamentals of Database System", (6th Ed), Addison Wesley Publications Co.

Reference Books:-

3. Ivan Bayross, (2010), "SQL, PL/SQL-The Programming Language of Oracle", (4th Ed), BPB Publications.

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Core Courses: Semester – V

Sub Code: GN10103A **Credit: 1 (L-1, T-0, P-0)**

PROFESSIONAL COMMUNICATION AND TECHNICAL WRITING

Questions to be set:5 (All compulsory and choice may be given in question no. 5 from same Course Outcome)".

Course Objectives: The objective of this course is to provide the students a general understanding of designing effective technical document which helps in problem solving and decision making reports with an importance of Ethics in research.

Pre-requisites: Nil

CourseOutcomes: On successfulcompletion ofthis course,studentswill beable to:

1. Develop skills required for effective communication of scientific knowledge in terms of oral presentation
2. Enhance skills required for effective communication of scientific knowledge in terms of technical writing
3. Analyze the importance of peer review and criticisms on Technical papers and proposals
4. Understand the importance of Ethics in research

** not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: < Introduction >	in class	Discussion of research ideas and where they come from	4	1,4	10, 12	1
	****Assignment Topics**					
Module 2: < Hypothesis reasoning>	in class	Highlights on hypothesis reasoning and testing Discussion on Hypothesis testing and experiments	6	2	8,10, 12	1
	****Assignment Topics**					
Module 3: < Advanced Skills and Discussion on Scientific writing >	in class	Discussion on Scientific writing – how to get started Define the purpose of a proposal Gather, record, and interpret data	2	3	8, 10, 11, 12	1
	****Assignment Topics**					
Module 4: <Highlights on Publishing and peer review process and Schematic diagrams >	in class	Highlights on Publishing and peer review process: The good, the bad, the ugly. Rationale on the usage of Schematic diagrams, figures, tables and flow charts	4	4	8,10, 12	1
	****Assignment Topics**					
Module 5: < Different forms of writing >	in class	Discussion on different forms of writing viz. scientific report, proposal, and reviews Enhancing oral presentation skill sets	4	1,3	8, 10, 12	1
	****Assignment Topics**					

Text Book

1. George E. Kennedy, Tracy T. Montgomery, Technical and Professional Writing, Pearson, 2002.

References

1. Charles T. Brusaw, Gerald J. Alred, Walter E. Oliu, Handbook of Technical Writing, 9780312057336, 4th Edition 2018.

References Links

1. https://www.springer.com/gp/authors-editors/authorandreviewertutorials
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3178846/
3. http://libguides.usc.edu/writingguide/methodology
4. http://libguides.usc.edu/writingguide/results
5. http://mrcophth.com/publishorperish/methods.html
6. https://www.editage.com/insights/tips-on-effective-use-of-tables-and-figures-in-research-papers
7. https://www.elsevier.com/connect/how-to-give-a-dynamic-scientific-presentation
8. https://publishingcampus.elsevier.com/websites/elsevier_ publishingcampus/files/Guides/Brochure_Ethics_2_web.pdf

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AD10109A **Credit: 3 (L-3, T-0, P-0)**

Formal Language & Automata Theory

Questions to be set: 05 (All Compulsory)

Course Objectives: The central objective of the course is to provide learners with a detailed understanding of the mathematical models of the machines and their evolution through requirement generation and advancement in languages.

Pre-requisites: Computer Programming concepts and Discrete Structures for Computer Science.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Define a system and recognize the behavior of a system and compare different systems performances.

CO 2: Reframe Finite Automata to regular expression.

CO 3: Describe context free grammar and to check equivalence of regular linear grammar and FA or CFL and PDA.

CO 4: Design Turing Machine and calculate the effect of Undesirability.

CO 5: Explain the recursively enumerable languages, and its Language learning process.

Module	**Topics**	**Hrs**	**CO**
Module 1: Introduction And Finite automata	Mathematical preliminaries: Sets, Logic, Functions, Relations, Languages Definitions: Language, Grammar, Automata, Relation between language, Grammar and automata, Importance of automata theory. Informal introduction: Drawing examples from everyday life to bring out the essence of finite automata, Finiteness and its importance in automata theory. Deterministic finite automata: Definition, Processing strings, Transition functions, Language of a DFA, Nondeterministic finite automata: Non-determinism, Definition, Extended transition functions, Language of a NFA, Equivalence of DFA and NFA, Kleene's theorem, Epsilon transitions, Applications of Finite automata in text search.	9	1
Module 2: Regular expressions , languages and	Memory required to recognize a language, Regular expressions, Regular expression to finite automata, Finite automata to regular expression, Algebraic laws for regular expressions, Applications of regular expressions, Criterion for regularity, Regular languages.	6	2

Properties	Pigeonhole principle, Pumping lemma for regular languages, Closure properties, Testing membership of regular languages, Equivalence of automata.		
Module 3: Context Free Grammars , Languages and Pushdown automata	Definition, Leftmost and rightmost grammars, Parse trees, Ambiguity: Ambiguous grammar, Removing ambiguity. Normal forms, Applications of context free grammars: Parsers Definition of pushdown automata, Representing pushdown automata, Acceptance by pushdown automata: By final state, By empty stack, Deterministic pushdown automata, Equivalence of pushdown automata and context free grammars, Pumping lemma for context free languages, Closure properties of context free languages, Testing membership of context free, Decision problems for context free languages.	9	3
Module 4: Turing machines and Undesirability	Definition, Language of a turing machine, Programming turing machines, The church-turing thesis, A simple programming language, Extensions of the basic turing machine. The halting problem, the post correspondence problem, Time and space complexity of turing machines, Complexity classes.	7	4
Module 5: Recursively enumerable languages, and Language learning	Definition, Enumeration, Chomsky hierarchy of Recursively enumerable languages. Learning framework, Inductive inference, Grammar induction	5	5

Text Books:

1. John. E. Hopcroft, Rajeev Motwani, Jeffry. Ullman,(2006) “Introduction to Automata Theory, Languages and Computation”, (3rd ed) Pearson Education.
2. John Martin ,(2011) “Introduction to Languages and the Theory of Computation”,(4th ed) Tata McGraw Hill.
3. Peter Linz, “An Introduction to Formal Languages and Automata”, Narosa.

Reference Books:

1. James. L. Hein, “Discrete Structures, Logic and Computability”, Narosa.
2. Partha Niyogi, “The Computational Nature of Language Learning and Evolution”, PHI.
3. Zvi Kohavi and Niraj K. Jha, “Switching and Finite Automata theory”, Tata McGraw Hill

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AD10110A **Credit: 3 (L-3, T-0, P-0)**

Big Data Analytics

Questions to be set: 05 (All Compulsory)

Course Objectives: To provide knowledge regarding the Big Data processing, analyzing, visualization and design solutions for data analytics using computer programming . This course also provides the methods of applying machine learning algorithms for business data analysis**.**

Pre-requisites: C++ Programming, Object Oriented Programing.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain the basic idea of big data.

CO 2: Explain the basic idea of Hadoop.

CO 3: Describe and categorize the processfor big data.

CO 4: Explain the basic idea of Spark related to big data.

CO 5: Articulate among process,and various mining data streams.

Module	**Topics**	**Hrs**	**CO**
Module 1: Introduction to Big Data	Evolution, structuring, elements, big data analytics, distributed and parallel computing for big data, Hadoop, Cloud computing and big data, in-memory computing technology for big data, Big Data Stack, Virtualization and Big Data.	10	1
Module 2: Hadoop	Introduction to Hadoop,ecosystem, Hadoop Distributed File System (HDFS) and its implementation.	5	2
Module 3: Map Reduce	Map Reduce Framework, optimizing Map Reduce jobs, Map Reduce Applications, Understanding YARN architecture, HBase, Exploring Hive, Analyzing data with Pig, Using Oozie, Introduction to Mahout, role of HBase in Big Data Processing, RHadoop: Data Analysis Using the MapReduce Technique in RHadoop,	7	3

Module 4: Spark	Core Concepts, Spark's Python and Scala shells, Programming with RDD: RDD Operations, Passing Functions to Spark, Common Transformations and Actions.	7	4
Module 5: Mining Data Streams and Case Studies	Streams Concepts, stream Data Model and Architecture, stream computing, filtering Streams, estimating Moments, decaying window, Real time Analytics Platform (RTAP) Applications.Case study on Real Time Sentiment Analysis, Stock Market Predictions	7	5

Textbooks:

1. Vignesh Prajapathi, (2013), "Big Data Analytics with R and Hadoop", (1st ed), Packt Publishing.
2. Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, (2015), "Learning Spark: Lightning-Fast Big Data Analysis", (1st ed), O'Reilly Media Inc.

Reference Books:

1. Michael Minnelli, Michele Chambers, (2013), "Big Data Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley India Pvt. Ltd.
2. Arvind Sathi, (2012), "Big Data Analytics", (1st ed), MC Press, LLC.

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AD10111A **Credit: 3 (L-3, T-0, P-0)**

Machine Learning

Questions to be set: 05 (All Compulsory)

Course Objectives: To provide knowledge regarding the fundamental concepts in machine learning algorithms such as supervised, unsupervised learning algorithms and their applications.

Pre-requisites: Basic knowledge of Probability, Statistics and basic concept of algorithm.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Apply the knowledge of linear regression and logistic regression for prediction and classification problems.

CO 2: Use supervised learning algorithms to solve classification problems.

CO 3: Explain the theoretical framework for analyzing the generalization error of a learning algorithm.

CO 4: Apply unsupervised learning algorithms for dimensionality reduction and clustering techniques to real world problems.

CO 5: Explain the basic concept of Artificial Neural Network and case study.

Module	**Topics**	**Hrs**	**CO**
Module 1: Basics of ML and Regression	Basic Definition, Types of Learning: Supervised Learning, Unsupervised Learning, Semi supervised Learning and Reinforcement Learning, Examples of Machine Learning Applications., hypothesis space and inductive bias, evaluation, cross-validation **Linear Regression:** Linear Regression with Single Variables- Model Representation and Cost Function; Parameter Learning: Gradient Descent, Gradient Descent Intuition, Gradient Descent for Linear Regression, Linear Regression with Multiple Variables- Multiple Features, Gradient Descent for Multiple Variables, Gradient Descent in Practice: Feature Scaling and Learning Rate; Features and Polynomial Regression; **Logistic Regression**: Classification and Representation- Classification, Hypothesis Representation and Decision Boundary, Logistic Regression Model - Cost Function, Simplified Cost Function and Gradient Descent Multiclass Classification- One-vs-all, **Regularization:** Overfitting problems, Regularized Linear Regression, Regularized Logistic Regression	8	1

Module 2: Supervised Learning	Nearest neighbor (NN), Linear Discriminant Analysis, Support vector machines, Decision Trees, Generative classifiers like naive Bayes;	8	2
Module 3: Computational learning theory	PAC learning model, Sample complexity, VC Dimension, Ensemble learning: Bagging, Boosting, Stacking	6	3
Module 4: Unsupervised Learning	Principle component Analysis, Factor Analysis, Non-negative matrix factorization, Rate-Distortion Theory, K-means, hierarchical clustering, Gaussian mixture model, Expectation-Maximization Algorithm	8	4
Module 5: Neural Networks& case study	Overview of neural networks, perceptron's, Activation functions, Multilayer network, backpropagation Algorithm. Case study for business problem solving.	6	5

Text Books:

1. Ethem Alpaydın (2010). *Introduction to Machine Learning* (2nd edition), MIT Press.
2. Tom M. Mitchell (1997). *Machine Learning.* McGraw-Hill Science.
2. Trevor Hastie, Robert Tibshirani and Jerome Friedman (2009). *The Elements of Statistical Learning* (2nd edition). Springer.

Reference Books:

1. Christopher M. Bishop (2006). *Pattern Recognition and Machine Learning*. Springer.
2. Stephen Marsland (2015). *Machine Learning: An Algorithmic Perspective* (2nd edition). CRC Press.
3. R. O. Duda, P. E. Hart, and D. G. Stork (2012). *Pattern classification.* John Wiley & Sons.
4. Shai Shalev-Shwartz and Shai Ben-David (2017). *Understanding Machine Learning*.. Cambridge University Press.

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Sub Code: **GN10102A** **Credit: 0 (L-3, T-0, P-0)**

Behavior Management and Leadership (Capsule Course/Certificate course)

(Optional Audit Course)

Questions to be set: 05 (All Compulsory)

Course Objective: o To improve personality by enhancing life skills for a meaningful contribution to self and society. To understand the nature of emotions and feelings for better interpersonal relationships. To develop constructive and empathetic global leaders. To develop professional and personal skills for a successful life.

Pre-requisites: NA

Course Outcomes (CO): On successful completion of the course

CO1: Evaluate self-awareness, self-management concepts to help others understand themselves better

CO2: Judge ethical issues and values in professional/personal situations and decision making

CO3: Demonstrate enhanced ability to think and reason creatively while solving problems

CO4: Estimate Stress levels and causes and develop strategies for managing stress

CO5: Acquire better capabilities to communicate and forge interpersonal relationships

CO6: Develop abilities to build teams and lead them

UNIT	Topics	Total Contact Hours = 36
I	**SELF-AWARENESS AND SELF-MANAGEMENT:** Understanding self, dimensions of self, Concept and Importance of self-esteem, positive and negative self-esteem, Developing positive self-esteem, Self-development and happiness. Role of motivation in self-growth, nature and types of motivation, factors affecting motivation, Achievement motivation, Relationship between achievement motivation and emotions. Nature and Significance of self-management skills, Aspects of self-management, Social competency behavior	6

II	**VALUES&ETHICS:** Meaning, types and determinants of Values, Concept of Ethics, Relationship between Values and Ethics Its implication in one's life. Concept of Moral Development, factors responsible for moral development. Ethical Decision making, Challenges in its implementation. Prevention of Corruption & Crime; Personal Values-Empathy, honesty, courage, commitment. Professional Values-Work ethics, respect for others, Its role in personality development	**6**
III	**THINKING AND REASONING:** Nature and types of thinking, Problem Solving- Types of problems, Approaches to problem solving, Steps and styles of problem solving, Hindrances to Problem Solving Process- Perception, Expression, Emotion, Intellect; Creative Thinking- **M**eaning, nature and characteristics of creativity, factors affecting creativity, stages of creativity, personality of a creative person, factors enhancing creativity. Reasoning-types of reasoning, Distortion in thinking and reasoning	**5**
IV	**EMOTIONAL INTELLIGENCE &COPING WITH STRESS:** Nature of Emotions, biology of emotions, Needfor and importance ofEmotions, Emotion Anger:Introduction to Anger, types of anger, causes of anger, consequences of anger, Expression of anger-passive and aggressive anger, Anger management; Introduction to Emotional Intelligence, Competencies in emotional intelligence, Types of emotional intelligence, Strategies to enhance emotional intelligence; Expected outcomes of emotional intelligence; Nature of stress, relation between demands and coping, types and causes of stress, Indicators of stress, coping strategies to manage stress, Effective time management strategies	**6**
V	**COMMUNICATION:** Nature and importance of communication, types of communication-indicators of verbal and non-verbal communication, communication styles; Assertiveness-Introduction, types of behavior, nature of assertiveness, Assumptions and Rights in Interpersonal communication, strategies to become assertive, Assertiveness in daily life, Characteristics of an assertive person	**4**
VI	**INTERPERSONAL RELATIONSHIPS:** Importance of interpersonal relations, Types of Interpersonal Relationships, Barriers to effective communication in relationships, steps to improve interpersonal communication, Role of feedback in interpersonal communication, Conflict management, strategies for maintaining good interpersonal relations, relating to others in virtual world	**5**
VII	**LEADERSHIP & TEAM BUILDING** Leadership- Definition, Meaning, Nature and Functions of leader, Types of leaders, Leadership styles, Functions of a Leader, Decision-making, personality traits of an effective leader; Significance and nature of team building, Stages of team building, types of teams, factors influencing the effectiveness of a team	**4**

PedagogyforCourseDelivery: Lectures,PPTPresentation,Activities,Psychometrictesting,GroupDiscussion, Projectetc.

Theory Assessment (L&T):

Continuous Assessment/Internal Assessment				End Term Examination
Components	Internal Assessment			
	Class Quiz/Test	Project/Activity	Attendance	
Weightage (%)	30%	15%	05%	50%

Text&References:

1. Wadkar A (2016). Life Skills for Success, Sage Publications, New Delhi, India
2. SmitherRobertD. (1994).ThePsychologyofWorkandHumanPerformance,Harper CollinsCollegePublishers
3. SinghA. January (2013); AchievingBehavioural ExcellenceforSuccess;WileyPublication.
4. Raman,A.T.(2003)KnowledgeManagement:AResource Book. ExcelBooks,Delhi.
5. Bates, A. P. and Julian, J.: Sociology - Understanding Social Behaviour
6. J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 2, Group (1996); Pfeiffer & Company
7. Pestonjee, D.M.; Stress and Coping: The Indian Experience
8. Clegg, Brian; Instant Stress Management – Bring calm to your life now
9. Phil Lowe Koge Page: Creativity and Problem Solving, New Delhi, 1996
10. Bensley, Alan D.: Critical Thinking in Psychology – A Unified Skills Approach, (1998), Brooks/Cole Publishing Company.
11. Vangelist L. Anita, Mark N. Knapp, Interpersonal Communication and Human Relationships: Third Edition, Allyn and Bacon
12. Julia T. Wood. Interpersonal Communication everyday encounter
13. Simons, Christine, Naylor, Belinda: Effective Communication for Managers, 1997 1st Edition Cassel
14. Hoover, Judhith D. Effective Small Group and Team Communication, 2002, Harcourt College Publishers
15. Dick, Mc Cann & Margerison, Charles: Team Management, 1992 Edition, viva books

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AD10405A **Credit: 1(L-0,T-0,P-2)**

Big Data Analytics Lab

Minimum Experiment to be done: 12

Course Objectives: Provide practical knowledge of various tools and technologies used in big data.

Pre-requisites: Basic knowledge of big data and use of tools.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Describe the process for down-loading, installing and implementation of Hadoop.

CO 2: Explain various tools and technologies of Big Data like Apache Cassandra and MongoDB.

CO 3: Deploy big data implementations of machine learning algorithms and Map Reduce Paradigm.

CO 4: Design K-means clustering.

CO 5: Describe the process for installation of HBase & thrift and importing and exporting data from various data sets.

List of Experiments:

Module	Name of Experiments	Hours	CO
Module:1	**Experiment no 0**: Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files	3	1
	Experiment no 1: Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files	3	1
	Experiment no 2 : Implement of Matrix Multiplication with Hadoop Map Reduce	3	1
	Experiment no 3: Experiments on Cloudera Distribution for Hadoop	3	1
Module:2	**Experiment no 4:** Experiments on Tutorial for Big Data tools and technologies.	3	2
	Experiment no 5 Experiments on Apache Cassandra,	3	2
	Experiment no 6: Experiments on MongoDB suggested	3	2
Module:3	**Experiment no 7:** Experiments with big datasets to be defined in lab manual.	3	3
	Experiment no 8: To deploy big data implementations of machine learning algorithms.	3	3
	Experiment no 9: Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm	3	3

Module:4	**Experiment no 10:** Implementation of K-means clustering using Map Reduce	3	4
	Experiment no 11: Installation of Hive along with practice examples.	3	4
Module:5	**Experiment no 12:** Installation of HBase, Installing thrift along with Practice examples	3	5
	Experiment no 13: Experiment on importing and exporting data from various databases	3	5

Textbooks:

1. Vignesh Prajapathi, (2013), "Big Data Analytics with R and Hadoop", open source, Packt Publishing.
2. Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, (2015), "Learning Spark: Lightning-Fast Big Data Analysis", (1st ed), O'Reilly Media Inc.

Reference Books:

1. Michael Minnelli, Michele Chambers, (2013), "Big Data Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", (1st ed), Wiley India Pvt. Ltd.

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AD10406A **Credit: 1(L-0,T-0,P-2)**

Machine Learning Lab

Minimum Experiment to be done: 12

Course Objectives: To provide knowledge regarding the hands-on exposure to ML tools and techniques to solve real-world problems. The knowledge of ML techniques leads to the advancement of research and technology.

Pre-requisites: Python programming, Linear Algebra, Probability and Statistics.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Demonstrate FIND-S algorithm in context with specific data set.

CO 2: Understand the Elimination algorithm, ID3 algorithm, Artificial Neural Network with back propagation.

CO 3: Design Bayesian classifier and network.

CO 4: Understand the EM algorithm, k-Means and k-Nearest Neighbor algorithm.

CO 5: Develop different regression models.

List of Experiments:

Module	Name of Experiments	Hours	CO
Module:1	**Experiment no 1:** Write python program to implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given (Read the training data from a .CSV) set of training data samples.	3	1
Module:2	**Experiment no 2:** Write a python program to implement and demonstrate the Candidate-Elimination algorithm based on a given (Read the training data from a .CSV) set of training data samples.	3	2
	Experiment no 3: Write python program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.	3	
	Experiment no 4: Write python program to build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.	3	
Module:3	**Experiment no 5:** Write a python program to implement the naïve Bayesian classifier	3	3

	for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.		
	Experiment no 6: Write python program to develop Bayesian Classifier model to perform a specific task. Calculate the accuracy, precision, and recall for your data set.	3	
	Experiment no 7: Write a python program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard heart disease	3	
Module:4	**Experiment no 8:** Write a python program to implement EM algorithm to cluster a set of data stored in a .CSV file.	3	4
	Experiment no 9: Write python program to implement clustering using k-Means algorithm. Compare the results with EM algorithm and comment on the quality of clustering.		
	Experiment no 10: Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions.	3	
Module:5	**Experiment no 11:** Write a python program to implement the linear Regression algorithm to fit data points. Select appropriate data set for your experiment and draw graphs	3	5
Module:4	**Experiment no 12:** Write a python program to implement the logistic Regression algorithm to fit data points. Select appropriate data set for your experiment and draw graphs	3	
	Experiment no 13: Experimental based tiny ML projects about revolutionizing precision farming.	3	
	Experiment no 14: Experimental based tinyML projects to create a network of low-cost sensors for mapping carbon emissions.	3	

Textbooks:

1. Saikat Dutta, (2020), "Machine Learning", (5th ed), Pearson press.

2. Ethem Alpaydın,(2010) "Introduction to Machine Learning", (2nd ed), MIT Press.

3. Tom M. Mitchell, (1997), "Machine Learning", (1st ed), McGraw-Hill Science.

Reference Books:

1. Christopher M. Bishop, (2006), "Pattern Recognition and Machine Learning", (1st ed), Springer.
2. Stephen Marsland, (2015), "Machine Learning: An Algorithmic Perspective", (2nd ed), CRC Press.

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Core Courses: SEMESTER – VI

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Sub Code: BA 10146A **Credit: 2 (L-2, T-0, P-0)**

Industrial Management

Questions to be set: 05 (All compulsory)

Course Objective: To provide basic knowledge of functions of management along with their practical implications

Pre-requisites: NIL

Course Outcomes (CO):

CO1: To provide basic knowledge and application of functions of management

CO2: To help students to understand and apply principles of management evolved by pioneers of management.

CO3: To enable students to apply basic quantitative techniques for making decisions related to operations management

CO4: To help students apply various techniques for optimal production management

CO5: To apply concepts of materials management for maintaining optimal inventory

Module	Topics	Hrs	CO
Introduction	Philosophy and Development of Management thought. Concept and definition of management, Functions and Roles of Management, Social Responsibilities of Management.	3	1
Pioneers in Management	Taylor's Scientific Management, Contribution of Henry Fayol, Maslow, McGregor, Gilbreth and Mayo.	3	2
Quantitative Techniques in Managerial Decisions	Concept of budget and budgetary control. Time-event network analysis; ABC Analysis, Break-even Analysis; Decision Tables; Concept of productivity, measuring productivity, Use information technology	5	3
Production Management	Types of production; Types of Planning, Manufacturing Planning; Production planning, Scheduling; Work study & Method Study; Systems of wage payments, bonus, Automation. Organization of production, planning and control department.	5	4
Materials Management	Practice of purchasing and materials management, quality, Inventory Management, EOQ model; Value Analysis and Value Engineering.	4	5

Text Books:

1. H. Koontz and H. Weihrich (1989). Management. McGraw Hill.

Reference Books:

1. Dobler W.D. (1984). Purchasing & Materials Management. TMHC, New Delhi.

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112A **Credit: 3 (L-3, T-0, P-0)**

Deep Learning

Questions to be set: 05 (All Compulsory)

Course Objectives: The objective of the course is to familiarize students with deep learning algorithms, regularization and optimization techniques for deep learning.

Pre-requisites: Familiarity with Probability theory and Linear Algebra, Basic Programming knowledge and model development.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain the basic concept of deep learning.

CO 2: Describe Shallow and Deep Feed Forward Networks.

CO 3: Illustrate Regularization and Optimization.

CO 4: Explain the architecture and utility of Convolutional Networks and Stacked Auto Encoders.

CO 5: Co relate among deep generative models, deep Belief and Generative Adversarial Networks.

Module	Topics	Hrs	CO
Module 1: Introduction	Neural Network Basics: Multi-layer perceptron, Back propagation algorithm, training procedures	6	1
Module 2: Shallow and Deep Feed Forward Networks	Shallow Neural Networks: Review, Gradient descent and Activation Function Deep Feed Forward Networks: Forward and Backward Propagation, Hidden units, architecture design, Dimensionality reduction, learning time.	6	2
Module 3: Regularization and Optimization	Regularization for Deep Learning: Parameter Norm Penalties, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise-Robustness, Bagging and Other Ensemble Methods, Dropout, Adversarial Training. Optimization for Training Deep Models: Challenges in Neural Network Optimization. Deep Neural Networks and the Brain	8	3

Module 4: Convolutional Networks and Stacked Auto Encoders	Convolutional Networks: convolution operation, pooling Object detection and Face recognition Sequence Modeling: Recurrent and Recursive Networks, Stacked Auto Encoders: Under complete, Regularized, sparse, de-noising, Monte Carlo Methods. Markov Models, Hidden Markov models: evaluation problem, finding the state sequence, HMM as graphical model.	8	4
Module 5: Deep Generative Models, Deep Belief and Generative Adversarial Networks	Deep Generative Models: Boltzmann Machines-the physics, randomness, impact on cognitive learning. Deep Boltzmann Machines, Deep Belief Networks-its relationship to Boltzmann Machines, concept of greedy networks, application to drug discovery. Generative Adversarial Networks, Auto-regressive Networks. Practical Methodology: Performance Metrics, Default Baseline Models, Selecting hyper parameters, Debugging Strategies	8	5

Text Books:

1. Aaron Courville, Ian Goodfellow, and Yoshua Bengio, (2015)"Deep Learning", (1st ed), MIT Press

2. Li Deng and Dong Yu , (2014), "Deep Learning: Methods and Applications"(1st ed) new publishers.

Reference Books:

1. "Deep Learning Tutorial" By LISA Lab, University of Montreal

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AD10113A **Credit: 3 (L-3, T-0, P-0)**

Text Analytics and Natural Language Processing

Questions to be set: 05 (All Compulsory)

Course Objectives:To provide knowledge regarding the technique that how the NLP attempts to interact with humans and human texts via language through a set of sequential process like problem definition, analysing and decision making.This course also provide the idea about the translating from one language to another with cooperative tasks.

Pre-requisites: Data Structures. Basic of text and natural language, some familiarity with probability would help.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain the basic concepts of automata.

CO 2: Describe Morphology Parsing.

CO 3: Use words and sentence tokenization for natural language processing.

CO 4: Explain the process steps in NLP.

CO 5: Performnormalization and segmentation of text and other processes for Text analysis.

Module	**Topics**	**Hrs**	**CO**
Module 1: Basics of automata	Basics of Finite State Automata, Knowledge in Speech and Language Processing, Ambiguity, Models and Algorithm	7	1
Module 2: Survey of English Morphology	Survey of English Morphology, Finite-State Morphological Parsing, Building a Finite- State Lexicon, FSTs for Morphological Parsing, Lexicon-Free FSTs	7	2
Module 3: Words and sentence tokenization	Words and sentence tokenization, Detecting and Correcting Spelling Errors. English Word Classes :Tag-sets for English, Part-of-Speech Tagging, The Noisy Channel Model for Spelling	6	3
Module 4: Natural Language	Introduction, Components of NLP , Difficulties in NLU , NLP Terminology , Process Steps in NLP , Deep Learning Based NLP, Implementation Aspects of	6	4

Processing	Syntactic Analysis , Advantages and limitations of NLP, Application of NLP		
Module 5: Case study	Normalizing Text, Segmentation. N-Grams, Unsmoothed N-Grams, Smoothing, Interpolation, and Backoff, Automatic Tagging. Constituency, Some Grammar Rules for English, The Penn Treebank project, Dependency Grammar. Parsing with Context Free Grammars, CKY algorithm, Statistical Parsing	10	5

Text Books:

1. Steven Bird, Ewan Klein and Edward Loper, (2009), "Natural Language Processing with Python" (1st ed), O'Reilly publishers .

2. Julia Silge and David Robinson, (2017), "Text Mining with R", (1st ed), O'Reilly publishers .

Reference Books:

1. Christopher Manning, and Hinrich Schütze, (1999), "Foundations of Statistical Natural Language Processing", (1st ed). MIT press.

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AD10114A **Credit: 3 (L-3, T-0, P-0)**

Data Communication And Networks

Questions to be set: 05 (All Compulsory)

Course Objectives:The objective of this course is to identify the different approaches towards computer networking, compare and contrast the underlying technologies and problem solving based on case studies

Pre-requisites: Basic communication system.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain the basic concept of data communication and computer network.

CO 2: Describe the concept of different types of IP Address and their architecture.

CO 3: Relatedifferent types of Routing technique.

CO 4: Explain the process for achieving flow control, error control and congestion control in TCP.

CO 5: Describe the basic ideas of IPv4 and IPv6.

Module	Topics	Hrs	CO
Module 1: Introduction	Basic concepts of data communication and computer networks, Layered architecture and comparison between ISO/OSI, TCP/IP layered models. Significance of Datalink layer and protocols. Network layer functionalities.	7	1
Module 2: IP Address	Classful, classless IP addressing, address allocation and role of forwarding module in forwarding the packet using routing table. Roles played by IP, ARP, RARP, ICMP & IGMP protocols in network layer	7	2
Module 3: Routing	Introduction to routing, Different types and architecture of routing, Inter-domain and intra-domain routing algorithms for routing tables.	7	3
Module 4: TCP	Importance of transport layer in achieving process-to-process communication. Insight of connection oriented protocol TCP and connectionless protocol UDP. Features of TCP in achieving flow control, error control and congestion control. Requirement of different timers in TCP.	8	4

Module 5: IPv4 and IPv6	Introduction to IPv4 addressing and new IP addressing scheme IPv6. Migrating from IPv4 to IPv6. Introduction to application layer, a client/server application program and a case study. Client-server application program-Dynamic Host Configuration Protocol (DHCP).	7	5

Text Books:-

1. Behrouz A. Forouzan, (2010), "TCP/IP Protocol Suite", (4th ed), Tata McGraw Hill.

2. Tannenbaum, A.S, (2011), "Computer Networks", (5th ed), Prentice Hall of India EE Edition.

Reference Books:-

1. Behrouz A. Forouzan, (2013), "Data Communications and Networking", (5th ed), Tata McGraw Hill.

2. Leon Garcia and Widjala, (2017), "Communication Networks", (5th ed), Tata McGraw Hill.

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Sub Code: **GN11001A** **Credit: 0 (L-3, T-0, P-0)**

QUANTITATIVE APTITUDE AND LOGICAL REASONING
(Optional Audit Course)

Questions to be set: 05 (All Compulsory)

Course Objective: The main aim of introducing "Quantitative Aptitude" to engineering students is to develop numerical skills among students and to prepare them for various examinations to enhance better job prospects. Efforts to accommodate fundamental, mathematical aspects to impart confidence among students. Enrich students' knowledge and develop the logical reasoning thinking ability.

Pre-requisites: NIL

Course Outcomes (CO): On successful completion of the course

CO1 Student will be able to solve variety of problems in the space of quantitative domain.
CO2 Students will be able to use data to determine or to deduce other facts from a set of given data.
CO3 Students will be able to use shortcuts, tricks and techniques to solve the problems with accuracy.
CO4 Students will be able to demonstrate essential skills pertaining to business communications.

Module	Topics to be covered	Topics	Hrs.	CO
Module 1: **Quantitative Aptitude**	In class	Problems on Trains, Time and Distance, Height and Distance, Time and Work, Simple Interest, Compound Interest, Profit and Loss, Partnership, Percentage, Problems on Ages, Calendar, Clocks, Average, Area, Volume and Surface Area, Permutations and Combinations, Probability, Numbers, Problems on Numbers, Problems on HCF and LCM, Decimal Fraction, Simplification, Square Root and Cube Root, Surds and Indices, Ratio and Proportion, Chain Rule, Pipes and Cistern, Boats and Streams, Allegation and Mixtures, Logarithm, Races and Games, Stocks and Shares, Probability, True Discount, Odd man out and Series.	16	1

Module 2: **Puzzles, Problem Solving and Analysis**	In class	Sudoku, Number Puzzles, Missing Letter Puzzles, Playing Card Puzzles, Clock Puzzles, Logical Connectives and Syllogisms, Data Interpretation, Cases, Venn Diagrams.	5	2
Module 3: **Logical Reasoning**	In class	Number Series, Letter and Symbol series, Verbal Classification Essential Part, odd man out and visual reasoning, Analogies, Artificial Language, Matching Definitions, Making Judgements, Verbal Reasoning, Logical Problems, Logical Games, Data Arrangement and Blood Relations, Analyzing Arguments, Statement and Assumption, Course of action, Statement and Conclusion, Theme Detection, Cause and Effect, Statement and Argument, Logical Deduction.	10	3
Module 4: **Professional Builder**	In class	CV Writing, Verbal & Non Verbal Communication, Group Discussion, Netiquettes, Telephone Etiquettes.	5	4

Textbooks:

1. R.S. Aggarwal, Quantitative Aptitude for Competitive Examinations, S CHAND.
2. Shakuntala Devi, Puzzles to Puzzle You.

Reference Books:-

1. R.V. Praveen, Quantitative Aptitude and Reasoning, 2nd Revised Edition 2013, Prentice-Hall of India Pvt.Ltd.

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AD10407A **Credit: 1(L-0,T-0,P-2)**

Deep Learning - Lab

Minimum Experiment to be done: 12

Course Objectives: Make student efficient to develop different models used in deep learning with the help of Python associated with tensor-flow.

Pre-requisites: Basic knowledge in deep learning, Python script and tensor flow.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Write python for multi-layer perceptron, back propagation algorithm, Shallow Neural Networks.

CO 2: Write python for Deep Feed Forward, Parameter Norm Penalties, Regularization and Under-Constrained Problems, Dataset Augmentation.

CO 3: Write python for Noise-Robustness, Optimization for Training Deep Models, Convolutional Networks.

CO 4: Write python for Deep Generative Models, Large Scale Deep Learning, and Computer Vision.

CO 5: Write python for Speech Recognition, Economics, Fraud detection, Crime detection.

List of Experiments:

Module	Name of Experiments	Hours	CO
Module:1	**Experiment no 1**: Write a program for Multi-layer perceptron in python language.	3	1
	Experiment no 2: Write a program for Back propagation algorithm in python language.	3	1
	Experiment no 3: Write a program for Shallow Neural Networks in python language.	3	1
Module:2	**Experiment no 4**: Write a program for Deep Feed Forward in python language.	3	2
	Experiment no 5: Write a program for Parameter Norm Penalties, Regularization and Under-Constrained Problems in python language.	3	2
	Experiment no 6: Write a program for Dataset Augmentation in python language.	3	2
Module:3	**Experiment no 7**: Write a program for Noise-Robustness in python language.	3	3
	Experiment no 8: Write a program for Optimization for Training Deep Models in python language.	3	3
	Experiment no 9: Write a program for Convolutional Networks in python language.	3	3

Module:4	**Experiment no 10**: Write a program for Deep Generative Models in python language.	3	4
	Experiment no 11: Write a program for Large Scale Deep Learning in python language.	3	4
	Experiment no 12: Write a program for Computer Vision in python language.	3	4
Module:5	**Experiment no 13**: Write a program for Speech Recognition in python language.	3	5
	Experiment no 14: Write a program for Economics, Fraud detection in python language.	3	5
	Experiment no 15: Write a program for Crime detection in python language.	3	5
	Experiment no 16: Experiments on autonomous systems.	3	5
	Experiment no 17: Experiments on Virtual Agent.	3	5
	Experiment no 18: Experiments on automatic robotics.	3	5

Textbooks:

1. Yoshua Bengio , Aaron Courville (2016) Deep Learning by Ian Good fellow. The MIT Press.
2. Mark Lutz , (2013), "Learning Python", (5th ed), O'Reilly publishers
3. Hadley Wickham , Garrett Grolemund, (2017), "R for data science". (1st ed), O′Reilly publishers

Reference Books:

1. Li Deng ,Dong Yu, (2014), "Deep Learning: Methods and Applications". (1st ed) , now publishers Inc
2. Deep Learning Tutorial by LISA Lab, University of Montreal

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AD10408A **Credit: 1 (L-0,T-0,P-2)**

Text Analytics and NLP Lab

Minimum Experiment to be done: 12

Course Objectives: Provide knowledge for analysis, generation, translate and find morphology of word or language or documents by using virtual tools

Pre-requisites: Basic knowledge in language processing

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Use word analysis, generation and find morphology with virtual tools.

CO 2: Appraise N Grams, POS and CKY algorithm by using virtual tools.

CO 3: Explain the natural language Chunking,parsing with Context Free Grammars and Statistical Parsingby using virtual tools

CO 4: Use the documents properly.

CO 5: Modify the language in a proper way

List of Experiments:

Exp No	Name of Experiments	Hours	CO
Module:1	**Experiment 1:** Experiments on word analysis by using virtual tools.	3	1
	Experiment 2: Experiments on Word generation by using virtual tools	3	1
	Experiment 3: Experiments on morphology by using virtual tools	3	1
Module:2	**Experiment 4:** Experiments on N Grams by using virtual tools	3	2
	Experiment 5: Experiments on POS tagging and Building POS trigger by using virtual tools	3	2
	Experiment 6: Experiments onCKY algorithm by using virtual tools	3	2
Module:3	**Experiment 7:** Experiments on Chunking and Building chuker by using virtual tools	3	3
	Experiment 8: Experiments on Parsing with Context Free Grammars and Statistical Parsingby using virtual tools	3	3
Module:4	**Experiment 9:**Experiments on Word Trends and N-grams by using web-based tool, the Google Books Ngram Viewer by using virtual tools	3	4

	Experiment 10: Counting things in documents and visualizing trends and associations among the words in one or more documents by using language tools (The Voyant system).	3	4
Module:5	**Experiment 11:** Analysis of sentiment by using Senti mood tools.	3	5
	Experiment 12: Experiments on Machine Translation or language translation bu using virtual tools.	3	5

Text Books:

1. Steven Bird, Ewan Klein and Edward Loper, (2009), "Natural Language Processing with Python" (1st ed), O'Reilly publishers
2. Julia Silge and David Robinson, (2017), "Text Mining with R", (1st ed), O'Reilly publishers.

Reference Books:

1. Christopher Manning, and Hinrich Schütze, (1999), "Foundations of Statistical Natural Language", (1st ed) , MIT Press. Cambridge

Program Electives

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Program Elective-I (4th Semester)

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AD10301ACredit: 3 (L-3, T-0, P-0)

Analog Electronics and Integrated Circuits

Questions to be set: 05 (All Compulsory)

Course Objectives: To enrich the knowledge of the students with a sound understanding of analog electronic circuit, this will help them in the further course of their studies. It exposes the students to various types of analog electronic circuit, which will help them to relate this with the other courses, which they have in their future semesters, as well as its importance from industrial point of view.

Pre-requisites: Basic idea on Electrical and Electronic Circuits. Engineering Physics.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Illustrate working principle of different electronic circuits and their application in real life. 2. Define semiconductor device and different operating condition and their performance parameter.

CO 3: Choose proper semiconductor devices depending upon application considering economic and technological up-gradation.

CO 4: Employ mathematical and graphical analysis considering different practical issues modeling of semiconductor device; analyze the performance parameter of the system.

CO 5: Recognize different signal processing circuit and the use in industrial, real life, modern control system application.

Module	Topics	Hrs	CO
Module 1: Feedback Amplifiers & Oscillators	Basic principles and types of feedback, feedback topology, derivation of expression for gain, effect of negative feedback in gain, stability, distortion and bandwidth of an amplifier, Barkhaushen criterion, Different oscillator circuits- RC Phase Shift, Wien-Bridge, Hartley, Colpitt and Crystal.	6	1
Module 2: Power Amplifiers	Class A, B, AB, C, Conversion Efficiency, Push-Pull Amplifiers, Tuned Amplifiers.	2	2
Module 3: Operational Amplifiers and its applications	Characteristics of an ideal operational amplifier and its block diagram, Differential amplifiers and its characteristics-CMRR, Slew-Rate, Offset Voltage and Current, Gain-Bandwidth Product, Open & Closed loop operation, inverting and non-inverting amplifier, voltage follower, Summing amplifier, Differentiator, Integrator, Comparator, Schmitt trigger, Precision rectifiers, Sample and Hold circuits, Instrumentation amplifier.	8	3
Module 4: Active Filters & Multi-vibrators	Design and analysis of first and second order low pass, high pass, band pass, band reject filters and notch filters, Gain-Frequency Curve. Implementation of Multi-vibrators using Transistor and 555 Timer.	6	4
Module 5: Special Functional Circuits & Applications	Introduction of VCO and PLL A-to-D Converter, D-to-A Converter	6	5

Text Books:

1. Robert L. Boylestad, Louis Nashelsky (2017).Electronic devices and circuit theory, (11th edition)Pearson Education.
2. Jacob Millman, Christos Halkias, Chetan Parikh (2009). Integrated Electronics, (2nd Edition)McGraw Hill Education.
3. Ramakant A, Gayakwad (2009). Opamps& Linear Integrated Circuits, (4th Edition) PHI.
4. V S Kanchana Bhaaskaran, Salivahanan (2007) Linear Integrated Circuits,(2nd Edition) Tata Mcgraw Hill Education Private Limited.

Reference Books:

1. Schilling, D. L., C. Belove, T. Apelewicz and R. J. Saccardi (2002). Electronic circuits: discrete and integrated,(3rd Edition)McGraw-Hill New York.
2. S Salivahanan, N. Suresh Kumar (2012). Electronic Devices and Circuit, (3rd Edition) McGraw Hill Education (India) Private Limited.
3. D. Chattopadhyay, P.C. Rakshit (2015) Foundations of Electronics, (2nd Edition) New Age International Publishers Ltd.

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AD10302ACredit: 3 (L-3, T-0, P-0)

Digital Signal Processing

Questions to be set: 05 (All Compulsory)

Course Objectives:

(1) To Analyze signals and systems in time and frequency domain.

(2) To attain a good analytical ability in digital filter design.

(3) To investigate the applications of digital signal processing.

Pre-requisites: Calculus

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Illustrate signals, systems and their significance.

CO 2: Analyze the signals using various digital transforms DFT, FFT etc.

CO 3: Design IIR filters with desired frequency responses.

CO 4: Design FIR filters with desired frequency responses.

CO 5: Use MATLAB/OCTAVE software in implementing real-world applications of digital signal processing.

Module	Topics	Hrs	CO
Module 1: Signals and Systems	Continuous-Time and Discrete-Time Signals, Continuous-Time and Discrete-Time Systems, Basic System Properties, LTI Systems and its properties, Generation of Signals and basic operations using MATLAB/OCTAVE	**8**	**1**
Module 2: Frequency Analysis	Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT) Discrete Cosine Transform (DCT), Z-Transform, ROC, Poles & Zeros, Estimating Power Spectral Density	8	2

	Frequency analysis of signals and systems using MATLAB/OCTAVE		
Module 3: Design of IIR Filter	Characterizing Digital Filters: Filter Coefficients, Filter Responses Zeros and Poles Introduction to Analog IIR Filters; Design of Digital IIR Filters & Structures	7	3
Module 4: Design of FIR Filters	Design of FIR filter using Window and Constrained Least-Squares methods, FIR filter structures	6	4
Module 5: Adaptive Filters and DSP Applications	Basics of Adaptive filters; Real-world applications of digital signal processing in Engineering using MATLAB/OCTAVE	7	5

Text Books:

1. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab (1996).*Signals and Systems* (2nd ed.). PHI
2. John G Proakis, Dimitris Manolakis (2007). *Digital Signal Processing* (4th ed.). Pearson
3. S.K.Mitra (2013). *Digital Signal Processing: A Computer - Based Approach* (4th edition). McGraw Hill Education.

Reference Books:

1. K.S. Thyagarajan (2019). *Introduction to Digital Signal Processing Using MATLAB with Application to Digital Communication*s (1st Edition)Springer
2. *Vinay K. Ingle and John G. Proakis (2011). Digital Signal Processing Using MATLAB* (3rd Edition). CL Engineering.

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AD10303ACredit: 3 (L-3, T-0, P-0)

Programming in Java

Questions to be set: 05 (All Compulsory)

Course Objectives: The Java Programming Language course provides students with a solid foundation for programming with JAVA. It also highlights the creation of graphical user interfaces (GUIs), exceptions, file input/output (I/O), and threads; and network programming.

Pre-requisites: Object Oriented Programming.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Use the syntax and semantics of java programming language and basic concepts of OOP.

CO 2: Develop reusable programs using the concepts of inheritance, polymorphism and interfaces.

CO 3: Transfer reusable programs using the concepts Strings handling, Interfaces and Packages.

CO 4: Apply the concepts of Multithreading and Exception handling to develop efficient and error free codes.

CO5: Design event driven GUI and web related applications which mimic the real word scenarios.

Module	Topics	Hrs	CO
Module 1: Introduction to Java	Evolution and features of java, Overview of java, Two control statements, Lexical issues, Data types, Variables and arrays, Literals, Variables, Type conversion and casting, Type promotion in expression, arrays, Operators, Bitwise operators, Relational operators, Boolean and logical operators, Assignment Operators, The '?' operator, Operator precedence, JAVA statements.	6	1
Module 2: Introducing classes and Methods	Class fundamentals, Declaring objects, Assigning object reference Variables, Introducing methods, Constructors, 'this' keyword, Garbage collection, The finalize() method, stack class. Overloading methods and constructors, using object as parameters, Argument passing, Returning objects, Recursion, Access control, Static methods, Nested and inner classes, Command line argument.	6	2

	1.		
Module 3: Strings handling, Interfaces and Packages	String constructors, String length, Special string operators, Character extraction, String comparison, String searching, String modification, Changing case of characters within a string, Compression and String buffer, String builder. Inheritance, Basics of inheritance, Types of inheritance, Using super keyword, method overriding, Dynamic method dispatch, Abstract class, Using final with inheritance, The object class, Defining and implementing interface, Extending interfaces, Nested interfaces, Applying interfaces, Defining and creating packages, Access protection, Importing packages. Exception Handling, Fundamentals, Exception types, Uncaught exceptions, Using try and catch, Multiple catch clauses, Nested try statements, Throws, Finally, Java's built in exceptions, Creating own exception classes.	6	3
Module 4: Input/Output, file handling and Multithreaded programming	Java I/O classes and interfaces, The stream classes, Byte streams, The character streams, The console class, File class, Byte-stream class, Random access files. Thread basics, Java's thread model, Thread priorities, Synchronization, Messaging, Thread class and runnable interface. The main thread, Creating a thread, Creating multiple threads, Interthread communication, Suspending/resuming and stopping threads.	6	4
Module 5: Network programming and Event Based Programming	Networking basics, The networking classes and interfaces, The InetAddress class, Inet4Address, TCP socket, URL, URLConnection, HTTP/URL Connection, TCP/IP server sockets, Datagram socket and Datagram Packet. The applet class, Repaint(), The HTML applet tag, Passing Parameter to applet, Event handling, Using delegation event model, Abstract Window program, Displaying information within a window, AWT controls.	6	5

Text Books:

1. E. Balaguruswami (2006), Programming With JAVA (2nd Edition) TMH Publication.
2. Herbert Scheldt (2007) Java: The Complete Reference (7th Edition) TMH Publication.

Reference Books:

1. Ken Arnold, James Gosling, David Holmes(2005).The Java Programming Language (4th edition) Addison-Wesley
2. Cedric Buest, Subrahmanyam Allamaraju (2007). Professional Java Server Programming: J2EE (3rd edition) Dreamtech Press
3. Patrick Naughton, HarbertSchildt (2017). JAVA2: The Complete Reference (3rd Edition) TMH Publication.

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AD10304ACredit: 3 (L-3, T-0, P-0)

ARM Controller

Questions to be set: 05 (All Compulsory)

Course Objectives: Collect knowledge of architecture of ARM 7processor, LPC2148 and assembly programming of ARM. Learn to design, construct, program, verify, analyze and troubleshoot ARM assembly and C language programs and supporting hardware.

Pre-requisites: Knowledge of Digital electronics, Microcontroller Architecture and Programming

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Understand the features of embedded systems, architecture of ARM7 and applications.

CO 2: Analyse and understand the instruction set and development tools of ARM

CO 3:Analyse and understand the THUMB state and achieving competency in assembly programming of ARM.

CO 4: Understand the exception, interrupts and interrupt handling schemes

CO 5: Understand the architectural features of LPC2148 microcontrollers and hardware and interfacing peripheral devices to LPC2148.

Module	Topics	Hrs	CO
Module 1: ARM Embedded Systems and ARM Processor Fundamentals	The RISC design philosophy, ARM design philosophy, embedded system hardware- AMBA bus protocol, embedded system software- applications. ARM core data flow model, Registers, CPSR-Processor modes, Banked registers. Pipeline- Characteristics.	8	1
Module 2: ARM Instruction Set	Fundamentals of ARM instructions, Barrel shifter, Classification and explanation of instructions with examples-Data processing, Branch, Load-store, SWI and Program Status Register instruction.	4	2

Module 3: Introduction to THUMB and ARM Programming	Introduction to THUMB, Differences between ARM and THUMB, Register usage in Thumb,ARM Thumb Interworking. General Structure of ARM assembly module, Assemblerdirectives- AREA, ENTRY, END, SPACE, DCD, DCB, DCW, DCI, DCQ, EQU, EXPORT,ALIGN, CODE16, CODE32, DATA. Simple ALP programs on Arithmetic & logical operations, Factorial, string operation, sorting, searching, and Scan.	6	3
Module 4: Exception and Interrupt handling schemes	Exception handling- ARM processor exceptions and modes, vector table, exception priorities,link register offsets. Interrupts- assigning interrupts, interrupt latency, IRQ and FIQexceptions with example- code for enabling and disabling IRQ and FIQ exceptions,Comparison between exception and interrupts. Interrupt handling schemes- nested interrupt handler, non-nested interrupt handler. Basic interrupt stack design.	6	4
Module 5: LPC 2148 – ARM CPUPeripherals	LPC 2148 - Salient features, block diagram, memory mapping. Functional features of Interrupt controller, RTC, USB, I2C, SPI controllers, watch dog timers, Pin Connect Block- Features, Register description with example. GPIO- Features, Applications, Pin description, Register description with examples PLL-Features, block diagram, PLL frequency Calculation- procedure for determining PLL settings, examples for PLL ConfigurationTimers-Features, applications, Architecture of timer module, register description, Simple C programs for application using -GPIO, PLL, Timer.	8	5

Text Books:

1. Andrew Sloss, Dominic Symes, Chris Wright (2004).*ARM System Developer's Guide: Designing and Optimizing System Software*. Morgan Kaufmann
2. William Hohl, Christopher Hinds. *ARM Assembly Language* (2nd ed.), CRC Press.

Reference Books:

1. Steve Furber (2009), ARM System-on-chip Architecture (2nd ed.). Pearson Education.
2. A P Godse (2020). ARM Controller: ARM Fundamentals, LPC2148 CPU and Peripherals. Amazon Digital Services LLC - KDP Print US
3. James K. Peckol (2008). Embedded Systems: A Contemporary Design Tool. Wiley.

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Program Elective-II (5th Semester)

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AD10305ACredit: 3 (L-3, T-0, P-0)
Digital Image Processing

Questions to be set: 05 (All Compulsory)
Course Objectives: To study the image fundamentals and mathematical transformations necessary for image processing. To study image enhancement techniques. To study image restoration procedures. To study the image compression procedures.
Pre-requisites: Digital Signal Processing
Course Outcomes (CO):
Upon successful completion of the course, students should be able to
CO 1: Understand the need for image transforms different types of image transforms and their properties.
CO 2: Learn different techniques employed for the enhancement of images.
CO 3: Summarize the Image restoration.
CO 4: Reframe different feature extraction techniques for image analysis and recognition
CO 5: Apply different causes for image reconstruction from projections

Module	Topics	Hrs	CO
Module 1: Fundamentals of Image Processing; Image Transforms	Need for DIP- Fundamental steps in DIP – Elements of visual perception -Image sensing and Acquisition – Image Sampling and Quantization – Imaging geometry, discrete image mathematical characterization. Two-dimensional Fourier Transform-Properties – Fast Fourier Transform – Inverse FFT,Discrete cosine transform and KL transform. -Discrete Short time Fourier Transform- Wavelet Transform- Discrete wavelet Transform- and its application in Compression.	6	1
Module 2: Image Enhancement	Spatial Domain: Basic relationship between pixels- Basic Gray level Transformations – Histogram Processing – Smoothing spatial filters- Sharpening spatial filters. Frequency Domain: Smoothing frequency domain filters- sharpening	6	2

	frequency domain filters Homomorphic filtering		
Module 3: Image Restoration	Overview of Degradation models –Unconstrained and constrained restorations- Inverse Filtering ,Wiener Filter.	6	3
Module 4: Feature Extraction	Detection of discontinuities – Edge linking and Boundary detection- Thresholding- - Edge based segmentation-Region based Segmentation- matching-Advanced optimal border and surface detection- Use of motion in segmentation. Image Morphology – Boundary descriptors- Regional descriptors.	6	4
Module 5: Image Reconstruction from Projections	Need- Radon Transform – Back projection operator- Projection Theorem- Inverse Radon Transform.	4	5

Text Books:

1. Rafael C.Gonzalez, Richard E.Woods (2017). Digital Image Processing (4th edition). Pearson Education.
2. Anil.K.Jain (2003).Fundamentals of Digital Image Processing. Pearson Education.

Reference Books:

1. B.Chanda, D.Dutta Majumder (2002).Digital Image Processing and Analysis (2nd edition). Prentice Hall of India.
2. William K. Pratt (1991). Digital Image Processing (2nd Edition). John Wiley & Sons.\

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AD10306ACredit: 3 (L-3, T-0, P-0)

Compiler Design

Questions to be set: 05 (All Compulsory)

Course Objectives: The main objective of this course is to introduce the major concept areas of language translation and compiler design and to develop an awareness of the function and

complexity of modern compilers. This course is a study of the theory and practice required for the design and implementation of interpreters and compilers for programming languages.

Pre-requisites: Discrete Structures for Computer Science, Formal Language and Automata Theory and Programming skills

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Learn the process of translating a modern high-level language to executable code.

CO 2: Develop an awareness of the function and complexity of modern compilers.

CO 3: Apply the code generation algorithms to get the machine code for the optimized

Code.

CO 4: Understand the machine dependent code and intermediate codes.

CO 5: Apply the optimization techniques to have a better code for code generation

Module	Topics	Hrs	CO
Module 1: Compiler structure and Lexical analysis	Analysis-synthesis model of compilation, Various phases of a compiler, Tool based approach to compiler construction, Input Buffering. Interface with input, Parser and symbol table, Token, Lexeme and patterns, Regular definition, Transition diagrams, LEX.	6	1
Module 2: Syntax analysis and Syntax directed translation	CFG's, Ambiguity, Associativity, Precedence, Top down parsing, Recursive descend parsing, Transformation on the grammars, Predictive parsing, Bottom up parsing, Operator precedence grammars, LR parsers (SLR, Canonical, LALR), YACC. Inherited and synthesized attributes, Dependency graph, Evaluation order, Bottom up evaluation of S- attributed definitions L- attributed definitions and top down translation of attributes.	6	2

	2.		
Module 3: Type checking and Run time environments	Type system, Type expressions, Structural and name equivalence of types, Type conversion. Storage organization, Storage-allocation strategies, Access to nonlocal names, Activation tree, Activation record, Parameter passing, Symbol table and dynamic storage allocation	6	3
Module 4: Intermediate code generation	Intermediate representations, Translation of declarations, Assignments, Control flow, Boolean expressions and procedure calls ,Three-address code, Implementation of three address statements (Quadruples, Triples, Indirect triples).	6	4
Module 5: Code generation	Issues in the design of a code generator, Basic blocks and flow graphs, Next use information, Register allocation, Code generation algorithm, Dag representation of programs, Code generation from dags, Peephole optimization and code generator generators.	6	5

Text Books:

1. A.V. Aho, R. Sethi, J.D. Ullman (2006). Compilers: Principles, Techniques and Tools (2nd edition). Addison Wesley.
2. Steven S. Muchnick (2007). Advanced Compiler Design and Implementation (1st Edition) Elsevier Science & Technology.

Reference Books:

1. W. Appel (2004) Modern Compiler Implementation in C: Basic design. Cambridge Press.
2. C. Fraser, D. Hanson (1985) Retargetable C Compiler: Design and Implementation (1st edition). Addison-Wesley.
3. A. V. Aho, J. D. Ullman (1972) Theory of Parsing, Translation and Compiling Prentice Hall.

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AD10307A **Credit: 3 (L-3, T-0, P-0)**

AI for Internet of Things (IoT)

Questions to be set: 05 (All Compulsory)

Course Objectives: This Course focuses on hands-on AI based IoT concepts such as sensing, actuation and communication. It covers the development of AI based Internet of Things (IoT) prototypes—including devices for sensing, actuation, processing, and communication—to help you develop skills and experiences. The AI based Internet of Things (IOT) is the next wave, world is going to witness. Today we live in an era of connected devices the future is of connected things.

Pre-requisites: Basic programming concept and hardware interface

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Understand the concept of AI based Internet of Things

CO 2: Implement interfacing of various sensors with Arduino.

CO 3: Demonstrate the ability to transmit data wirelessly between different devices.

CO 4: Use ability to upload/download sensor data on cloud and server.

CO 5: Apply the concept of AI based Internet of Things Protocols and Cloud Platforms

Module	Topics	Hrs	CO
Module 1: Introduction to IOT	Understanding IoT fundamentals , IOT Architecture and protocols , Various Platforms for IoT , Real time Examples of IoT , Overview of IoT components and IoT Communication Technologies , Challenges in IOT	5	1

Module 2: Arduino / Raspberry Pi Simulation Environment	Arduino Uno/ Raspberry Pi Architecture , Setup the IDE, Writing Arduino/ Raspberry Pi Software , Arduino/ Raspberry Pi Libraries , Basics of Embedded C programming for Arduino/ Raspberry Pi , Interfacing LED, push button and buzzer with Arduino, Interfacing Arduino with LCD	7	2
Module 3: Sensor & Actuators with Arduino	Overview of Sensors working, Analog and Digital Sensors, Interfacing of Temperature, Humidity, Motion, Light and Gas Sensor with Arduino , Interfacing of Actuators with Arduino. Interfacing of Relay Switch and Servo Motor with Arduino	6	3
Module 4: Basic Networking with ESP8266 WiFi module	Basics of Wireless Networking , Introduction to ESP8266 Wi-Fi Module, Various Wi-Fi library , Web server- introduction, installation, configuration , Posting sensor(s) data to web server.	6	4
Module 5: IoT Protocols and Cloud Platforms for IOT	M2M vs. IOT, Communication Protocols. Virtualization concepts and Cloud Architecture , Cloud computing, benefits, Cloud services -- SaaS, PaaS, IaaS, Cloud providers & offerings , Study of IOT Cloud platforms , ThingSpeak API and MQTT, Interfacing ESP8266 with Web services.	6	5

Text Books:

1. Cuno Pfister (2011).Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud **(**1st edition). Make Community, LLC.

Reference Books:

1. Miller Michael (2015).Internet of Things, The: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World. QUE
2. Andrew Minteer (2017).Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices (1st edition). Packt Publishing.

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AD10308A **Credit: 3 (L-3, T-0, P-0)**

Speech Processing

Questions to be set: 05 (All Compulsory)

Course Objectives: To enrich the knowledge of the students with a sound understanding of various techniques of speech processing. It begins with the human speech production mechanism and then goes on to the fundamental parameters of speech such as pitch frequency, formants, spectral features like log spectrum, 3-D spectrogram, cepstral features, MFCC, linear prediction coefficients, transform-domain parameters, etc. It deals with applications like speech coding, speech enhancement, speaker and language recognition, speech recognition, text to speech synthesis, and the overview of state-of-the-art techniques like DNN for speech processing

Pre-requisites: Signal Processing (Recommended, but not necessary), Probability and Random Process.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain the speech production and perception process.

CO 2: Analyze speech signals in time and frequency domain.

CO 3: Describe statistical modeling techniques for speech signal.

CO 4: Apply channel compensation and classification techniques to speech processing applications.

CO 5: Implement simple algorithms for processing speech signals.

Module	**Topics**	**Hrs**	**CO**
Module 1: Speech Signal: Production, Perception, and Acoustic-phonetic characterization	Process of **S**peech production and Perceptions in Human Beings, Speech-Production Process, Representing Speech in the Time and Frequency domains, Place and Manner of Articulation, Windowing, Pre-emphasis filter, STFT, Spectrogram. Concept of filter bank, Auditory perception: psycho acoustics	8	1

Module 2: Speech Analysis	Prosodic features:-Energy contour, Pitch contour, and Syllable duration, Voiced /Unvoiced detection using Energy and Zero crossing Rate, AMDF and Pitch. Acoustic features:- LPC- Basic Principles of linear predictive analysis, Auto correlation method, Solution of LPC equations using Durbin's Recursive algorithm, Cepstral analysis of Speech, MFCC, Shifted Delta Cepstral. Perceptual Linear Prediction (PLP) Speech distortion measures – mathematical and perceptual considerations; Spectral–Distortion Measures: Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Liftering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.	8	2
Module 3: Statistical Modeling	K-means clustering and Vector quantization, Gaussian mixture Modeling, Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues	8	3
Module 4: Channel Compensation Techniques and Classifiers	*Overview of Compensation Techniques:* Linear Discriminant Analysis (LDA), Within-class covariance normalization (WCCN), Nuisance Attribute Projection (NAP) *Overview of Classifiers:* Cosine distance scoring, Support vector machine, Gaussian PLDA, Logistic regression, Deep Neural network (DNN)	6	4
Module 5: Application of speech processing	Speech Coding, Speech Enhancement, Speaker and Language recognition, Automatic Speech Recognition, Text to Speech Synthesis	6	5

Text Books:

1. Thomas F, Quatieri (2008). Discrete-Time Speech Signal Processing.(Prentice Hall Pearson Education,2004.

2. Douglas O'Shaughnessy, Speech communication: human and machine, Addison-Wesley Pub.Co.,1987
3. L.R. Rabiner and B. H. Juang, Fundamentals of Speech Recognition, Prentice Hall,1993.

Reference Books:

1. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons Inc., Singapore, 2004
2. L.R.Rabiner and R.W.Schaffer – Digital Processing of Speech signals – Prentice Hall -1979
3. J.R. Deller, J.H.L. Hansen and J.G. Proakis, Discrete Time Processing of Speech Signals, John Wiley, IEEE Press, 1999.

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Program Elective-III (6th Semester)

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AD10309A **Credit: 3 (L-3, T-0, P-0)**

Cloud Computing

Questions to be set: 05 (All Compulsory)

Course Objectives: This course gives an introduction to cloud computing and its techniques - Infrastructure as a Service (IaaS), Platform-as-a-Service (PaaS), Software as a Service (SaaS), issues, ecosystem and case studies

Pre-requisites: Knowledge of computer systems, programming and debugging, with a strong competency in at least one language (such as Java/Python), and the ability to pick up other languages as needed.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Understanding Cloud Computing and Privacy /Security in Cloud computing

CO 2: Developing different Cloud Services

CO 3: Reframe Business profit using Cloud

CO 4: Implementation cloud computing every aspect

CO 5: Develop various cloud programming models and apply them to solve problems on the cloud

Module	Topics	Hrs	CO
Module 1: Understanding Cloud Computing and Privacy /Security in Cloud computing	Cloud computing, History of cloud computing, Cloud architecture, Cloud storage, Why cloud computing matters, Advantages of cloud computing, Disadvantages of cloud computing, Companies in the cloud today. Federation in the cloud, Presence in the cloud, Privacy and its relation to cloud-based information systems, Security in the cloud, Common standards in the cloud, End-user access to the cloud computing.	6	1
Module 2: Developing Cloud	Web-based application, Pros and cons of cloud service development, Types of cloud service development, Software as a service, Platform as a service, Web	6	2

Services	services, On demand computing, Discovering cloud services, Development services and tools, Amazon Ec2, Google app engine, IBM clouds.		
Module 3: Cloud Utility and Business profit	Software utility application architecture, Characteristics of a SaaS, Software utility applications, Cost versus value, Software application services framework, Common enablers, Conceptual view to reality, Business profits, Implementing database systems for multitenant architecture.	6	3
Module 4: Cloud Computing for Everyone	Centralizing email communications, Collaborating on schedules, Collaborating on To-Do Lists, Collaborating contact lists, Cloud computing for the community, Collaborating on group projects and events, Cloud computing for the corporation.	6	4
Module 5: Using cloud services	Collaborating on calendars, Schedules and task management, Exploring online scheduling applications, Exploring online planning and task management, Collaborating on event management, Collaborating on contact management, Collaborating on project management, Collaborating on word processing, Collaborating on databases, Storing and sharing files.	6	5

Text Books:

1. Michael Miller (2008). Cloud computing: Web based applications that change the way you work and collaborate online. (1st edition) . Pearson Education India.
2. Haley Beard (2009). Cloud computing best practices for managing and measuring processes for on demand computing, Applications and data centers in the cloud with SLAs.(2nd edition) . Emereo Pty Ltd.

Reference Books:

1. Guy Bunker, Darren Thomson (2007) . Delivering Utility Computing. (1st edition).John Wiley & Sons.
2. George Reese (2009). Cloud Application Architectures.(1st edition).O'Reilly Media.

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AD10310A **Credit: 3 (L-3, T-0, P-0)**

Remote Sensing & GIS

Questions to be set: 05 (All Compulsory)

Course Objectives: Remote Sensing and GIS is a relatively recent discipline and is an area of emerging technology with a phenomenal growth over last four decades. The Remote Sensing technology is now beyond the art of Map making from satellite or Aerial images. The demand for Remote Sensing and GIS is increasing day by day in Government and Private sector. The course is not only going to enhance job opportunity for the civil students but shall also open an avenue of effective and viable interaction with national establishments related to various aspects of remote sensing

Pre-requisites: Knowledge of surveying, map reading and basic mathematics

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Understand the concepts of Photogrammetry and compute the heights of objects

CO 2: Relate the principles of aerial and satellite remote sensing, Able to comprehend the energy interactions with earth surface features, spectral properties of water bodies .

CO 3: Categorize the basic concept of GIS and its applications, know different types of data representation in GIS

CO 4: Reframe and Develop models for GIS spatial Analysis and will be able to know what the questions that GIS can answer are

CO 5: Apply knowledge of GIS software and able to work with GIS software in various application fields

Module	Topics	Hrs	CO
Module 1: Remote Sensing and Electromagnetic Radiation	Definition of Remote Sensing; History and development of RS; Benefits of RS over conventional method of resource survey. Components of Remote Sensing System. Electromagnetic Radiation (EMR), Nature and generation of EMR; Effects of atmosphere on EMR and its interaction with rocks minerals vegetation, water, soil etc.	6	1
Module 2: Platform and properties of sensors	Platform, Role of platform in Remote Sensing, Types of platform with their specific uses. Fundamental properties of sensors and their functions. Basic features of	6	2

	different types of sensors in use.		
Module 3: RS data and GIS	RS data products. Principles of RS data analysis and their applications. Fundamentals of Geographic information system. Components of GIS.	6	3
Module 4: Classification schemes in GIS	Classification schemes in GIS. Training site selection; supervised classification.	2	4
Module 5: . Application of RS and GIS	Geographic information system, Data structure of GIS, Raster and vector data for geographical entities. Application of RS and GIS in Geology and Geography. Application of RS and GIS in Environmental Science and Town planning.	6	5

Text Books:

1. Lillesand, T.M., Keifer, R.W., Chipman, J.W(2008) Remote Sensing and Image interpretation. (6^{th} edition). John Wiley & Sons.

Reference Books:

1. Jenson, J.R (2013) Remote Sensing of the Environment. (2nd edition). Pearson Education India.
2. Panda, B.C (2008) Remote Sensing- principles and Application. Viva Books.

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AD10311A **Credit: 3 (L-3, T-0, P-0)**

Augmented and Virtual Reality

Questions to be set: 05 (All Compulsory)

Course Objectives: The objective of the course is to establish and cultivate a broad and comprehensive understanding of this rapidly evolving and commercially viable field of Computer Science. The technology of VR and AR is really hitting the ground right now. With these methods, the businesses are trying to get their brands to a whole new level of success and popularity. Integrating AR/VR in development can provide many advantages like: Improved Experience for Learning in sectors like education, Increasing Efficiency In Business, Unmatchable Virtual Experience, Increase In User Engagement, Boost In Brand Loyalty, Mobility, Better Advertising of products and many more

Pre-requisites: NA

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Understand fundamental computer vision, computer graphics andhuman-computer interaction techniques related to VR/AR. (Understand)

CO 2: Illustrate geometric modeling and Virtual environment. (Understand)

CO 3: Relate and differentiate VR/AR technology. (Analyse)

CO 4: Use various types of Hardware and software in virtual Reality systems (Apply)

CO 5: Implement Virtual/Augmented Reality applications. (Apply)

Module	Topics	Hrs	CO
Module 1: Introduction to Virtual Reality	Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark.	5	1
Module 2: Computer Graphics And	Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, Colour theory, Conversion From 2D to 3D, 3D space curves, 3D boundary	6	2

Geometric Modelling	representation, Simple 3D modelling, 3D clipping, Illumination models, Reflection models, Shading algorithms. Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection. Virtual Environment: Input: Tracker, Sensor, Digital Gloves, Movement Capture, Video-based Input, 3D Menus & 3D Scanner etc. Output: Visual /Auditory / Haptic Devices.		
Module 3: Generic VR system	Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.	6	3
Module 4: Animating the Virtual Environment	Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in between, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.	6	4
Module 5: Augmented Reality	Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.	6	5

Text Books:

1. Alan Craig, William Sherman, Jeffrey Will (2009) Developing Virtual Reality Applications: Foundations of Effective Design. Morgan Kaufmann.
2. John Vince(1995) Virtual Reality Systems. Addison Wesley.

Reference Books:

1. Grigore C. Burdea, Philippe Coiffet (2006) Virtual Reality Technology. (2nd edition) Wiley .
2. Alan B. Craig (2013) Understanding Augmented Reality: Concepts and Applications. (1st edition) Morgan Kaufmann.

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AD10312A **Credit: 3 (L-3, T-0, P-0)**

Parallel and Distributed Algorithms

Questions to be set: 05 (All Compulsory)

Course Objectives: **:** To provide you with an introduction and overview to the computational aspects of parallel and distributed computing. To introduce several important parallel computing models that capture the essence of existing and proposed types of synchronous and asynchronous parallel computers. To study typical models for distributed computing.

Pre-requisites: Multiprocessor systems, Design and Analysis of Algorithms, Parallel Computing.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Develop and apply knowledge of parallel and distributed computing techniques and methodologies.

CO 2: Apply design, development, and performance analysis of parallel and distributed applications.

CO 3: Transfer the design, testing, and performance analysis of a software system, and to be able to communicate that design to others.

CO 4: Correlate the concept of Scheduling and Dictionary Operations

CO 5: Design the application of fundamental Computer Science methods and algorithms in the development of parallel applications.

Module	**Topics**	**Hrs**	**CO**
Module 1: The Idea of Parallelism	A Parallelised version of the Sieve of Eratosthenes, PRAM Model of Parallel Computation, Pointer Jumping and Divide & Conquer: Useful Techniques for Parallelization	6	1
Module 2: PRAM Algorithms	Parallel Reduction, Prefix Sums, List Ranking, Preorder Tree Traversal, Merging Two Sorted Lists, Graph Coloring, Reducing the Number of Processors and Brent's Theorem	4	2

Module 3: Dichotomoy of Parallel Computing Platforms	Cost of Communication, Programmer's view of modern multi-core processors, The role of compilers and writing efficient serial programs, Parallel Programming Languages: Shared Memory Parallel Programming using OpenMP, Parallel Complexity: The P-Complete Class	8	3
Module 4: Scheduling and Dictionary Operations	Mapping and Scheduling, Elementary Parallel Algorithms, Matrix Multiplication, Writing efficient openMP programs, Sorting Parallel Search, Graph Algorithms, Safety, liveness, termination, logical time and event ordering	6	4
Module 5: Algorithms and Synchronization	Global state and snapshot algorithms, Mutual exclusion and Clock Synchronization, Distributed Graph algorithms, Distributed Memory Parallel Programming: Cover MPI programming basics with simple programs and most useful directives; Demonstrate Parallel Monte Carlo	4	5

Text Books:

1. Michael J Quinn (2017). Parallel Computing (2nd edition). McGraw Hill Education TMH
2. Joseph Jaja (1992). An Introduction to Parallel Algorithms(1st edition). Pearson Education India.

Reference Books:

1. Mukesh Singhal , Niranjan G. Shivaratri (2017). Advanced Concepts in Operating Systems. McGraw Hill Education.
2. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar (2003) Introduction to Parallel Computing (2nd edition). Addison-Wesley.

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Program Elective-IV (6th Semester)

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AD10313A **Credit: 3 (L-3, T-0, P-0)**

Social Network Analytics

Questions to be set: 05 (All Compulsory)

Course Objectives: To understand how the world is connected -- socially, strategically, technologically, and why it matters, To introduce the basic notions and model used for social

Pre-requisites: Data Structure, DBMS

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Develop and apply knowledge of Social Network

CO 2: Analyze master theories of social networks and social behaviour

CO 3: Acquire techniques for analyzing social network data

CO 4: Reframe analytical skills to social network data

CO 5: Apply social network analysis to marketing research

Module	Topics	Hrs	CO
Module 1: Introduction and Social Network Data	Motivation, The Social network perspective, Different sources of network data, Historical and Theoretical Foundation, Fundamental concepts of network analysis. Preliminaries and definitions, Erdos Number Project, Centrality measures, Balance and Homophily; Definition, Boundary Specification and Sampling, Types of networks – One mode networks, Two mode networks, Ego-centered and Specific Dyadic networks, Network data, Measurement, Collection, Datasets.	6	1
Module 2: Mathematical Representation of	Notation for Social network data, Graph Theory, Sociometri Notation, Algebraic Notation, Graphs, Directed Graph, Signed graph, Valued graph, Multigraph, Hypergraph, Matrices of graph, digraph, hypergraph, Random	7	2

Social Network	graphs and alternative models, Models of network growth, Navigation in social Networks.		
Module 3: Structural Properties of Networks	Cohesiveness of subgroups, roles and positions, Multidimensional Scaling, Ego networks, Weak ties, Structural equivalence, Structural hole, Equitable partitions, Stochastic block models.	6	3
Module 4: Cascading Properties of Networks	Information/influence diffusion on networks, Maximizing influence spread, Power Law and Heavy tail distributions, Preferential attachment models, Small world experiments, Small world models, Origins of small world, Heavy tails, Small Diameter,	6	4
Module 5: Clustering of connectivity Models of Network Formation and Preferential Model	Erdos-Renyi Model- The Model & Threshold Phenomenon, Clustering Models – The Model, Programming Clustering, Clustering Coefficient, Community and cluster detection: random walks, spectral methods; link analysis for web mining.	6	5

Text Books:

1. S. Wasserman , K. Faust(1994). Social Network Analysis: Methods and Applications. (1st edition). Cambridge University Press.
2. D. Easley , J. Kleinber (2010). Networks, Crowds and Markets: Reasoning about a highly connected world. Cambridge University Press.

Reference Books:

1. Peter R. Monge, Noshir S (2003). Contractor, Theories of communication networks.(1st edition) Oxford University Press.
2. Duncan Watts.(2004). Six degrees: the science of a connected age.(Reprint edition) W. W. Norton & Company .

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AD10314A **Credit: 3 (L-3, T-0, P-0)**

Block Chain Technologies

Questions to be set: 05 (All Compulsory)

Course Objectives: **:** This course is intended to study the basics of Blockchain technology. During this course learner will explore various aspects of Blockchain technology like application in various domains. By implementing learner will have idea about private and public Blockchain, and smart contract.

Pre-requisites: Cryptography, Data Structure, Networking, OOP

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Describe the basic concepts and technology used for blockchain.

CO 2: Understand the primitives of the distributed computing and cryptography related to blockchain.

CO 3: Relate the concepts of Bitcoin and their usage.

CO 4: Implement Ethereum block chain contract.

CO 5: Apply security features in blockchain technologies.

Module	Topics	Hrs	CO
Module 1: Introduction of Cryptography and Blockchain	What is Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions And Blocks, P2P Systems, Keys As Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.	6	1
Module 2: BitCoin and Cryptocurrency	What is Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain And Digital Currency, Transactional Blocks, Impact Of Blockchain Technology On Cryptocurrency.	6	2

Module 3: Introduction to Ethereum	What is Ethereum, Introduction to Ethereum, Consensus Mechanisms, How Smart Contracts Work, Metamask Setup, Ethereum Accounts, Receiving Ether's What's a Transaction?, Smart Contracts.	6	3
Module 4: Introduction to Hyperledger and Solidity Programming	What is Hyperledger? Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types (Int, Real, String, Bytes, Arrays, Mapping, Enum, address)	8	4
Module 5: Blockchain Applications	Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.	4	5

Text Books:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller , Steven Goldfeder (2016). Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction.(Illustrated edition)Princeton University Press .
2. Andreas M. Antonopoulos (1 January 2017)Antonopoulos, Mastering Bitcoin.(Second edition)Shroff/O'Reilly

Reference Books:

3. Antonopoulos , G. Wood (2018) Mastering Ethereum. O′Reilly.

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AD10315A **Credit: 3 (L-3, T-0, P-0)**

High Performance Computing

Questions to be set: 05 (All Compulsory)

Course Objectives: To explore the fundamental concepts of Parallel programming and HPC Solutions and their applications. To develop in-depth knowledge and understanding of HPC domain. To understand the various search methods and visualization techniques. To learn to use various HPC tools. To understand the applications using Map Reduce Concepts, OpenMP, CUDA, MPI, Xeon Phi programming.

Pre-requisites: Programming in C/C++, basic knowledge of UNIX/Linux shell, familiarity with basic numerical algorithms and computer architecture.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Understanding principles of multi-threading and distributed computing

CO 2: Solving sources and models of costs in parallel environments (cache, memory, network)

CO 3: Relate parallel programming patterns. Being able to design and develop cluster systems and MPI Implementations

CO 4: Estimate and measure performance of a Hybrid programming

CO 5: Collaborate different parallel programming programing Tools

Module	Topics	Hrs	CO
Module 1: Introduction and Categories of machines	High performance computing: Why, and why now? Concepts and scientific applications, Parallel decomposition, basic architecture and OS concepts, Multi-core CPUs, High-speed interconnects, High performance file systems, GPU systems, High performance clusters. Multicore and many core shared memory machines via the work-span model, distributed memory machines like clusters and supercomputers via network models, and sequential or parallel machines with deep memory hierarchies.	6	1

Module 2: Parallel computing and Programming of multicore systems	Parallel computer architecture and parallel software, processor and memory systems of parallel computers, different types of parallelism (on instruction level, on computational task level and data parallelism), performance models for parallel systems Shared memory multiprocessing programming (OpenMP). OpenMP Programming Model, OpenMP API Overview, Compiling OpenMP Programs, OpenMP, Synchronization Constructs, Directives, Data Scope Attribute Clauses, Directive Binding and Nesting Rules, Run-Time Library Routines, Environment Variables, Thread Stack Size and Thread Binding, Monitoring, Debugging and Performance Analysis Tools for OpenMP, Case Studies (Algorithms and Parallelization Approaches), Matrix –Matrix-multiplication.	6	2
Module 3: Programming of cluster systems and MPI Implementations	Message Passing Interface (MPI) and approaches for the parallelization of programs: General Introduction, Point-to-Point Communication, Blocking vs. Non-blocking sends, Collective Communication, MPI hybrid models, profiling, and debugging, Case Studies (Algorithms and Parallelization Approaches). Compilers, Environment Management Routines: Point to Point Communication Routines, MPI Message Passing Routine Arguments, Blocking Message Passing Routines, Non-blocking Message Passing Routines, Collective Communication Routines, Derived Data Types Group and Communicator Management Routines, Virtual Topologies.	6	3
Module 4: Hybrid programming (OpenMP and MPI)	Numerical libraries & high performance I/O libraries, Introduction to multi-threading accelerators, A Brief introduction on MPI-2 and MPI-3.	6	4
Module 5: HPC tools	Profiling and Debugging of codes tools: gprof, Vtune, gdb, Performance library like mkl, lapack, fft , Analysis tools like : ITAC , MPI libraries. Demo of the sample code by using the above tools.	6	5

Text Books:

1. Michael J Quinn (2008). Parallel Programming in C with MPI and OpenMP. McGraw-Hill Higher Education.
2. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar (2003) Introduction to Parallel Computing(2nd edition). Pearson Education India.
3. Rohit Chandra, Ramesh Menon, Leo Dagum, David Kohr,Dror Maydan,Jeff McDonald (11 October 2000). Parallel Programming in OpenMP (1st edition). Morgan Kaufmann.

Reference Books:

1. Georg Hager, Gerhard Wellein July 7, 2010 Introduction to High Performance Computing for Scientists and Engineers. Chapman & Hall / CRC Computational Science series, 2011.

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AD10316A **Credit: 3 (L-3, T-0, P-0)**

Bio-Inspired Computing

Questions to be set: 05 (All Compulsory)

Course Objectives: To Learn bio-inspired theorem and algorithms, To Understand random walk and simulated annealing, To Learn genetic algorithm and differential evolution, To Learn swarm optimization and ant colony for feature selection, To understand bio-inspired application in image processing

Pre-requisites: Statistics and Optimization Methods,Basic of AI and image processing

Course Outcomes(CO):

Upon successful completion of the course, students should be able to

CO 1: Implement and apply bio-inspired algorithms

CO 2: Explain random walk and simulated annealing

CO 3: Implement and apply genetic algorithms

CO 4: Explain swarm intelligence and ant colony for feature selection

CO 5: Apply bio-inspired techniques in image processing.

Module	Topics	Hrs	CO
Module 1: INTRODUCTION	Introduction to algorithm - Newton ' s method - optimization algorithm - No-Free-Lunch Theorems - Nature-Inspired Mataheuristics -Analysis of Algorithms -Nature Inspires Algorithms -Parameter tuning and parameter control.	6	1
Module 2: RANDOM WALK AND ANEALING	Random variables - Isotropic random walks - Levy distribution and flights - Markov chains - step sizes and search efficiency - Modality and intermittent search strategy - importance of randomization- Eagle strategy-Annealing and Boltzmann Distribution - parameters -SA algorithm - Stochastic Tunneling.	6	2

Module 3: GENETIC ALOGORITHMS AND DIFFERENTIAL EVOLUTION	Introduction to genetic algorithms and - role of genetic operators - choice of parameters - GA varients - schema theorem - convergence analysis - introduction to differential evolution - varients - choice of parameters - convergence analysis - implementation.	6	3
Module 4: SWARM OPTIMIZATION AND FIREFLY ALGORITHM	Swarm intelligence - PSO algorithm - accelerated PSO - implementation - convergence analysis - binary PSO - The Firefly algorithm - algorithm analysis - implementation - varients- Ant colony optimization toward feature selection.	6	4
Module 5: APPLICATION IN IMAGE PROCESSING	Bio-Inspired Computation and its Applications in Image Processing: An Overview - Fine- Tuning Enhanced Probabilistic Neural Networks Using Meta-heuristic-driven Optimization - Fine-Tuning Deep Belief Networks using Cuckoo Search - Improved Weighted Thresholded Histogram Equalization Algorithm for Digital Image Contrast Enhancement Using Bat Algorithm - Ground Glass Opacity Nodules Detection and Segmentation using Snake Model - Mobile Object Tracking Using Cuckoo Search	6	5

Textbooks:

1. Stephan Olariu and Albert Zomaya, (2006) Hanbook of Bioinspired Algorithms and Applications, Taylor & Francis Ltd

Reference Books:

1. Nancy Forbes(2004). Imitation of Life - How Biology Is Inspiring Computing (1st edition) MIT Press.
2. Bonabeau, Eric, Dorigo, Marco, & Theraulaz, Guy(1999). Swarm Intelligence: From Natural to Artificial Systems(1st edition) . Oxford.

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Program Elective-V (7th Semester)

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AD10317A Credit: 3 (L-3, T-0, P-0)

Quantum Computing

Questions to be set: 05 (All Compulsory)

Course Objectives: Analyze the behavior of basic quantum algorithms; ii. Implement simple quantum algorithms and information channels in the quantum circuit model; iii. Simulate a simple quantum error-correcting code; iv. Prove basic facts about quantum information channels

Pre-requisites: Familiarity with linear algebra including concepts such as vector space, inner products, matrices, eigenvalues and eigenvectors will be assumed.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Understand what quantum computing and quantum protocols are about, why they matter, and what the scientific prospects of the field are.

CO 2: This includes a structural transfer of some basic quantum mechanics, knowledge of important algorithms

CO 3: Analyze Quantum error correction

CO 4: At the same time, the student will evaluate Quantum Entanglement

CO 5: Develop different implementations of quantum computers

Module	Topics	Hrs	CO
Module 1: Introduction of Quantum Cryptography	Introduction of quantum computing Cryptography, classical cryptography, introduction to quantum cryptography. BB84, B92 protocols. Introduction to security proofs for these protocols.	6	1
Module 2: Quantum Algorithm	Introduction to quantum algorithms. Deutsch-Jozsa algorithm, Grover's quantum search algorithm, Simon's algorithm. Shor's	6	2

	quantum factorization algorithm.		
Module 3: Error Correction	Errors and correction for errors. Simple examples of error correcting codes in classical computation. Linear codes. Quantum error correction and simple examples. Shor code.	6	3
Module 4: Quantum Entanglement	Quantum correlations, Bell's inequalities, EPR paradox. Theory of quantum entanglement. Entanglement of pure bipartite states. Entanglement of mixed states. Peres partial transpose criterion. NPT and PPT states, bound entanglement, entanglement witnesses.	6	4
Module 5: Implementations	Different implementations of quantum computers. NMR and ensemble quantum computing, Ion trap implementations. Optical implementations.	6	5

Text Books:

1. M.A. Nielsen, I.L.Chuang (2010). Quantum Computation and Quantum Information Cambridge. University Press.

Reference Books:

1. P. Kaye, R. Laflamme, M. Mosca (2007). An Introduction to Quantum Computing. Oxford.
2. Robert Loredo (2020) Learn Quantum Computing with Python and IBM Quantum Experience: A hands-on introduction to quantum computing and writing your own quantum programs with Python. Packt Publishing Limited.

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AD10318A **Credit: 3 (L-3, T-0, P-0)**

Machine learning in VLSI Design

Questions to be set: 05 (All Compulsory)

Course Objectives: 1.Use machine learning technologies in VLSI CAD to further automate the design, verification and implementation of the most advanced chips. 2. Relate to the usage of machine learning algorithms for Compact Lithographic Process Models. 3. Apply Machine Learning in Mask Synthesis and Physical Verification to bear on CAD problems such as hotspot detection, efficient test generation, post-silicon measurement minimization. 4. Predict the Yield and Reliability of VLSI chips using machine learning methods

Pre-requisites: **:** Probability and Random Process, Linear Algebra, and Optimization Techniques.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: To illustrate knowledge of VLSI design

CO 2: To interpret knowledge about the Artificial Neural networks and deep learning in VLSI CAD.

CO 3: To apply the fundamental concepts relevant to ANN architectures and deep learning algorithms in Compact Lithographic Process.

CO 4: To relate the applications of ML in mask synthesis

CO 5: To reframe the applications and use cases of Deep Learning architectures for VLSI circuits and design automation

Module	**Topics**	**Hrs**	**CO**
Module 1: **VLSI Design Concepts**	Moore's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI – basic idea only), CMOS inverter, Complex logic circuit, Pass transistors, Transmission gate, Complementary passes logic circuit, Dynamic CMOS circuit, NORA logic, Domino Logic, CMOS logic circuits (SR latch, D flip flop), DRAM, SRAM, An overview of clean room, single crystal wafer formation, oxidation, ion implantation and metallization, photolithography, Stick diagram, with specific examples, layout rules. Basic concept of Floor paining, Placement and routing methods and their important algorithms; Fault types and models	10	1
Module 2: A Preliminary Taxonomy for	VLSI CAD Abstraction levels, Machine Learning for Compact Lithographic Process Models, Introduction, Lithographic Patterning Process, Representation of Lithographic Patterning Process –Mask, Imaging, Resist & Etch Transfer	5	2

Machine Learning in VLSI CAD	Function		
Module 3: Machine Learning of Compact Lithographic Process Models	Compact process model machine learning problem statement, CPM Task, CPM Training Experience,Performance metrics, Supervised learning of a CPM ,Neural Network Compact Patterning Models,Neural Network Mask Transfer Function, Neural Network Image Transfer Function, Neural Network Resist Transfer Function, Neural Network Etch Transfer Function	5	3
Module 4: Machine Learning for Mask Synthesis	Introduction, Machine Learning guided OPC, MLP Construction, ML-EPC, EPC Algorithm,Machine Learning in Physical Verification,Introduction, Machine Learning in Physical Verification – layout feature extraction & encoding	5	4
Module 5: Machine Learning in Mask Synthesis and Physical Design	Machine Learning inMask Synthesis – mask synthesis flow, Machine Learning for sub-resolution assist,features, Machine Learning for optical proximity correction, Machine Learning inPhysical Design - for datapath placement, routability driven placement, clock, optimization, lithography friendly routing,Machine Learning for Manufacturing,Gaussian Process-Based Wafer-Level Correlation Modeling and Its Applications, Machine Learning for Yield and Reliability	6	5

Text Books:

1. Ibrahim (Abe)M Elfadel, Duane SBoning, Xin Li (2019) Machine Learning in VLSI Computer Aided Design(1st edition) SpringerInternational Publishing
2. S.M Kang (2003). CMOS Digital Integrated Circuits (3rd edition) Tata McGraw Hill

Reference Books:

1. Christopher M. Bishop (2006) Pattern Recognition And Machine Learning Springer
2. Stephen Marsland (2015). Machine Learning: An Algorithmic Perspective (2nd Edition), CRC Press.
3. S.M Sze (2003). VLSI Technology(2nd edition) McGraw Hill

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AD10319A **Credit: 3 (L-3, T-0, P-0)**

Cryptography and Network Security

Questions to be set: 05 (All Compulsory)

Course Objectives: This course provides an overview of computer security principles ranging from cryptography to network security. The course will help students to learn the principles and practices of computer security in various computing environments.

Pre-requisites: Computer Networks and Number theory.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Understand basic concept of Cryptography and Block Ciphers

CO 1: Transfer knowledge in the emerging areas of cryptography and network security.

CO 1: Implement various networking sicurity.

CO 1: Reframe add-on Protestation any network from the threats in the world.

CO 1: Implement various networking/ web application

Module	Topics	Hrs	CO
Module 1: (Introduction to Cryptography and Block Ciphers)	Introduction to security attacks - services and mechanism - introduction to cryptography - Conventional Encryption: Conventional encryption model - classical encryption techniques - substitution ciphers and transposition ciphers – cryptanalysis – steganography - stream and blockciphers - Modern Block Ciphers: Block ciphers principals - Shannon's theory of confusion anddiffusion - fiestal structure - data encryption standard(DES) - strength of DES - differential and linearcrypt analysis of DES - block cipher modes of operations - triple DES – AES	6	1
Module 2: (Confidentiality and Modular Arithmetic)	Confidentiality using conventional encryption - traffic confidentiality - key distribution - random number generation - Introduction to graph - ring and field - prime and relative prime numbers - modular arithmetic - Fermat's and Euler's theorem - primality testing - Euclid's Algorithm - Chinese	6	2

	Remainder theorem - discrete algorithms.		
Module 3: (Public key cryptography and Authentication requirements)	I Principles of public key crypto systems - RSA algorithm - security of RSA - key management – Diffle-Hellman key exchange algorithm - introductory idea of Elliptic curve cryptography – Elgamel encryption - Message Authentication and Hash Function: Authentication requirements - authentication functions - message authentication code - hash functions - birthday attacks – security of hash functions and MACS.	6	3
Module 4: (Integrity checks and Authentication algorithms)	MD5 message digest algorithm - Secure hash algorithm (SHA) Digital Signatures: Digital Signatures - authentication protocols - digital signature standards (DSS) - proof of digital signature algorithm - Authentication Applications: Kerberos and X.509 - directory authentication service - electronic mail security-pretty good privacy (PGP) - S/MIME.	6	4
Module 5: (IP Security and Key Management and Web and System Security)	IP Security: Architecture - Authentication header - Encapsulating security payloads - combining security associations - key management Secure socket layer and transport layer security - secure electronic transaction (SET) - System Security: Intruders - Viruses and related threads - firewall design principals – trusted systems.	6	5

Text Books:

1. William Stallings (2013). Cryptography and Network Security (6th Edition). Pearson.
2. Behrouz A Frouzan (2011) Cryptography and Network Security(2nd Edition) Tata McGraw Hill

Reference Books:

1. Richard E. Smith (2002). Internet Cryptography(1st Edition).Pearson.
2. D. Chapman, E. Zwicky (2000). Bulding Internet Firewalls (2nd Edition). O'Reilly.
3. Derek Atkins et al (1997). Internet Security, Professional Reference (2nd Edition).Techmedia.
4. Atul Kahate (2009). Cryptography and Network Security McGraw Hill (2nd Edition). 2nd Edition.

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AD10320A **Credit: 3 (L-3, T-0, P-0)**

Reinforcement Learning

Questions to be set: 05 (All Compulsory)

Course Objectives: The course deals with probabilistic models for problems of dynamic decision making under uncertainty. Stochastic dynamic programming is a general framework for modelling such problems. The course deals with building first the model based dynamic programming techniques and subsequently the model free, data driven algorithms, and deals with the theoretical foundations of these.

Pre-requisites: Probability and Statistics or an equivalent probability course

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Knowledge Creation on Reinforcement Learning

CO 2: Understand Tabular methods and Q-networks

CO 3: Apply different policy optimization technique

CO 4: Analysis different tools and modeling techniques for problems of dynamic decision making under uncertainty

CO 5: They will know the algorithms they can apply when faced with such problems and the convergence and accuracy guarantees that such algorithms would provide.

Module	**Topics**	**Hrs**	**CO**
Module 1: Foundations	Introduction and Basics of RL 2. Defining RL Framework and Markov Decision Process 3. Polices, Value Functions and Bellman Equations 4. Exploration vs. Exploitation 5. Code Standards and Libraries used in RL (Python/Keras/Tensorflow)	6	1
Module 2: Tabular methods and Q-networks	Planning through the use of Dynamic Programming and Monte Carlo 7. Temporal-Difference learning methods (TD(0), SARSA, Q-Learning) 8. Deep Q-networks (DQN, DDQN, Dueling DQN, Prioritised Experience Replay) 2	6	2
Module 3: Policy optimization	Introduction to policy-based methods 10. Vanilla Policy Gradient 11. REINFORCE algorithm and stochastic policy search 12. Actor-critic methods (A2C, A3C) 13. Advanced policy gradient (PPO, TRPO, DDPG)	6	3

Module 4: Model based RL	Model-based RL approach	6	4
Module 5: Recent Advances and Applications	Meta-learning 16. Multi-Agent Reinforcement Learning 17. Partially Observable Markov Decision Process 18. Ethics in RL 19. Applying RL for real-world problems	6	5

Text Books:

1. Richard S. Sutton,Francis Bach,(2019). Reinforcement Learning – An Introduction (Adaptive Computation and Machine Learning series) (Second Edition). MIT Press.
2. Lei, Chen (2021). Deep reinforcement learning. Springer
3. Wiering, Marco, Martijn Van Otterlo (2012). Reinforcement learning Adaptation, learning, and optimization. Springer.

Reference Books:

1. Russell, Stuart J., and Peter Norvig(2016) Artificial intelligence: a modern approach. Pearson Education Limited.
2. Goodfellow, Ian, Yoshua Bengio,Aaron Courville (2016). Deep learning. MIT press.

Open Electives

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OPEN ELECTIVES -1 (Semester- IV)

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AD10201A **Credit: 3 (L-3, T-0, P-0)**

Introduction to Python Programming

Questions to be set: 05 (All Compulsory)

Course Objectives: To understand the basics of algorithmic problem solving.; To learn to solve problems using Python conditionals and loops. To define Python functions and use function calls to solve problems.; To use Python data structures – lists, tuples, dictionaries to represent complex data.

Pre-requisites: Basic concept of programming

Course Outcomes:

Upon successful completion of the course, students should be able to

CO1: Summarize the strengths and limitations of Python programming tools.

CO2: Implement Python programs using conditionals and looping.

CO3: Use Python functions calls to solve problems.

CO4: Apply Python data structures – lists, tuples, and dictionaries to represent complex data.

CO5: Illustrate a class object, class function, and class methods.

Module	**Topics**	**Hrs**	**CO**
Module 1: Introduction to IDE	Course Introduction, Intro to Programming and The Python Language, Variables, Conditionals, Jupyter Notebook, and IDLE	8	1
Module 2: Python Loops and Functions	Intro to Lists, Loops, and Functions	7	2

Module 3: PyCharm	More with Lists, Strings, Tuples, Sets, and PyCharm [8 Hrs]	8	3
Module 4: Python Dictionaries and Files	Dictionaries and Files	7	4
Module 5: Python OOPs	Classes and Objects, Classes and functions, Classes and methods, Inheritance	6	5

Text Books:

1. Allen B. Downey (2016). *Think python: how to think like a computer scientist* (2nd Edition). O'Reilly

Reference Books:

1. Brian K. Jones and David Beazley (2013). *Python Cookbook* (3rd Edition). O'Reilly Media, Inc.

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OPEN ELECTIVES -2 (Semester- V)

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AD10202ACredit: 3 (L-3, T-0, P-0)

Data Analytics with Python

Questions to be set: 05 (All Compulsory)

Course Objectives: The course introduces several data analytic tools, statistical inferences, and providing hands-on experience for creating analytics models.

Pre-requisites: Basics of Python Programming

Course Outcomes:

Upon successful completion of the course, students should be able to

CO1: Use open-source IDE python software's to execute simple Python programs.

CO2: Understand and use python data science libraries as a tool for data analytics.

CO3: Demonstrate proficiency with statistical analysis of data.

CO4: Implement regression models.

CO5: Implement clustering and classification models.

Module	Topics	Hrs	CO
Module 1: Introduction	Introduction to data analytics and Python fundamentals, Integrated development environment (IDE) for python: Jupyter notebook and Pycharm	6	1
Module 2: Core Libraries in Python	Overview of Python Libraries: Math: Numpy, SciPy; Data Mining: BeautifulSoup, Scrapy; Data Exploration and Visualization: Pandas, Matplotlib, Plotly, Seaborn; Machine Learning: Scikit Learn, PyCaret, TensorFlow, Keras, PyTorch	8	2

Module 3: Descriptive Statistics	Introduction to probability, Sampling and sampling distributions, Hypothesis testing, Two sample testing and introduction to ANOVA, Two-way ANOVA	8	3
Module 4: Regression	Linear regression and multiple regressions, Logistic Regression, ROC and Regression Analysis Model Building	8	4
Module 5: Clustering	c^2 Test and introduction to cluster analysis, Classification and Regression Trees (CART)	6	5

Text Books:

1. Bharti Motwani (2020). *Data Analytics using Python* (1st edition). Wiley.
2. Phuong Vo.T.H, Martin Czygan, Ashish Kumar , and Kirthi Raman (2017). *Python: Data Analytics and Visualization*. Packt Publishing Limited.

Reference Books:a Analytics u

1. McKinney, W. (2012). *Python for data analysis: Data wrangling with Pandas, NumPy, and IPython*. O'Reilly Media, Inc.
2. Swaroop, C. H. (2003). *A Byte of Python*. Python Tutorial.
3. Ken Black (1994). *Business Statistics for Contemporary Decision Making*. South-Western
4. David R. Anderson et.al. (2020). *Statistics for Business and Economics*. Cengage India.
5. Douglas C. Montgomery, George C. Runger (2002). *Applied Statistics & Probability for Engineering*. John Wiley & Sons, Inc"
6. Jay L. Devore (2011). *Probability and Statistics for Engineering and the Sciences*. Cengage Learning.
7. David W. Hosmer, Stanley Lemeshow and Rodney X. Sturdivant (2000). *Applied logistic regression* (3rd edition). Wiley.
8. Jiawei Han, Micheline Kamber and Jian Pei (2006). *Data Mining: Concepts and Techniques* (2nd edition). Morgan Kaufmann
9. Leonard Kaufman, Peter J. Rousseeuw (1990). *Finding Groups in Data: An Introduction to Cluster Analysis* (1st edition). Wiley-Interscience.

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OPEN ELECTIVES -3 (Semester- VI)

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AD10203A **Credit: 3 (L-3, T-0, P-0)**

Introduction to Machine Learning

Questions to be set: 05 (All Compulsory)

Course Objectives: The objective of this course is to provide a concise introduction to the fundamental concepts in machine learning algorithms such as supervised and unsupervised learning algorithms.

Pre-requisites: Basic knowledge of Calculus, Linear Algebra, Probability and Statistics.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Apply the knowledge of linear regression and logistic regression for prediction and classification problems.

CO 2: Use supervised learning algorithms to solve classification problems.

CO 3: Explain the theoretical framework for analyzing the generalization error of a learning algorithm.

CO 4: Apply unsupervised learning algorithms for dimensionality reduction and clustering techniques to real world problems.

CO 5: Explain the basic concept of Artificial Neural Network.

Module	Topics	Hrs	CO
Module 1: Basics of ML and Regression	Basic Definition, Types of Learning: Supervised Learning, Unsupervised Learning, Semi supervised Learning and Reinforcement Learning, Examples of Machine Learning Applications., hypothesis space and inductive bias, evaluation, cross-validation ***Linear Regression:*** Linear Regression with Single Variables- Model Representation and Cost Function; Parameter Learning: Gradient Descent, Gradient Descent Intuition, Gradient Descent for Linear Regression, Linear Regression with Multiple Variables- Multiple Features, Gradient Descent for Multiple Variables, Gradient Descent in Practice: Feature Scaling and Learning Rate; Features and Polynomial Regression; ***Logistic Regression***: Classification and Representation- Classification, Hypothesis Representation and Decision Boundary, Logistic Regression Model - Cost Function, Simplified Cost Function and Gradient Descent Multiclass Classification- One-vs-all,	8	1

	Regularization: Overfitting problems, Regularized Linear Regression, Regularized Logistic Regression		
Module 2: Supervised Learning	Nearest neighbor (NN), Linear Discriminant Analysis, Support vector machines, Decision Trees, Generative classifiers like naive Bayes;	8	2
Module 3: Computational learning theory	PAC learning model, Sample complexity, VC Dimension, Ensemble learning:Bagging, Boosting, Stacking	6	3
Module 4: Unsupervised Learning	Principle component Analysis, Factor Analysis, Non-negative matrix factorization, Rate-Distortion Theory, K-means, hierarchical clustering, Gaussian mixture model, Expectation-Maximization Algorithm	8	4
Module 5: Neural Networks	Overview of neural networks, perceptron's, Activation functions, Multilayer network, backpropagation Algorithm	6	5

Text Books:

1. Ethem Alpaydın (2010). *Introduction to Machine Learning* (2nd edition), MIT Press.
2. Tom M. Mitchell (1997). *Machine Learning.* McGraw-Hill Science.
2. Trevor Hastie, Robert Tibshirani and Jerome Friedman (2009). *The Elements of Statistical Learning* (2nd edition). Springer.

Reference Books:

1. Christopher M. Bishop (2006). *Pattern Recognition and Machine Learning*. Springer.
2. Stephen Marsland (2015). *Machine Learning: An Algorithmic Perspective* (2nd edition). CRC Press.
3. R. O. Duda, P. E. Hart, and D. G. Stork (2012). *Pattern classification.* John Wiley & Sons.
4. Shai Shalev-Shwartz and Shai Ben-David (2017). *Understanding Machine Learning*.. Cambridge University Press.

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OPEN ELECTIVES -4 (Semester- VII)

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AD10203A **Credit: 3 (L-3, T-0, P-0)**

Biometric Technology

Questions to be set: 05 (All Compulsory)

Course Objectives: The objective of this course is to introduce several biometric identifiers and techniques used to develop biometric-based secure systems.

Pre-requisites: Basics of Calculus, Probability and Statistics.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO1: Describe the importance of biometric technology in day-to-day life.

CO2: Illustrate the speaker verification systems.

CO3: Illustrate the hand-written signature verification systems.

CO4: Illustrate the face recognition systems.

CO5: Explain the finger-print verification systems.

Module	Topics	Hrs	CO
Module 1: Introduction	Definition of Biometric security, Benefits of biometrics over traditional authentication systems, Types of Biometric identifier: Physiological (Fingerprint, Hand, Iris, Face, DNA , etc.) and behavioral (signature, voice, keystroke,etc.) , Overview of Biometric system, Applications, Pros and Cons of Biometrics	5	1
Module 2: Voice Biometric	Voice Biometric: Speaker Verification (Datasets; Preprocessing; Acoustic Feature: MFCC; Statistical modeling: GMM-UBM, Likelihood ratio, Performance measure; State-of-the-art Deep Neural Network based speaker recognition: Overview)	7	2

Module 3: Signature Biometric	Signature Biometric: Signature verification (Datasets, Preprocessing: Signature extraction, Noise Removal, Size normalization and centering, Signature representation, Signature alignment; Feature extraction: Handcrafted features, Deep learning-based features; Model Training: SVM, DNN; Performance measure)	8	3
Module 4: Face Biometric	Face Biometric: Face Recognition using PCA, LDA and Convolution Neural network (CNN), Standard datasets	8	4
Module 5: Fingerprint Biometric	Fingerprint Biometric: Fingerprint Recognition (Fingerprint Sensing and Storage, Fingerprint Analysis and Representation, Fingerprint Matching, Fingerprint Classification and Indexing)	8	5

Text Books:

1. Amine Naït-Ali and Régis Fournier (2012). *Signal and Image Processing for Biometrics* (1st edition). Wiley-ISTE
2. John R. Vacca (2007). *Biometric Technologies and Verification Systems*. Elsevier Science.

References (Paper):

1. Reynolds, D.A., Quatieri, T.F. and Dunn, R.B., 2000. Speaker verification using adapted Gaussian mixture models. *Digital signal processing*, *10*(1-3), pp.19-41.
2. Bai, Z. and Zhang, X.L., 2021. Speaker recognition based on deep learning: An overview. *Neural Networks*, *140*, pp.65-99
3. L. G. Hafemann, R. Sabourin and L. S. Oliveira, "Offline handwritten signature verification — Literature review," *2017 Seventh International Conference on Image Processing Theory, Tools and Applications (IPTA)*, 2017, pp. 1-8, doi: 10.1109/IPTA.2017.8310112, https://arxiv.org/pdf/1507.07909
4. Zhao, W., Chellappa, R., Phillips, P.J. and Rosenfeld, A., 2003. Face recognition: A literature survey. *ACM computing surveys (CSUR)*, *35*(4), pp.399-458.
5. Belhumeur, P.N., Hespanha, J.P. and Kriegman, D.J., 1997. Eigenfaces vs. fisherfaces: Recognition using class specific linear projection. *IEEE Transactions on pattern analysis and machine intelligence*, *19*(7), pp.711-720.
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HONOURS SPECIALIZATION

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HONOURS SPECIALIZATION: AI in Healthcare

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AD10321A **Credit: 3 (L-3, T-0, P-0)**

Artificial Intelligence for Health and Medicine

Questions to be set: 05 (All Compulsory)

Course Objective: Comprehend a collection of machine learning models (identified and covered in the course), and their applications in medicine and healthcare. Identify and apply appropriate intelligent system models and computational tools to specific problems in biomedicine and healthcare. Analyze the performance of specific models as applied to biomedical problems and justify their use and limitations. Identify, understand, and interpret methods and evidence from artificial intelligence and other relevant literature.

Pre-requisites: A foundation in linear algebra, probability and statistics are recommended for this course. Additionally, students should be open to learning new computing tools and technologies.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain the difference between Human and Artificial Intelligence.

CO 2: Apply supervised learning models to medicine and healthcare problems.

CO 3: Apply unsupervised learning models to medicine and healthcare problems.

CO 4: Describe the time-series analysis and issues involved in medicine and healthcare applications.

CO 5: Explain Clinical decision-making and intelligent systems, tools and technologies for Implementing AI methods.

Module	Topics	Hrs	CO
Module: 1 Introduction	Introduction to Human and Artificial Intelligence: terminologies, computational models of intelligence; conceptual frameworks from cognitive and educational psychology, neuroscience, information theory, and linguistics; philosophical foundations of AI, Review of relevant mathematical and statistical concepts: logarithmic loss, cross entropy	7	1

	optimizing cost functions; linear and logistic regression.		
Module: 2 Supervised Learning	Forms of Learning: supervised, semi-supervised, unsupervised, active, and transfer learning, Supervised Learning: (a) Decision trees, non-parametric methods for learning, support vector machines, (b) Bio-inspired Learning (from perceptron to deep learning): neural basis of computing, classical neural networks, deep neural networks, deep belief networks, recurrent neural networks, and convolutional neural networks.	7	2
Module: 3 Unsupervised Learning	Unsupervised Learning: basic and advanced clustering techniques, dimensionality reduction (feature selection and feature extraction), Knowledge Representation and Reasoning: Prepositional logic, first-order logic, ontological engineering, probabilistic reasoning	7	3
Module: 4 Time Series Analysis and Unique characteristics and challenges in medicine and healthcare	Time-series analysis: temporal models (probabilistic reasoning over time), Emerging paradigms and concepts in artificial social and emotional intelligence Unique characteristics and challenges in medicine and healthcare; History and status quo of intelligent and expert systems in medicine. Risk stratification, patient outcome prediction, disease progression modeling	7	4
Module: 5 Clinical decision making and intelligent systems	Clinical decision-making and intelligent systems to support evidence-based medicine, Phenotype and clinical/bio-marker discovery, Relevance to personalized medicine Analysis of tissue morphology and other medical imaging applications, Tools and Technologies for implementing AI methods,	8	5

Text Book:

1. Stuart Russell and Peter Norvig (2009). *Artificial Intelligence: A Modern Approach* (3rd edition). Prentice Hall Press.
2. Toby Segaran (2007). *Programming Collective Intelligence* (1st edition). O'Reilly.
3. Tony J. Cleophas and Aeilko H. Zwinderman (2015). *Machine Learning in Medicine - A Complete Overview.* Springer.

Reference Book:

1. Sunila Gollapudi, S. (2016). *Practical Machine Learning*. Packt Publishing Ltd.
2. Peter Harrington (2012). *Machine Learning in Action*. Manning Publications Co., Greenwich, CT, USA.

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AD10322A **Credit: 3 (L-3, T-0, P-0)**

Bioinformatics

Questions to be set: 05 (All Compulsory)

Course Objective:The objective of the course is to introduce students to the rapidly evolving field of bioinformatics. The aim is to cover in the lectures the most fundamental topics, such as molecular biology data generation, storage, retrieving, sequence alignments and pattern findings.

Pre-requisites: Basics of Biology, Probability and Statistics

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain bioinformatics, generation of molecular biology data, and associated tools/software.

CO 2: Describe several types of biological database and file formats.

CO 3: Explain Metadata and Ontologies for bioinformatics.

CO 4: Analyse biological data using visualization tools.

CO 5: Explain Gene expression and regular expression.

Module	Topics	Hrs	CO
Module: 1 Bioinformatics and Data Generation	Introduction to bioinformatics and data generation: What is bioinformatics and its relation with molecular biology. Examples of related tools(FASTA, BLAST, BLAT, RASMOL), databases(GENBANK, Pubmed, PDB) and software(RASMOL,Ligand Explorer). Data generation: Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics.	7	1
Module: 2 Biological Database, Storage, and	Biological Database and its Types: Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein	7	2

retrieval	databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB).Structure databases (CATH, SCOP, and PDBsum) Data storage and retrieval and Interoperability: Flat files, relational, object oriented databases and controlled vocabularies. File Format(Genbank, DDBJ, FASTA, PDB, SwissProt).		
Module: 3 Metadata and Search	Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search. The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts. General Introduction to XML, UMLS, CORBA, PYTHON and OMG/LIFESCIENCE.	7	3
Module: 4 Sequence Alignments and Visualization	Sequence Alignments and Visualization: Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example),Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment(Clustal W algorithm).Methods for presenting large quantities of biological data: sequence viewers (Artemis,SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization.	7	4
Module: 5 Gene Expresseion and Regular Expression	Gene Expression and and Representation of patterns and relationship General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies, and Graphical models (including Markov chain and Bayes notes), Genetic variability and connections to clinical data.	8	5

Text Book:

1. Sundar Rao & Richard (2012). *An Introduction to Biostatistics and Research Methods* (5rd edition). PHI.
2. Phillip Compeau and Pavel Pevzner (2014). *Bioinformatics Algorithms: An Active Learning Approach* (3rd edition). Active Learning Publishers.
3. D. Baxevanis and F. Oulette, (2002). *Bioinformatics: A practical guide to the analysis of genes and proteins*, Wiley Indian Edition
4. Bryan Bergeron MD (2003). *Bioinformatics Computing*. Prentice Hall India

Reference Book:

1. Jenny Olive (2004). *Maths-A Self Study Guide* (2nd edition). Cambridge University Press
2. James Stewart (2018). Calculus: Early Transcendentals (8th edition). Cengage Learning.
3. Seymour Lipschutz and Marc Lipson(2022). Probability (3rd edition). Shaum's Outline Series, Tata McGraw Hill.
4. Hema Ramachandran and Achuthsankar S Nair (2012). *SCILAB (A Free Software to Matlab)*. S.Chand Publishers.
5. A.K. Mukhopadhyay & S. Sengupta (2010). *A Course in Vector and Matrix Analysis for Engineers and Physicists*. IK International Publishing House Pvt. Ltd

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AD10323A **Credit: 3 (L-3, T-0, P-0)**

Healthcare Informatics

Questions to be set: 05 (All Compulsory)

Course Objective 1. Introduce students to problems and challenges that health informatics addresses 2. Introduce students to the research and practice of health informatics 3. Provide all students with basic skills and knowledge in health informatics to apply in their future health-related careers

Pre-requisites: NIL

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Develop knowledge about problems and challenges that health informatics addresses.

CO 2: Explain several ways of describing medical algorithms.

CO 3: Apply decision tree and regression algorithms in clinical decision-making process.

CO 4: Performmodelling and simulation in biomedicine.

CO 5: Describe knowledge management system and ways to organize Health IT services.

Module	**Topics**	**Hrs**	**CO**
Module: 1 Introduction	**Introduction to Health Informatics & Data, Information, and Knowledge**: Introduction to health informatics and its significance Definitions and key concepts in health informatics Background disciplines, historical overview, and future challenges, Introduction to knowledge hierarchy: Data, information, and knowledge The definitions of healthcare data and information Types of healthcare information (internal versus external data and information) The major purposes of maintain patient records The content and uses of patient records and claim content The common issues related to healthcare data quality The challenges associated with measuring and ensuring healthcare data quality Quality assessment including total quality management and data quality Introduction to	8	1

	biomedical research and publicly available resources **The National Landscape of Healthcare IT & History of Healthcare :** The major influences shaping the health IT landscape in the US, The roles played by the major government initiatives and private sectors in advancing health IT in the US, The major events that have influences the adoption of health IT and systems, History and evolution of healthcare information systems (HCIS), The major advances in information technology and significant federal initiatives that influenced the adoption of healthcare information systems, The major types of administrative and clinical information systems used in healthcare, Current issues pertaining to the use HCIS		
Module: 2 Medical Algorithms	Several ways to describe algorithms, such as flowchart, pseudocode, and conceptual graph; Introduction to medical algorithms, Algorithms in computer science, such as decision tree and regression, Calculation of measurements of classification performance—sensitivity and specificity	7	2
Module: 3 Medical Decision Making:	Decision-making process Medical decision-making process (diagnosis, treatment, monitoring, prognosis) Informatics in clinical decision-making Introduction to evidence-based medicine	7	3
Module: 4 Modeling and Simulations & PopulationHealth and Precision Medicine	Develop understanding of modeling and simulation Become familiar with applications of modeling and simulation in biomedicine Data and information needs of health systems in managing population health Key health IT tools and strategies for population health management Concepts of precision medicine	7	4

Module: 5 Knowledge management system & Organizing Health IT services	Introduction to knowledge management Knowledge discovery, data mining and text mining Knowledge management and decision-making support in biomedicine The roles, responsibilities, and major functions of the IT department in healthcare organizations The roles, responsibilities, and major functions of the IT leaders The various ways to organize IT services The key attributes of highly effective IT departments The role and major function of the data analytics department	7	5

Text Book:

1. Wager, K. A., Lee, F. W., & Glaser, J. P. (2017). *Health care information systems: A practical approach for health care management (4th Edition).* Jossey-Bass.

Reference Book:

1. Trotter, F. and Uhlman, D. (2011). *Hacking healthcare: A guide to standards, workflows, and meaningful use*. O'Reilly Media.

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AD10324A **Credit: 3 (L-3, T-0, P-0)**

Artificial Intelligence in Medical Imaging

Questions to be set: 05 (All Compulsory)

Course Objective: The objective of this course is to apply various AI algorithms and tools for medical Imaging applications.

Pre-requisites: A foundation in probability and statistics, and AI/ML/DL are recommended for this course.

Course Outcomes (CO):

After successful completion of the course, students should be able to

CO 1: Apply feature extraction and feature selection techniques in medical imaging.
CO 2: Apply neural network techniques in medical imaging.
CO 3: Explain various machine learning techniques such as data augmentation, transfer learning, semi-supervised and unsupervised learning.
CO 4: Describe Quantitative Image Analysis and Computer Aided Detection and Diagnosis.
CO 5: Use CAD for medical imaging applications.

Module	Topics	Hrs	CO
Module: 1 Feature Extraction, Selection and Classifiers	Feature extraction and selection: Feature Extraction, Feature Selection, Bayesian Classifiers, Linear Classifiers, Support Vector Machines, Random Forests, Neural Networks	7	1
Module: 2 Neural Network	Feedforward Neural Networks, Convolutional Neural Networks, Recurrent Neural Networks, Object Detection Network, Segmentation Network, Multi-stream and Multi-modal, Generative Adversarial Networks	7	2

Module: 3 Data Augmentation and Transfer Learning	Hyper-parameter Search, Data Augmentation, Transfer Learning, Domain Adaptation, Multi-task Learning, Semi-supervised and Unsupervised Learning	7	3
Module: 4 Computer Aided Detection and Diagnosis	From expert systems to deep learning: historical perspective, use cases: past, present, and future, Quantitative Image Analysis, Computer Aided Detection and Diagnosis, Triage, Image Registration, Radiomics: Radiology Meets Big Data, Applications beyond Image Interpretation, Applications beyond Radiology	7	4
Module: 5 Case Studies	Case studies, Carotid Intima-Media Segmentation, CAD in CT Colonography, CAD in Mammography and Digital, Breast Tomosynthesis Detection of lesions in mammography and tomosynthesis, Deep learning in mammography Designing AI Systems for Clinical, software as a medical device, Clinical Validation of SaMD, Data Collection: Factors Affecting	8	5

Text Book:

1. Lia Morra, Silvia Delsanto, and Loredana Correale (2019). *Artificial Intelligence in Medical Imaging-From Theory to Clinical Practice* (1st edition). CRC Press.
2. Erik R. Ranschaert, Sergey Morozov, and Paul R. Algra (2019). *Artificial Intelligence in Medical Imaging: Opportunities, applications and Risks.Springer.*

Reference Book:

1. K.C. Santosh et. Al. (2019), *Artificial Intelligence in Medical Imaging*, CRC press.

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HONOURS SPECIALIZATION: Intelligent Robotics &Automation

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AD10325A **Credit: 3 (L-3, T-0, P-0)**

Fundamentals Of Robotic System And Programming

Questions to be set: 05 (All Compulsory)

Course Objectives: The objective of this course is to enlighten the students about the fundamentals of robotic systems. To understand the basics of robot, Robot Transformations and Sensors, Micro/Nano robotic systems and to program them for functioning.

Pre-requisites: NIL

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Knowledge creation on Robot anatomy

CO 2: Understand End effectors and robot controls

CO 3: Apply different Robot transformations and sensors integration technique

CO 4: Analysis different Robot cell design and micro/nano robotics system with basic programming

CO 5: Apply VAL, VAL-II, RAPID and AML language for different applications.

Module	Topics	Hrs	CO
Module: 1 Introduction	Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems-Specifications of Robot-Speed of Robot-Robot joints and links-Robot Classifications-Architecture of robotic systems-Robot Drive systems-Hydraulic, Pneumatic and Electric system.	7	1
Module: 2 End effectors and robot controls	Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control.	7	2

Module: 3 Robot transformations and sensors	Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors – Robotic vision sensor-Force sensor-Light sensors, Pressure sensors.	7	3
Module: 4 Robot cell design and micro/nano robotics system with basic programming	Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software Introductions Robot applications- Material handling, Machine loading and unloading etc. Micro/Nanorobotics system overview-Scaling effect Top down and bottom up approach- Actuators of Micro/Nano robotics system- micro/nano grippers-Wall climbing micro robot working principles-	7	4
Module: 5 VAL,VAL-II, RAPID and AML language	Robot Languages-Classifications, Structures- VAL- language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications. RAPID- language basic commands- Motion InstructionsPick and place operation using Industrial robot- manual mode, automatic mode, subroutine command-based programming. Move-master command language- Introduction, syntax, simple problems. VALII programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot. AML Language-General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor commandsData processing.	8	5

Text Books:

1. Craig. J. J. (1999). *Introduction to Robotics Mechanics and Control.* Addison- Wesley.

Reference Books:

1. S.R. Deb (2009). *Robotics Technology and Flexible Automation*. Tata McGraw-Hill Education.
2. Mikell P Groover et. al. (2017). *Industrial Robotics -Technology, Programming and Applications* (2nd edition).McGraw Hill Education.
3. Richard D. Klafter et.al. (2009). *Robotics Engineering an Integrated Approach.* PHI Learning.

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AD10326A **Credit: 3 (L-3, T-0, P-0)**

Human Machine Interaction (HMI)

Questions to be set: 05 (All Compulsory)

Course Objectives:

The objective of this course is to enlighten the students about the fundamentals of HMI systems.

To understand the basics of HMI, and effective user-friendly interfaces design.

Apply Interactive Design process in real world applications.

Pre-requisites: Web Technologies; Software Engineering; Experience in designing interfaces for applications and web sites. Basic knowledge of designing tools and languages like HTML, Java, etc.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Identify User Interface (UI) design principles.

CO 2: Analysis of effective user-friendly interfaces.

CO 3: Apply Interactive Design process in real world applications.

CO 4: Evaluate UI design and justify.

CO 5: Create application for social and technical task.

Module	Topics	Hrs	CO
Module: 1 Foundations of HMI	The Human: History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving. The computer: Devices, Memory, processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms.	7	1
Module: 2 Graphical User Interface	The graphical User Interface: Popularity of graphics, the concept of direct manipulation, graphical systems, Characteristics. Web user Interface: Interface popularity, characteristics. The merging of graphical Business systems and the Web. Principles of user interface design.	7	2

Module: 3 Screen Designing	Design goals , Screen planning and purpose, organizing screen elements, ordering of screen data and content, screen navigation and flow, Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully, information retrieval on web, statistical graphics, Technological consideration in interface design.	7	3
Module: 4 Interface Design for Mobile Devices	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	7	4
Module: 5 Applications	Methodology used to develop a HMI application, Introduction to supervision, Role / limitations of HMI / supervision, Links between supervision and process	8	5

Text Books:

1. Alan Dix et.al. (2004). *Human Computer Interaction* (3rd edition). Pearson Education.
2. Wilbert O. Galitz (2002). *The Essential Guide to User Interface Design: An Introduction to GUI Design Principles and Techniques* (2nd edition). Wiley.
3. Alan Cooper et.al. (2014). *About Face3: Essentials of Interaction design* (4th edition). Wiley.
4. Jeff Johnson (2010). *Designing with the mind in mind: Simple Guide to Understanding User Interface Design Rules (*1st edition). Morgan Kaufmann.
5. Donald A. Normann (2013). *The Design of Everyday Things*. Basic Books.
6. Brian Fling (2009). *Mobile Design and Development* (1st edition). OReilly Media Inc.

Reference Books:

1. Helen Sharp et.al. (2019). *Interaction Design: Beyond Human Computer Interaction* (5th edition). Wiley.
2. Guy A. Boy (2012). *The Handbook of Human-Machine Interaction: A Human-Centered Design Approach*. Ashgate publishing Ltd.
3. Dhananjay R. Kalbande (2015). *Galitzs Human Machine Interaction*, Wiley Publications.

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AD10327A **Credit: 3 (L-3, T-0, P-0)**

Industrial Automation and Control

Questions to be set: 05 (All Compulsory)

Course Objectives: To introduce the importance of automation techniques in manufacturing and process industries. 2. To impart the role of PLC in industry automation. 3. To expose to various control techniques employed in process automation. 4. To develop automation systems for manufacturing and process industries.

Pre-requisites: NIL

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain Automation in production system and material handling system.

CO 2: Describe Automated Manufacturing Systems.

CO 3: Describe computer based industrial automation.

CO 4: Apply the knowledge of Programmable Logic Controller in Industrial Applications.

CO 5: Explain Distributed Control System.

Module	Topics	Hrs	CO
Module 1: **Automation in Manufacturing Industries-I**	Introduction- Automation in production system, Principles and strategies of automation, Basic elements of an automated system, Advanced automation functions, Levels of automations, Automated flow lines and transfer mechanisms, Analysis of transfer lines without storage, Automated flow lines with storage buffers. Material handling and identification technologies -Overview of material handling systems, Types of material handling equipment, Design of the system, Conveyor system, Automated guided vehicle system, Automated storage systems, Interfacing handling and storage with manufacturing, Overview of Automatic Identification Methods.	8	1

Module 2: **Automation in Manufacturing Industries-II**	Automated Manufacturing Systems-Components, Classification and overview of manufacturing systems, Cellular manufacturing, Flexible manufacturing system (FMS), FMS and its planning and implementation, Automated assembly system – design and types of automated assembly systems, Analysis of multi station and single station assembly machine**.**	8	2
Module 3: **Automation in Process Industries-I**	Introduction to computer based industrial automation- Direct Digital Control (DDC), Distributed Control System (DCS) and supervisory control and data acquisition (SCADA) based architectures. SCADA for process industries includes understanding of RTUs, Pumping stations, Evacuation processes, Mass Flow Meters and other flow meters, Leak-flow studies of pipelines, Transport Automation.	7	3
Module 4: Automation in Process Industries-II	Programmable Logic Controller (PLC)- Block diagram of PLC, Programming languages, Basic instruction sets, Design of alarm and interlocks, Networking of PLC, Overview of safety of PLC with case studies. Process Safety Automation: Levels of process safety through use of PLCs, Integrating Process safety PLC and DCS, Application of international standards in process safety control.	7	4
Module 5: Automation in Process Industries-III	Distributed Control System- Local Control Unit (LCU) architecture, LCU Process Interfacing Issues, Block diagram and Overview of different LCU security design approaches, Networking of DCS. Introduction to communication protocols- Profibus, Field bus, HART protocols. Data gathering, Data analytics, Real-time analysis of data stream from DCS, Historian build, Integration of business inputs with process data, Leveraging RTU (as different from PLCs and DCS)	7	5

Text Book:

1. M. P. Groover (2009). *Automation, Production Systems and Computer Integrated Manufacturing* (5th edition). Pearson Education.
2. John W. Webb and Ronald A. Reis (2003). *Programmable Logic Controllers: Principles and Applications* (5th edition). Prentice Hall Inc., New Jersey.
3. S. Mukhopadhyay, S. Sen and A. K. Deb (2013). *Industrial Instrumentation, Control and Automation.* Jaico Publishing House.

Reference Book:

1. Krishna Kant (2011). *Computer - Based Industrial Control (2nd Edition)*. Prentice Hall, New Delhi.
2. Frank D. Petruzella (2016). *Programmable Logic Controllers (5th Edition)*. McGraw- Hill, New York.

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AD10328A **Credit: 3 (L-3, T-0, P-0)**

Game Theory

Questions to be set: 05 (All Compulsory)

Course Objectives: The course will provide the basics: representing games and strategies, the extensive form (which computer scientists call game trees), Bayesian games (modeling things like auctions), repeated and stochastic games, and more.

Pre-requisites: Basics of Linear Algebra

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Describe the fundamentals of Game theory and its applications.

CO 2: Explain the concepts of players, strategies, payoffs, and equilibrium.

CO 3: Use the backward induction to solve sequential games.

CO 4: Explain repeated games and Folk Theorem.

CO 5: Describe Bayesian and Coalitional Games.

Module	Topics	Hrs	CO
Module 1: Game Strategies	Introduction and Overview: Introduction, overview, uses of game theory, some applications and examples, and formal definitions of the normal form, payoffs, strategies, pure strategy Nash equilibrium, dominant strategies Mixed-Strategy Nash Equilibrium: pure and mixed strategy Nash equilibria	7	1
Module 2: Alternate Solution Concepts	Iterative removal of strictly dominated strategies, minimax strategies and the minimax theorem for zero-sum game, correlated equilibria	8	2

Module 3: Extensive-Form Games	Perfect information games: trees, players assigned to nodes, payoffs, backward Induction, subgame perfect equilibrium, introduction to imperfect-information games, mixed versus behavioral strategies.	7	3
Module 4: Repeated Games	Repeated prisoners dilemma, finite and infinite repeated games, limited-average versus future-discounted reward, folk theorems, stochastic games and learning.	8	4
Module 5: Bayesian Games	General definitions, ex ante/interim Bayesian Nash equilibrium. Coalitional Games: Transferable utility cooperative games, Shapley value, Core, applications.	6	5

Text Book:

1. Martin J. Osborne (2012). *An Introduction to Game Theory* (1st edition). Oxford University Press.
2. Prajit K Dutta (1999). *Strategies and Games: Theory and Practice*, The MIT Press.

Reference Book:

1. Vijay Krishna (2009). *Auction Theory* (2nd edition). Academic Press.
2. J. Watson (2002). *Strategy: An Introduction to Game Theory* (2nd edition). W. W. Norton & Co.

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HONOURS SPECIALIZATION: Infrastructure and Big Data Management

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AD10329A **Credit: 3 (L-3, T-0, P-0)**

Parallel and Distributed Computer Architecture

Questions to be set: 05 (All Compulsory)

Course Objective: The practice of modern medicine in a highly regulated, complex, sociotechnical enterprise is a testament to the future healthcare system where the balance between human intelligence and artificial expertise will be at stake. The goal of this course is to introduce the underlying concepts, methods, and the potential of intelligent systems in medicine. We will explore foundational methods in artificial intelligence (AI) with greater emphasis on machine learning and knowledge representation and reasoning and apply them to specific areas in medicine and healthcare including, but not limited to, clinical risk stratification, phenotype and biomarker discovery, time series analysis of physiological data, disease progression modelling, and patient outcome prediction.

Pre-requisites: Computer Organization and Architecture

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1:Describe the concepts of Parallel processing and pipelining.

CO 2:. Explain Instruction-level parallelism and SIMD Array processors.

CO 3: Explain Multiprocessor Architecture.

CO 4: Apply elementary parallel algorithms to solve problems in practice.

CO 5: Describe Multiprocessor Architecture & Non von Neumann Architectures.

Module	Topics	Hrs	CO
Module 1: Parallel processing and pipelining	Criteria for judging the architecture, Architectural classification schemes, Trends towards parallel processing, Parallelism in uniprocessor systems, Parallel computer structure, Performance evaluation of Processors – Amdahl's law, Applications of parallel processing. Principles of linear and non-linear pipelining, Classification of pipeline processors, General pipelines and reservation tables, Interleaved memory organization.	8	1

Module 2: Instruction-level parallelism and SIMD array processors	Concepts of instruction-level parallelism (ILP), Techniques for increasing ILP; Superscalar, super-pipelined and VLIW processor architectures; Vector and symbolic processors. SIMD array processors: SIMD computer organization, Masking and data routing mechanisms, SIMD interconnection networks: static v/s dynamic, Mesh connected ILLIAC network, Barrel shifter network, Shuffle-exchange, and Omega network., Sequential matrix multiplication, Algorithm for processor array-2D mesh SIMD model, Hypercube SIMD model, Shuffle exchange mode.	8	2
Module 3: Multiprocessor Architecture	Functional structures, UMA and NUMA multiprocessors, Interconnection Networks: Time shared or common buses, Bus arbitration algorithm, Cross bar switch and multiport memories, Comparison of multiprocessor interconnection structure, multistage networks for multiprocessors.	7	3
Module 4: Elementary parallel algorithms	Developing algorithms for processor arrays/MIM computers, Process Communication, and synchronization on MIMD, Deadlock, Task scheduling on MIMD.	7	4
Module 5: Multiprocessor Architecture & Non von Neumann Architectures	**Multiprocessor Architecture:** Taxonomy of parallel architectures; Centralized shared-memory architecture, synchronization, memory consistency, interconnection networks; Distributed shared-memory architecture, Cluster computers, Case Study: Intel Montecito and Sun Niagara. **Non von Neumann Architectures**: Data flow Computers, Reduction computer architectures, Systolic Architectures.	7	5

Textbooks:

1. Kai Hwang and Faye A. Briggs (2017). *Computer Architecture and Parallel Processing*. McGraw Hill Education.
2. Michael J. Quinn (2017). *Parallel Computing: Theory and Practice* (2nd edition). McGraw Hill Education.
3. John L. Hennessy and David A. Patterson (1995). *Computer Architecture: A Quantitative Approach.* Morgan Kaufmann.

Reference Books:

1. Kai Hwang (1993). *Advanced Computer Architecture – Parallelism, Scalability, Programmability*. McGraw-Hill Education.
2. Mark Allen Weiss (2002). *Data Structures and Algorithm Analysis in C* (2nd edition). Pearson Education India.
3. Rajiv Chopra (2010). *Advanced Computer Architecture*. S Chand & Company

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AD10330A **Credit: 3 (L-3, T-0, P-0)**

Cloud Computing architecture and services

Questions to be set: 05 (All Compulsory)

Course Objective: This course introduces cloud computing and its techniques - Infrastructure as a Service (IaaS), Platform-as-a-Service (PaaS), Software as a Service (SaaS), issues, ecosystem, and case studies.

Pre-requisites: Operating Systems and Computer Network

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain basics of cloud computing, its importance and Privacy and Security aspects.

CO 2: Develop cloud services.

CO 3: Describe cloud utility and Business profit.

CO 4: Explain few applications of cloud computing.

CO 5: Describe the usage of cloud services.

Module	Topics	Hrs	CO
Module 1: Introduction	**Understanding Cloud Computing:** Cloud computing, History of cloud computing, Cloud architecture, Cloud storage, Why cloud computing matters, Advantages of cloud computing, Disadvantages of cloud computing, Companies in the cloud today. **Privacy and Security in Cloud computing:** Federation in the cloud, Presence in the cloud, Privacy and its relation to cloud-based information systems, Security in the cloud, Common standards in the cloud, End-user access to the cloud computing	9	1
Module 2: Developing Cloud Services	**Developing Cloud Services:** Web-based application, Pros and cons of cloud service development, Types of cloud service development, Software as a service, Platform as a service, Web services, On demand computing, Discovering cloud services, Development services and tools, Amazon Ec2, Google app engine, IBM clouds.	7	2

Module 3: Cloud Utility and Business profit	**Cloud Utility and Business profit:** Software utility application architecture, Characteristics of a SaaS, Software utility applications, Cost versus value, Software application services framework, Common enablers, Conceptual view to reality, Business profits, Implementing database systems for multitenant architecture.	7	3
Module 4: Cloud Computing for Everyone	**Cloud Computing for Everyone:** Centralizing email communications, collaborating on schedules, Collaborating on To-Do Lists, Collaborating contact lists, Cloud computing for the community, Collaborating on group projects and events, Cloud computing for the corporation.	7	4
Module 5: Using cloud services:	**Using cloud services:** Collaborating on calendars, Schedules and task management, Exploring online scheduling applications, Exploring online planning and task management, Collaborating on event management, Collaborating on contact management, Collaborating on project management, Collaborating on word processing, Collaborating on databases, Storing and sharing files.	6	5

Text Books:

1. Haley Beard (2009). *Cloud computing best practices for managing and measuring processes for on demand computing, Applications and data centers in the cloud with SLAs* (2nd edition). United Kingdom, Emereo Pty Ltd.
2. Michael Miller (2008). *Cloud computing: Web based applications that change the way you work and collaborate online* (1st edition). Pearson Education India

Reference Books:

1. Guy Bunker and Darren Thomson (2005). *Delivering Utility Computing: Business-driven IT Optimization* (1st edition). Wiley.
2. George Reese (2011). *Cloud Application Architectures: Building Applications and Infrastructure in the Cloud* (1st edition).Penguin Books Ltd. O'Reilly.
3. Lee Gillam (2010). *Cloud Computing: Principles, Systems and Applications.* Springer.
4. Brian J. S. Chee and Curtis Franklin, Jr., *Cloud Computing: Technologies and Strategies of the Ubiquitous Data Center* (1st edition) CRC Press.

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AD10331A **Credit: 3 (L-3, T-0, P-0)**

Big Data algorithms for large scale data processing

Questions to be set: 05 (All Compulsory)

Course Objective: The objective of this course is to introduce students to big data algorithms and programming tools for processing large scale data, as well as to understand the issues involved in big data problems in practice.

Pre-requisites: Basic Programming Knowledge

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Be proficient with existing big data techniques/tools.
CO 2: Perform big data extraction and integration.
CO 3: Describe Big data stream techniques and algorithms.
CO 4: Apply visualization tools for big data analysis.
CO 5: Solve the big data problems in real applications.

Module	**Topics**	**Hrs**	**CO**
Module 1: Computing Platforms and big data programming tools	Overview of Big Data, State-of-the-art computing paradigms/platforms, Big data programming tools (e.g., Hadoop, MongoDB, Spark, etc.)	7	1
Module 2: Graph processing Techniques	Big data extraction and Integration, Big data storage, Scalable big data indexing. Large-scale graph processing techniques.	7	2

Module 3: Big data stream	Big data stream techniques and algorithms	7	3
Module 4: Data Analysis	Large-scale probabilistic data analysis, Big data privacy, Big data visualizations	7	4
Module 5: Problems in real Big data Application**s**	Problems in real applications of big spatial-temporal data (e.g., geographical databases), Problems in real applications of big financial data (e.g., time-series data), Problems in real applications of big multimedia data (e.g., audios/videos), Problems in real applications of big medical/health data, Problems in real applications of big social media data, Problems in real applications of big scientific data (e.g., bioinformatics data)	8	5

Textbooks:

1. Thomas Erl, Wajid Khattak, and Dr. Paul Buhler (2016). *Big Data Fundamentals: Concepts, Drivers & Techniques*. The Prentice Hall Service Technology Series, ISBN-13: 978-0134291079, 2016.

Reference Books

1. Kuan-Ching Li, Hai Jiang, Laurence T. Yang, and Alfredo Cuzzocrea (2015). *Big Data: Algorithms, Analytics, and Applications.* Chapman & Hall/CRC Big Data Series.

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AD10332A **Credit: 3 (L-3, T-0, P-0)**

Digital Marketing

Questions to be set: 05 (All Compulsory)

Course Objective: Students will be able to identify the importance of the digital marketing for marketing success, to manage customer relationships across all digital channels and build better customer relationships, to create a digital marketing plan, starting from the SWOT analysis and defining a target group, then identifying digital channels, their advantages, and limitations, to perceiving ways of their integration taking into consideration the available budget.

Pre-requisites: Understand the internet characteristics and challenges, Know the existing internet/digital data processing platforms/tools

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Create a digital marketing plan, starting from the SWOT analysis and defining a target group, then identifying digital channels, their advantages, and limitations.

CO 2: Describe the strategy of Online Advertising.

CO 3: Understand the importance of Web Analytics.

CO 4: Describe the optimization methods for Websites and Search Engine.

CO 5: Explain Email and Social Media marketing.

Module	Topics	Hrs	CO
Module 1: Introduction	Introduction to digital marketing, Digital vs. Real Marketing, Digital Marketing Channels, Creating initial digital marketing plan, Content management, SWOT analysis, Target group analysis, EXERCISE: Define a target group (working in groups)	6	1
Module 2: Online Advertising	Google AdWords- creating accounts, Google AdWords- types, Exercise: Google AdWords (working in groups), Introduction to CRM, CRM platform, CRM models, Exercise: CRM strategy (working in groups)	7	2

Module 3: Conversational Marketing and CRO	**Conversational Marketing**: Introduction to Web analytics, Web analytics – levels	6	3
Module 4: CRO & SEO	Overview of CRO and its importance Overview of SEO, SEO Optimization, Writing the SEO content, Exercise: Writing the SEO content (working in groups)	7	4
Module 5: Email Marketing and Social Media Marketing	E-mail marketing plan, E-mail marketing campaign analysis, Keeping up with conversions Introduction of Social Media Marketing, Exercise: Social Media Marketing plan (working in groups), Creating a Facebook page, Visual identity of a Facebook page, Types of publications, Exercise: Making a Facebook page (working in groups), Business opportunities and Instagram options, Optimization of Instagram profiles, Integrating Instagram with a Web Site and other social networks, Keeping up with posts, Business tools on LinkedIn, Creating campaigns on LinkedIn, Analyzing visitation on LinkedIn, Creating business accounts on YouTube, YouTube Advertising, YouTube Analytics, Facebook Ads, Creating Facebook Ads, Ads Visibility	10	5

Text Book:

1. The Beginner's Guide to Digital Marketing (2015). Digital Marketer.
2. Pulizzi,J.(2014) *Epic Content Marketing: How to Tell a Different Story, Break through the Clutter, and Win More Customers by Marketing Less*. Mcgraw Hill Education.

Reference Books:

1. Ryan, D. (2014). *Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation*, Kogan Page Limited.

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HONOURS SPECIALIZATION: Computer Vision and Speech Technology

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AD10333A **Credit: 3 (L-3, T-0, P-0)**

Introduction to Speech Disorders

Questions to be set: 05 (All Compulsory)

Course Objective: The purpose of this course is to provide students with an introduction to speech disorders. Basic information about normal speech development is reviewed and then used as background for introductory study of the nature, assessment, prevention, and treatment of articulation, fluency, voice, and resonance disorders. The role of cultural variables in the identification and treatment of speech differences and disorders will be discussed, along with differences in speech disorders across the life span. Swallowing disorders, which often can co-occur with certain types of speech disorders, will be discussed, as well.

Pre-requisites: NIL

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Understand how disorders of hearing, speech, and language adversely affect communication; the processes and systems that underlie speech and language development.

CO2: Learn how speech sounds are categorized based on voicing, place, and manner of production; how articulation and phonological disorders are identified and treated.

CO3: Differentiate between stuttering-like and non-stuttering-like speech disfluencies

CO4: Explain procedures for evaluating dysphagia and aphasia disorders.

CO5: Describe how distinct parts of the auditory system work; the causes of hearing loss; and the basic components and benefits of personal amplification systems, including hearing aids and cochlear implants.

Module	**Topics**	**Hrs**	**CO**
Module 1: Introduction	Intro to CSD, Communication across the Life Span, & Social and Cultural Bases of Communication	5	1
Module 2: Developmental Speech Disorders	Speech Science, Developmental Speech Disorders & Voice Disorders	7	2

Module 3: Fluency Speech Disorders	Fluency Disorders, Motor Speech, & Cleft Lip and Palate	8	3
Module 4: Dysphagia	Dysphagia, Language Impairment in Children, & Acquired Neurogenic Language Disorders	8	4
Module 5: Hearing Disorders	Hearing Science, Hearing Disorders, & Audiologic Rehabilitation	8	5

Textbooks:

1. Gillam, R. B., & Marquardt, T. P. (2016). *Communication Sciences & Disorders* (4th Edition). Sudbury, MA: Jones & Bartlett Learning.

Reference Book:

2. Noma B. Anderson George H. Shames (2014). *Human Communication Disorders: An Introduction (8th* Edition). Pearson.

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AD10334A **Credit: 3 (L-3, T-0, P-0)**

Biometric Technology

Questions to be set: 05 (All Compulsory)

Course Objectives: The objective of this course is to introduce several biometric identifiers and techniques used to develop biometric-based secure systems.

Pre-requisites: Completion of a basic course in Calculus, Probability and Statistics (Recommended)

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Describe the importance of biometric technology in day-to-day life.

CO 2: Illustrate the speaker verification systems.

CO 3: Illustrate the hand-written signature verification systems.

CO 4: Illustrate the face recognition systems.

CO 5: Explain the finger-print verification systems.

Module	Topics	Hrs	CO
Module 1: Introduction	Definition of Biometric security, Benefits of biometrics over traditional authentication systems, Types of Biometric identifier: Physiological (Fingerprint, Hand, Iris, Face, DNA , etc.) and behavioral (signature, voice, keystroke,etc.) , Overview of Biometric system, Applications, Pros and Cons of Biometrics	5	1
Module 2: Voice Biometric	Voice Biometric: Speaker Verification (Datasets; Preprocessing; Acoustic Feature: MFCC; Statistical modeling: GMM-UBM, Likelihood ratio, Performance measure; State-of-the-art Deep Neural Network based speaker recognition: Overview)	7	2
Module 3: Signature Biometric	Signature Biometric: Signature verification (Datasets, Preprocessing: Signature extraction, Noise Removal, Size normalization and centering, Signature representation, Signature alignment; Feature extraction: Handcrafted features, Deep learning based features; Model Training: SVM, DNN; Performance measure)	8	3

Module 4: Face Biometric	Face Biometric: Face Recognition using PCA, LDA and Convolution Neural network (CNN), Standard datasets	8	4
Module 5: Fingerprint Biometric	Fingerprint Biometric: Fingerprint Recognition (Fingerprint Sensing and Storage, Fingerprint Analysis and Representation, Fingerprint Matching, Fingerprint Classification and Indexing)	8	5

Text Books:

1. Amine Naït-Ali and Régis Fournier (2012). *Signal and Image Processing for Biometrics* (1st edition). Wiley-ISTE.
2. John R. Vacca (2007). *Biometric Technologies and Verification Systems*. Elsevier Science.

References (Paper):

1. Reynolds, D.A., Quartieri, T.F. and Dunn, R.B., 2000. Speaker verification using adapted Gaussian mixture models. *Digital signal processing*, *10*(1-3), pp.19-41.
2. Bai, Z. and Zhang, X.L., 2021. Speaker recognition based on deep learning: An overview. *Neural Networks*, *140*, pp.65-99
3. L. G. Hafemann, R. Sabourin and L. S. Oliveira, "Offline handwritten signature verification — Literature review," *2017 Seventh International Conference on Image Processing Theory, Tools and Applications (IPTA)*, 2017, pp. 1-8, doi: 10.1109/IPTA.2017.8310112, https://arxiv.org/pdf/1507.07909
4. Zhao, W., Chellappa, R., Phillips, P.J. and Rosenfeld, A., 2003. Face recognition: A literature survey. *ACM computing surveys (CSUR)*, *35*(4), pp.399-458.
5. Belhumeur, P.N., Hespanha, J.P. and Kriegman, D.J., 1997. Eigenfaces vs. fisherfaces: Recognition using class specific linear projection. *IEEE Transactions on pattern analysis and machine intelligence*, *19*(7), pp.711-720.
6. Maltoni, D., Maio, D., Jain, A.K. and Prabhakar, S., 2009. *Handbook of fingerprint recognition*. Springer Science & Business Media.

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AD10335A **Credit: 3 (L-3, T-0, P-0)**

Automatic Speech Recognition

Questions to be set: 05 (All Compulsory)

Course Objectives: The course offers an in-depth introduction to automatic speech recognition (ASR), the problem of automatically converting speech into text.

Prerequisites: Completion of a basic course in Machine Learning (Recommended, but not mandatory)

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain the mechanism of human speech production and acoustic features for ASR.

CO 2: Describe the Weighted Finite State Transducers and their application to ASR

CO 3: Apply acoustic models for ASR application.

CO 4: Apply n-gram language models for ASR.

CO 5: Solve the ASR decoding problem.

Module	**Topics**	**Hrs**	**CO**
Module 1: Acoustic Signal Processing	Acoustic Signal Processing for ASR: Speech Production Basics, Acoustic Features for ASR	5	1
Module 2: Statistical approach	Introduction to the statistical approach for automatic speech recognition (ASR) Weighted Finite State Transducers and their Application to ASR	7	2
Module 3: Acoustic models	Acoustic models: Hidden Markov Models, Gaussian Mixture Models, Baum-Welch Maximum Likelihood Estimation, Neural network models (Deep feed-forward neural networks, convolutional neural networks and recurrent neural networks) Discriminative Training of Acoustic Models: Maximum Mutual Information, Minimum Word/Phone Error Criteria	8	3

Module 4: Pronunciation models	Pronunciation models: Pronunciation dictionaries, grapheme-to-phoneme models, feature-based models N-gram language models: estimation, smoothing	8	4
Module 5: ASR decoding problem	ASR decoding problem: search algorithms, Viterbi estimation, finite-state transducer optimizations	8	5

Text Books:

1. Daniel Jurafsky and James H. Martin (2008).*Speech and Language Processing*(2nd edition). Prentice-Hall.

Reference Books:

1. Thomas F, Quatieri (2004). *Discrete-Time Speech Signal Processing* (1st edition). Pearson Education.
2. L.R. Rabiner, B. H. Juang, and B. Yegnanarayan (2008). *Fundamentals of Speech Recognition* (1st edition). Pearson India.
3. Douglas O'Shaughnessy (2012). *Speech communication: human and machine* (2nd edition).Wiley India Pvt Ltd.
4. Mehryar Mohri, Fernando Pereira and Michael Riley, "Weighted Finite-state Transducers in Speech Recognition", *Computer Speech and Language*, 16.1:69-88, 2002.
5. Mark Gales and Steve Young, "The Application of Hidden Markov Models in Speech Recognition", *Foundations and Trends in Signal Processing*, 1(3):195-304, 2008.

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AD10336A **Credit: 3 (L-3, T-0, P-0)**

Deep Learning for Computer Vision

Questions to be set: 05 (All Compulsory)

Course Objectives: The automatic analysis and understanding of images and videos, a field called Computer Vision, occupies significant importance in applications including security, healthcare, entertainment, mobility, etc. The recent success of deep learning methods has revolutionized the field of computer vision, making new developments increasingly closer to deployment that benefits end users. This course will introduce the students to traditional computer vision topics, before presenting deep learning methods for computer vision. The course will cover basics as well as recent advancements in these areas, which will help the student learn the basics as well as become proficient in applying these methods to real-world applications.

Prerequisites: Completion of a basic course in Machine Learning and Deep Learning (Recommended, but not mandatory), Knowledge of basics in probability, linear algebra, and calculus.

Course Outcomes (CO):

Upon successful completion of the course, students should be able to

CO 1: Explain Visual features, visual representations, and visual matching.

CO 2: Describe deep learning techniques such as CNN and its standard architectures.

CO 3: Apply CNN to computer vision tasks such as recognition, verification, detection, and segmentation.

CO 4: Apply RNN+CNN, attention model, GAN in computer vision applications.

CO 5: Explain different applications of computer vision.

Module	Topics	Hrs	CO
Module 1: Visual Features, Representations, and Visual Matching	Introduction and Overview: Course Overview, Motivation; Introduction to Image Formation, Capture and Representation; Linear Filtering, Correlation, Convolution, Visual Features and Representations: Edge, Blobs, Corner Detection; Scale Space and Scale Selection; SIFT, SURF; HoG, LBP, etc. Visual Matching: Bag-of-words, VLAD; RANSAC, Hough transform; Pyramid Matching; Optical Flow.	7	1

Module 2: Deep Learning	Deep Learning Review: Review of Deep Learning, Multi-layer Perceptrons, Backpropagation. Convolutional Neural Networks (CNNs): Introduction to CNNs; Evolution of CNN Architectures: AlexNet, ZFNet, VGG, InceptionNets, ResNets, DenseNets; Visualization and Understanding CNNs : Visualization of Kernels; Backprop-to-image/Deconvolution Methods; Deep Dream, Hallucination, Neural Style Transfer; CAM,Grad-CAM, Grad-CAM++; Recent Methods (IG, Segment-IG, SmoothGrad)	8	2
Module 3: CNNs for Recognition, Verification, Detection, Segmentation	CNNs for Recognition and Verification (Siamese Networks, Triplet Loss, Contrastive Loss, Ranking Loss); CNNs for Detection: Background of Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD, RetinaNet; CNNs for Segmentation: FCN, SegNet, U-Net, Mask-RCNN	7	3
Module 4: RNN, Attention model, and Deep Generative model	Review of RNNs; CNN + RNN Models for Video Understanding: Spatio-temporal Models, Action/Activity Recognition Introduction to Attention Models in Vision; Vision and Language: Image Captioning, Visual QA, Visual Dialog; Spatial Transformers; Transformer Networks Review of (Popular) Deep Generative Models: GANs, VAEs; Other Generative Models: Pixel RNNs, NADE, Normalizing Flows, etc.	8	4
Module 5: Applications and Recent Trends	Applications: Image Editing, Inpainting, Superresolution, 3D Object Generation, Security; Variants: CycleGANs, Progressive GANs, StackGANs, Pix2Pix, etc. Recent Trends (Self Study): Zero-shot, One-shot, Few-shot Learning; Self-supervised Learning; Reinforcement Learning in Vision; Other Recent Topics and Applications	6	5

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville (2016). *Deep Learning*. MIT Press.
2. Simon J.D. Prince (2012). *Computer Vision: Models, Learning, and Inference*.Cambridge University Press
3. Mitchell, Tom (1997). *Machine Learning*. New York, NY: McGraw-Hill.

Reference Books:

1. Michael Nielsen (2016). *Neural Networks and Deep Learning*. [Online]: http://neuralnetworksanddeeplearning.com/index.html
2. Yoshua Bengio (2009). *Learning Deep Architectures for AI*.now publishers Inc.
3. Richard Szeliski (2010), *Computer Vision: Algorithms and Applications* (2nd edition).Springer.
4. David Forsyth and Jean Ponce (2011). Computer Vision: A Modern Approach (2nd edition), Pearson.
5. Bishop, Christopher M. (2005). *Neural Networks for Pattern Recognition*. New York, NY: Oxford University Press.
6. Bishop, Christopher M. (2006). *Pattern Recognition and Machine Learning* (1st edition). Springer.
7. Duda, Richard, Peter Hart, and David Stork (2007). *Pattern Classification* (2nd edition). Wiley.
8. Richard Hartley and Andrew Zisserman (2004). *Multiple View Geometry in Computer Vision* (2nd edition), Cambridge University Press.

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INVITATION TO BOS MEMBERS AND THEIR CONSENT:

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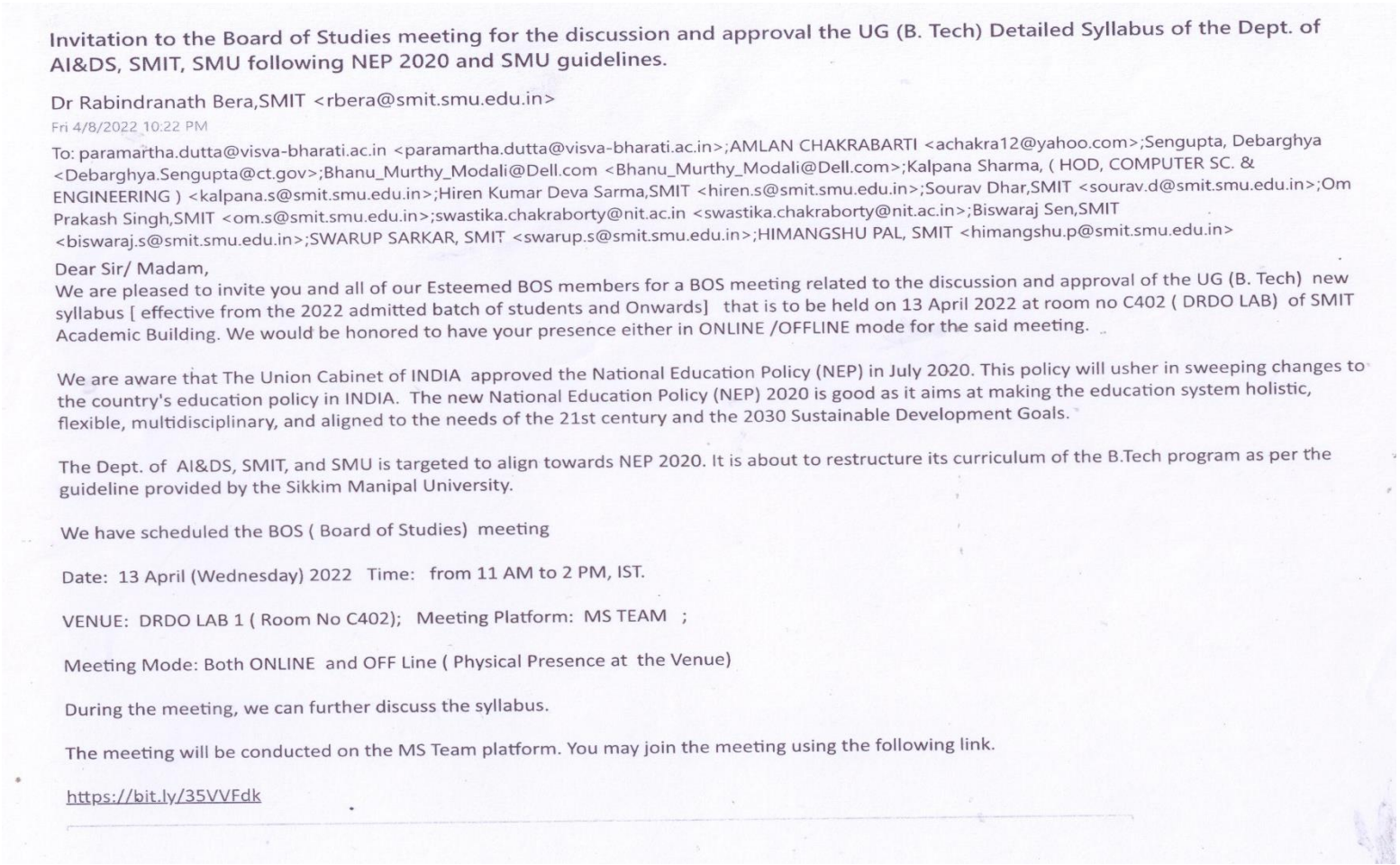
Invitation to the Board of Studies meeting for the discussion and approval the UG (B. Tech) Detailed Syllabus of the Dept. of AI&DS, SMIT, SMU following NEP 2020 and SMU guidelines.



Invitation to the Board of Studies meeting for the discussion and approval the UG (B. Tech) Detailed Syllabus of the Dept. of AI&DS, SMIT, SMU following NEP 2020 and SMU guidelines.

Dr Rabindranath Bera,SMIT <rbera@smit.smu.edu.in>

Fri 4/8/2022 10:22 PM

To: paramartha.dutta@visva-bharati.ac.in <paramartha.dutta@visva-bharati.ac.in>;AMLAN CHAKRABARTI <achakra12@yahoo.com>;Sengupta, Debarghya <Debarghya.Sengupta@ct.gov>;Bhanu_Murthy_Modali@Dell.com <Bhanu_Murthy_Modali@Dell.com>;Kalpana Sharma, (HOD, COMPUTER SC. & ENGINEERING) <kalpana.s@smit.smu.edu.in>;Hiren Kumar Deva Sarma,SMIT <hiren.s@smit.smu.edu.in>;Sourav Dhar,SMIT <sourav.d@smit.smu.edu.in>;Om Prakash Singh,SMIT <om.s@smit.smu.edu.in>;swastika.chakraborty@nit.ac.in <swastika.chakraborty@nit.ac.in>;Biswaraj Sen,SMIT <biswaraj.s@smit.smu.edu.in>;SWARUP SARKAR, SMIT <swarup.s@smit.smu.edu.in>;HIMANGSHU PAL, SMIT <himangshu.p@smit.smu.edu.in>

Dear Sir/ Madam,

We are pleased to invite you and all of our Esteemed BOS members for a BOS meeting related to the discussion and approval of the UG (B. Tech) new syllabus [effective from the 2022 admitted batch of students and Onwards] that is to be held on 13 April 2022 at room no C402 (DRDO LAB) of SMIT Academic Building. We would be honored to have your presence either in ONLINE /OFFLINE mode for the said meeting.

We are aware that The Union Cabinet of INDIA approved the National Education Policy (NEP) in July 2020. This policy will usher in sweeping changes to the country's education policy in INDIA. The new National Education Policy (NEP) 2020 is good as it aims at making the education system holistic, flexible, multidisciplinary, and aligned to the needs of the 21st century and the 2030 Sustainable Development Goals.

The Dept. of AI&DS, SMIT, and SMU is targeted to align towards NEP 2020. It is about to restructure its curriculum of the B.Tech program as per the guideline provided by the Sikkim Manipal University.

We have scheduled the BOS (Board of Studies) meeting

Date: 13 April (Wednesday) 2022 Time: from 11 AM to 2 PM, IST.

VENUE: DRDO LAB 1 (Room No C402); Meeting Platform: MS TEAM ;

Meeting Mode: Both ONLINE and OFF Line (Physical Presence at the Venue)

During the meeting, we can further discuss the syllabus.

The meeting will be conducted on the MS Team platform. You may join the meeting using the following link.

https://bit.ly/35VVFdk

Minutes of Internal BOS members:

Minutes of BOS Meeting held at AI&DS Department , SMIT on 13th April, 2022 in both ONLINE and OFF LINE hybrid mode for the Finalization of B. Tech (AI & DS.) Syllabus.

External BOS Member Present:

1. Prof. (Dr.) Paramartha Dutta- Professor, Viswa Bharati University.
2. Prof.(Dr.) Amlan Chakrabarty- Professor, University of Calcutta.
3. Mr. Debarghya Sengupta- Associate professor, Director of Enterprise Architecture with the State of Connecticut, USA.
4. Mr. Bhanu Murthy Modali- Director, IT Architecture - Dell Digital.
5. Prof.(Dr.) Swastika Chakraborty- Professor, Electronics and Communication Engineering Department, Narula Institute of Technology, Kolkata

Internal BOS Members Present:

1. Prof.(Dr.) Kalpana Sharma, Associate Director (R&D) and HOD, CSE ,SMIT
2. Prof.(Dr.) Sourav Dhar- HOD, E&C ,SMIT
3. Prof.(Dr.) H.K.D. Sharma- HOD, IT , SMIT
4. Prof.(Dr.) Biswaraj Sen- CSE , SMIT
5. Prof. (Dr.) R. N. Bera- HOD, AI &DS Department, SMIT.
6. Dr. Om Prakash Singh- Associate professor, AI &DS Dept., SMIT.
7. Dr. Swarup Sarkar- Associate professor, AI&DS Dept., SMIT.
8. Mr. Himangshu Pal- Special Invitee , AI&DS Dept., SMIT

In the welcome address, the HOD, AI&DS, SMIT highlighted the importance of NEP 2020 and also mentioned about how the Dept. of AI&DS, SMIT, and SMU is targeted to align towards NEP 2020. It is about to restructure its curriculum of the B.Tech program as per the guideline provided by the Sikkim Manipal University. The B.Tech (AI & DS) syllabus has also been presented to the BOS Members by the HOD, AI & DS Department for their consideration and approval. All the members had a detailed look and discussion on the Draft Syllabus and suggested changes to be incorporated onto the Draft Syllabus. All the suggestions received from both Academic and Industrial BOS members have been incorporated in this Final Syllabus and finally the FINAL Syllabus has been formulated. **The syllabus will be effective for the academic session for the 2022 admitted Batch of students and onwards.**

SMIT, Majitar

Date: 13th April, 2022.

The Consents in the form of Signatures by Internal BOS Members, SMIT on Final Syllabus are included:-

Dr. R. N. Bera

Dr. Kalpana Sharma 13/4/2022

Dr. H.K.D. Sharma

Dr. Sourav Dhar

Dr. O.P. Singh 13.4.22

Dr. Swarup Sarkar 13/04/2022

Mr. Himanshu Pal

Enclosures: The e-mail Consents received through e-mail by External/Internal BOS Members on Final Syllabus are also included and attached below.

RE: Invitation to the Board of Studies meeting for the discussion and approval the UG (B. Tech) Detailed Syllabus of the Dept. of AI&DS, SMIT, SMU following NEP 2020 and SMU guidelines.

Biswaraj Sen,SMIT <biswaraj.s@smit.smu.edu.in>
Sun 4/10/2022 8:44 PM

To: Dr Rabindranath Bera,SMIT <rbera@smit.smu.edu.in>

Dear Sir,
I regret that I will not be able to participate in the BoS meeting due to my prior engagements / compulsions which incidentally coincides with the date of your BoS meeting.
However, I would like to convey that after going through the detailed syllabus I find this appropriate, contemporary and definitely will give an enriching learning experience to the learners.

I hereby give my consent to this syllabus and wish the department VERY BEST on the academic endeavors.

Thanks,
Biswaraj Sen.
SMIT

From: Dr Rabindranath Bera,SMIT <rbera@smit.smu.edu.in>
Sent: Friday, April 8, 2022 10:23 PM
To: paramartha.dutta@visva-bharati.ac.in; AMLAN CHAKRABARTI <achakra12@yahoo.com>; Sengupta, Debarghya <Debarghya.Sengupta@ct.gov>; Bhanu_Murthy_Modali@Dell.com; Kalpana Sharma, (HOD, COMPUTER SC. & ENGINEERING) <kalpana.s@smit.smu.edu.in>; Hiren Kumar Deva Sarma,SMIT <hiren.s@smit.smu.edu.in>; Sourav Dhar,SMIT <sourav.d@smit.smu.edu.in>; Om Prakash Singh,SMIT <om.s@smit.smu.edu.in>; swastika.chakraborty@nit.ac.in; Biswaraj Sen,SMIT <biswaraj.s@smit.smu.edu.in>; SWARUP SARKAR, SMIT <swarup.s@smit.smu.edu.in>; HIMANGSHU PAL, SMIT <himangshu.p@smit.smu.edu.in>
Subject: Invitation to the Board of Studies meeting for the discussion and approval the UG (B. Tech) Detailed Syllabus of the Dept. of AI&DS, SMIT, SMU following NEP 2020 and SMU guidelines.

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We are aware that The Union Cabinet of INDIA approved the National Education Policy (NEP) in July 2020. This policy will usher in sweeping changes to the country's education policy in INDIA. The new National Education Policy (NEP) 2020 is good as it aims at making the education system holistic, flexible, multidisciplinary, and aligned to the needs of the 21st century and the 2030 Sustainable Development Goals.

Minutes of External BOS members:

Consent for the modification suggested in BOS meeting of 13th April 2022

Swastika Chakraborty <swastika.chakraborty@nit.ac.in>
Fri 4/15/2022 10:39 AM
To: Dr Rabindranath Bera,SMIT <rbera@smit.smu.edu.in>

Dear Sir

I have full consent on the modification suggested in the BOS meeting of 13th April , 2022 and I have seen all the modifications are incorporated in the new syllabus framed.

Thanks and Regards
Dr. Swastika Chakraborty
Professor, Electronics and Communication Engineering Department
Narula Institute of Technology
Kolkata, India

Ask...Believe...Receive

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7 Sarat Bose Road, 1st Floor, Kolkata -700 020

Re: SMIT_AI & DS Syllabus_NEP_BOS_29_04_2022

AMLAN CHAKRABARTI <achakra12@yahoo.com>

Fri 4/29/2022 11:06 PM

To: paramartha.dutta@visva-bharati.ac.in <paramartha.dutta@visva-bharati.ac.in>;Modali, Bhanu Murthy <bhanu.murthy.modali@dell.com>;Dr Rabindranath Bera,SMIT <rbera@smit.smu.edu.in>

Dear Professor Bera,

I offer my full consent in favor of the course syllabus.

Regards,

Prof. Amlan Chakrabarti

Head, IT & Tech. Innovation Cell
Dept. of Higher Education, Govt. of West Bengal
&
Professor & Director,
A.K. Choudhury School of I.T.University of Calcutta.

Re: SMIT_AI & DS Syllabus_NEP_BOS_29_04_2022

Paramartha Dutta <paramartha.dutta@gmail.com>
Sat 4/30/2022 1:36 PM
To: Dr Rabindranath Bera,SMIT <rbera@smit.smu.edu.in>
Cc: Modali, Bhanu Murthy <Bhanu.Murthy.Modali@dell.com>;AMLAN CHAKRABARTI <achakra12@yahoo.com>

Sir

Now I find it convincing. Please proceed at your end.

Regards

Paramartha Dutta

Re: Invitation to the Board of Studies meeting for the discussion and approval the UG (B. Tech) Detailed Syllabus of the Dept. of AI&DS, SMIT, SMU following NEP 2020 and SMU guidelines.

Sengupta, Debarghya <Debarghya.Sengupta@ct.gov>
Sun 4/10/2022 7:13 AM
To: Dr Rabindranath Bera,SMIT <rbera@smit.smu.edu.in>
Cc: Biswaraj Sen,SMIT <biswaraj.s@smit.smu.edu.in>

Dear Dr. Bera,

Thanks for inviting me to the meeting. Unfortunately the meeting time is a little late for me. I will not be able to attend.

I reviewed the syllabus and do not have any significant observation. Please consider this as my consent.

I wish the department and the esteemed institution all the best.

Regards,
Debarghya Sengupta

RE: SMIT_AI & DS Syllabus_NEP_BOS_29_04_2022

Modali, Bhanu Murthy <Bhanu.Murthy.Modali@dell.com>

Mon 5/2/2022 10:20 AM

To: Dr Rabindranath Bera,SMIT <rbera@smit.smu.edu.in>

Cc: paramartha.dutta@visva-bharati.ac.in <paramartha.dutta@visva-bharati.ac.in>;AMLAN CHAKRABARTI <achakra12@yahoo.com>

Dear Dr. Professor Bera,

Thank you for the session and considering the changes. I offer my consent to the course syllabus.

Thanks & Regards

Bhanu Murthy Modali
Director, IT Architecture,
Global Supply Chain Management,
Dell International Services India Pvt. Ltd.
Mobile +91 9989623632
Bhanu.Murthy.Modali@Dell.com