MANIPAL UNIVERSITY
JAIPUR

B.Tech Computer Science and Engineering (IoT and Intelligent Systems)
Proposed Scheme – 2021 Onwards

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	BB0025	Value, Ethics and Governance	2	0	0	2	EO2001	Economics	3	0	0	3
	MA2101	Engineering Mathematics – III	2	1	0	3	MA2201	Engineering Mathematics – IV	2	1	0	3
	IS2101	Digital Design and Computer Architecture	3	1	0	4	IS2201	Operating Systems	3	1	0	4
	IS 2102	Data Communications	3	1	0	4	IS2202	Relational Database Management Systems	3	1	0	4
	IS2103	Data Structures & Algorithms	3	1	0	4	IS2203	Web Technologies	3	1	0	4
	IS2104	Object Oriented Programming	3	1	0	4	IS2204	Automata Theory and Compiler Design	3	1	0	4
	IS2105	Python Programming	3	0	0	3	*** ***	Open Elective – I	3	0	0	3
	IS2130	Data Structures & Algorithms Lab	0	0	2	1	IS2230	Operating Systems Lab	0	0	2	1
	IS2131	Object Oriented Programming Lab	0	0	2	1	IS2231	Relational Database Management Systems Lab	0	0	2	1
	IS2132	Python Programming Lab	0	0	2	1	IS2232	Web Technologies Lab	0	0	2	1
	IS2170	Project Based Learning-1	0	0	2	1	IS2270	Project Based Learning -II	0	0	2	1
			19	5	8	**28**			20	5	8	**29**
	Total Contact Hours (L + T + P)		**32**				**Total Contact Hours (L + T + P) + OE**		**30+3= 33**			
III	**FIFTH SEMESTER**						**SIXTH SEMESTER**					
	IS3101	Design & Analysis of Algorithms	3	1	0	4	BB0026	Organization and Management	3	0	0	3
	IS3102	AI and Machine Learning	3	0	0	3	IS3201	Cryptography and Security	3	1	0	4
	IS3103	Sensors and Microcontrollers	3	1	0	4	IS3202	IoT Design	3	0	0	3
	IS3104	IoT Architecture and Its Protocols	3	1	0	4	IS3203	Deep Learning	3	0	0	3
	IS3105	Software Engineering	3	1	0	4	IS3204	Computer Networks	3	1	0	4
	IS31**	Program Elective-I	3	0	0	3	IS32**	Program Elective – II	3	0	0	3
	*** ***	Open Elective – II	3	0	0	3	*** ***	Open Elective – III	3	0	0	3
	IS3130	Design & Analysis of Algorithms Lab	0	0	2	1	IS3230	IoT Design Lab	0	0	2	1
	IS3131	AI and Machine Learning Lab	0	0	2	1	IS3231	Deep Learning Lab	0	0	2	1

	IS3132	Sensors and Microcontrollers Lab	0	0	2	1	IS3232	Computer Networks lab	0	0	2	1
	IS3170	Project Based Learning -III	0	0	2	1	IS3270	Minor Project	0	0	6	3
			21	4	8	**29**			21	2	12	**29**
	Total Contact Hours (L + T + P) + OE		**30+3=33**				**Total Contact Hours (L + T + P) + OE**		**32+3=35**			
IV	**SEVENTH SEMESTER**						**EIGHTH SEMESTER**					
	IS41**	Program Elective – III	3	0	0	3	IS4270	Major Project				12
	IS41**	Program Elective – IV	3	0	0	3						
	IS41**	Program Elective – V	3	0	0	3						
	IS41**	Program Elective – VI	3	0	0	3						
	IS41**	Program Elective – VII	3	0	0	3						
	IS4170	Industrial Training	0	0	2	1						
			15	0	2	**16**						**12**
	Total Contact Hours (L + T + P)		**15+ 2 = 17**									

Program Elective-I IS3140 Data Analytics and Visualization IS3141 Foundations of Data Science IS3142 Data Privacy and Security **Programme Electives II, III, IV** **Smart Healthcare** IS3240 Medical Image Processing IS4140 Computer Vision in Disease Visualization IS4141 Smart Patient Monitoring **Smart Cities** IS3241 Smart City Designing IS4142 Smart Urban Infrastructure and Management IS4143 Smart Transport Systems **Smart Farming** IS3242 Precision Agriculture IS4144 Data Analytics for Smart Farming IS4145 Smart Agriculture Systems	**Programme Electives (PE-V, VI, VII)** IS4151 Big data analytics IS4152 DevOps IS4153 Embedded Systems IS4154 Human Computer Interaction IS4155 Industry 4.0 IS4156 IoT Cloud and Edge Computing IS4157 Multiagent Systems IS4158 Natural Language Processing IS4159 Next Generation Telecom Networks IS4160 NoSQL Databases IS4161 Robotic Process Automation IS4162 Security and Trust Management in IoT IS4163 Social Network Analysis IS4164 Software Testing IS4165 Wireless Communication IS4166 Wireless Sensors & Adhoc Networks	**Open Electives** IS2280 Introduction to Intelligent Systems IS3180 Introduction to Smart Cities IS3280 Introduction to Industry 4.0

Evaluation Scheme: As per existing practice 60 % Internal; 40% End Term

BB0025: VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case Studies. Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects.CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies: Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. B. N. Ghosh, *Business Ethics & Corporate Governance*, (1e), McGraw Hill, 2011.
3. S. K. Mandal, *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. C. K. Ray, *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. A. Chatterjee, *Professional Ethics*, (2e), Oxford Publications,2017.

MA2101: ENGINEERING MATHEMATICS III [2 1 0 3]

Boolean Algebra: Partial ordering relations, Poset, Lattices, Basic Properties of Lattices. Distributive and complemented lattices, Boolean lattices and Boolean Algebra. Propositional and Predicate Calculus: Wellformed formula, connectives, quantifications, Inference theory of propositional and predicate calculus. Elementary configuration: Permutations and Combinations, Generating function, Principle of inclusion and exclusion Partitions, compositions. Ordering of permutations: Lexicographical and Fikes. Graph theory: Basic definitions, Degree, regular graphs, Eulerian and Hamiltonian graphs, Trees and Properties, Center, radius and diameter of a graph, Rooted and binary trees, Matrices associated with graphs, Algorithms for finding shortest path, Algorithm. Group theory: Semi groups, Monoids, Groups subgroups, Normal Subgroups, Cosets, Lagrange's Theorem, Cyclic groups.

References:

1. C. L. Liu, *Elements of Discrete Mathematics, (2e)*, Mc Graw Hill, New Delhi, 2007.
2. J. P. Trembaly and R. Manohar, *Discrete Mathematics Structures with Application to Computer Science*, Tata Mc Graw Hill, 2012.
3. E. S. Page and L. B. Wilson, *An Introduction to Computational Combinatorics*, Cambridge Univ. Press, 1979.
4. N. Deo, *Graph theory with Applications to Computer Science*, PHI, 2012.

IS2101: DIGITAL DESIGN AND COMPUTER ARCHITECTURE [3 1 0 4]

Digital logic circuits: logic gates, Boolean algebra, map simplification, combinational circuits, flip-flops, sequential circuits; Digital components: Integrated circuits, decoders, multiplexers, registers, shift registers, binary counters; Memory unit: Von-Neumann model for computer/ Von- Neumann architecture, performance; Machine instructions and programs: numbers, arithmetic operations and characters, memory locations and addresses, instructions and instruction sequencing, addressing modes, assembly language, additional instructions, encoding of machine instructions; Arithmetic: addition and subtraction of signed numbers, design of fast adders, multiplication of positive numbers, signed operand multiplication, fast multiplication, integer division, floating point numbers and operations; Introduction

to CPU design: instruction interpretation and execution, micro-operation and their RTL specification, memory hierarchy, main memory, types and interfacing; Cache Memory: organization and operations, levels of caches; memory management module: paging and segmentation, virtual memory, disk memory, raids, back-up memory; RISC and CISC processors; Introduction to input/output processing: programmed controlled i/o transfer, interrupt controlled I/O transfer, DMA controller; Pipelining and pipeline hazards: design issues of pipeline architecture; Instruction level parallelism and advanced issues: introduction to interconnection network and practical issues.

References:

1. M. M. Mano, *Computer System Architecture*, (3e), Pearson Education, 2017.
2. C. Hamacher, Z. Vranesic, S. Zaky, *Computer Organization*, (5e), McGraw Hill, 2011.
3. J. P. Hayes, *Computer Architecture and Organization*, (3e), McGraw Hill, 2017.
4. T. L. Floyd, *Digital Fundamentals*, (11e), Pearson Education, 2015.
5. W. Stallings, *Computer Organization and Architecture–Designing for Performance,* (10e), Pearson Education, 2016.

IS2102: DATA COMMUNICATIONS [3 1 0 4]

Introduction: Data communications, Networks, Network types, Standards. Protocol Layering: Protocol, Need for protocol architecture, OSI Model, TCP/IP protocol architecture. Data Transmission: Concepts and terminology, Analog and digital data transmission, Transmission impairments, Channel capacity, Transmission Media: Guided transmission media, Wireless transmission, Wireless propagation, LineofSight transmission. Signal Encoding Techniques: Analog and digital Signals, Digital-to-digital conversion: Line coding schemes, Block coding, scrambling, Analog-To-Digital Conversion: Pulse code modulation, Delta modulation. Digital Data Communication Techniques: asynchronous and synchronous transmission, Types of errors, Error detection, Error correction, Line configurations. Data Link Control Protocols: Flow control, Error control, High-level data link control. Multiplexing: Frequency-division multiplexing, Time-division multiplexing, Code-division multiple access. Space division multiplexing. Multiple Access: Random access, Aloha, Carrier sense multiple access, Carrier sense multiple access with collision detection, Carrier sense multiple access with collision avoidance, Code-division multiple access.

References:

1. B. Forouzan, *Data Communication & Networking,* (5e), McGraw Hill Education, 2017.
2. W. Stallings, *Data and Computer Communications*, (10e), Pearson Education,2018.

IS2103: DATA STRUCTURES AND ALGORITHMS [3 1 0 4]

Introduction: algorithm specification; Performance analysis: time and space complexity, asymptotic notation; C revision: pointer declaration and definition, memory allocation functions, array of pointers, structures in C, arrays of structures, structures and functions; Recursion in C; Linked list: implementation, various types and operations; Stack: implementations using array and linked list, operations and its applications; Queue: implementations using array and linked list, operations and its applications; Tree: terminologies, different types, implementations of binary tree using array and linked structure, binary search tree, different operations (recursive, non- recursive), red-black tree, AVL trees, B-tree, 2-3 tree, tree applications; Graph: representations, BFS, DFS; Searching techniques and hashing; Sorting.

References:

1. E. Horowitz, S. Sahni, S. Anderson-Freed, *Fundamentals of Data Structures in C*, (2e), Orient Black Swan, 2008.

2. A. M. Tenenbaum, Y. Langsam, M. J. Augenstein, *Data Structures using C*, (1e), Pearson Education, 2008.
3. A.V. Aho, J. E. Hopcroft, J. D. Ullman, *Data Structures and Algorithms*, (1e), Pearson Education, 2002.
4. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, *Introduction to Algorithms*, (3e), Prentice Hall of India, 2010.
5. S. Lipschutz, *Data Structures with C (Schaum's Outline Series)*, (3e), McGraw Hill, 2017.

IS2104: OBJECT ORIENTED PROGRAMMING [3 1 0 4]

Introduction: history and evolution of OOP, Introduction to OOPS and classes: class and object fundamentals, introduction to methods/functions, object initialization and clean-up (constructors and destructors), this keyword, overloading, objects as parameters, argument passing, returning objects, recursion, access control, classes within classes, string class; I/O basics: reading console input, writing console output, files; Inheritance: basics, multilevel hierarchy, overriding, abstract classes; Packages and Interfaces; exception handling; Multithreaded programming; String handling; Event handling; GUI and Introduction to AWT: classes, component, container, panel, window, frame, canvas, working with frame, working with graphics, Applet fundamentals; The collection framework: array list and vector, sets, map; Database programming using JDBC; Java Server Technologies: servlet; introduction to JDK, JRF and JVM, variables and data types, Unicode system, naming conventions.

References:

1. H. Schildt, *Java:The Complete Reference*, (10e), McGraw Hill, 2017.
2. C. Horstmann, *Core Java Volume-1 Fundamentals*, (11e), Prentice Hall of India, 2020.
3. S. Holzner, *Java 8 programming Black Book*, (1e), Dream Tech, 2015.
4. P. Deitel, H. Deitel, *Java How to Program*, (11e), Pearson Education, 2018.
5. E. Balagurusamy, *Programming with Java: A Primer*, (5e), McGraw Hill, 2017.

PYTHON PROGRAMMING [3 0 0 3]

Python Concepts: Introduction to Python, Features, History, Version, Applications, Install, Path, Example, Execute, Variables, Keywords, Identifiers, Literals, Operators, Comments. Python IDE: Introduction to Python IDE, Use of Python IDE (Pycharm, Pydev, VIM etc.). Control Statement: If, If else, else if, nested if, for loop, while loop, do while, break, continue, pass. Python OOPs: OOPs Concepts, Object, Class, Constructors, Inheritance, Multilevel Inheritance, Multiple Inheritance. Data structures: List, Set, Dictionary (mapping), Tuple, Graph (from a third-party library), List Slicing (sub list), List comprehension (shorthand for a loop), Mutable and immutable data structures, Distinction between identity and (abstract) value. Functions: Procedural abstraction, Functions as values, recursion, Function design methodology. The Python Library: String and Text Handling, Data Structures and Algorithms, Threading, Networking, Web Programming, Graphical Programming, Database Access. Python GUI: Introduction to python GUI framework, Use of Python GUI. Important Libraries.

References:

1. A. Martelli, *Python in a Nutshell*, (3e), O'Reilly Media, Inc, 2017.
2. J. Georzen, T. Bower, B. Rhodes, *Foundations of Python Network Programming*,(3e), APress, 2014.
3. D. M. Beazley, *Python Essential Reference*,(4e), Pearson Addison-Wesley Professional, 2009.
4. M. Lutz, *Programming Python*, (4e), O'Reilly Media, 2010

IS2130: DATA STRUCTURES AND ALGORITHMS LAB [0 0 2 1]

Array: application using arrays (1-D, 2-D), string operations; Linked list: applications (singly, doubly, circular, etc) like polynomial addition and multiplications, etc, Stack and queue: applications of stacks

(like arithmetic expression conversion and evaluation, etc), applications of queue; Binary tree: creation, deletion and traversal techniques, Binary search tree operations, AVL tree; sorting and searching techniques.

References:

1. E. Horowitz, S. Sahni, S. Anderson-Freed, *Fundamentals of Data Structures in C*, (2e), Orient Black Swan, 2008.
2. A. M. Tenenbaum, Y. Langsam, M. J. Augenstein, *Data Structures using C*, (1e), Pearson Education, 2019.
3. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, *Introduction to Algorithms*, (3e), Prentice Hall of India, 2010.
4. S. Lipschutz, *Data Structures with C (Schaum's Outline Series)*, (3e), McGraw Hill, 2017.

IS2131: OBJECT ORIENTED PROGRAMMING LAB [0 0 2 1]

Introduction to Java basics; Control statements and arrays; Stacks and lists; Strings; Classes and methods; Inheritance; Packages; Interfaces; Exception handling; Threads; Input/output; Event handling; Applets; Programs involving AWT; Swing; JDBC; Servlet.

References:

1. H. Schildt, *Java:The Complete Reference Java*, (10e), McGraw Hill, 2017.
2. C. Horstmann, *Core Java Volume-1 Fundamentals*, (10e), Prentice Hall of India, 2016.
3. S. Holzner, *Java 8 programming Black Book*, (1e), Dream Tech, 2015.
4. P. Deitel, H. Deitel, *Java How to Program*, (11e), Pearson Education, 2018.
5. E. Balagurusamy, *Programming with Java A Primer*, (5e), McGraw Hill, 2017.

IS2132: PYTHON PROGRAMMING LAB [0 0 4 2]

Python IDE: Introduction to Python IDE, Use of Python IDE (Jupyter, Pycharm, Pydev, VIM etc.). Control Statement: If, If else, else if, nested if, for loop, while loop, do while, break, continue, pass.
Python OOPs: OOPs Concepts, Object, Class, Constructors, Inheritance, Multilevel Inheritance, Multiple Inheritance. Data structures: List, Set, Dictionary (mapping), Tuple, Graph (from a third-party library), List Slicing (sub list), List comprehension (shorthand for a loop), Mutable and immutable data structures, Distinction between identity and (abstract) value. Functions: Procedural abstraction, Functions as values, recursion, Function design methodology. The Python Library: String and Text Handling, Data Structures and Algorithms, Threading, Networking, Web Programming, Graphical Programming, Database Access. Python GUI: Introduction to python GUI framework, Use of Python GUI.

References:

1. A. Martelli, *Python in a Nutshell*, (3e), O'Reilly Media, Inc, 2017.
2. J. Georzen, T. Bower, B. Rhodes, *Foundations of Python Network Programming*,(3e), APress, 2014.
3. D. M. Beazley, *Python Essential Reference*,(4e), Pearson Addison-Wesley Professional, 2009.
4. M. Lutz, *Programming Python*, (4e), O'Reilly Media, 2010

EO2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macro economics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing

marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR,AR,MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies,Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, *Macroeconomics Theory and Policy*, (20e) S. Chand Publication.
2. Peterson H C et.al., *Managerial Economics*, (9e), Pearson, 2012
3. P L Mehta, *Managerial Economics*, Sultan Chand & Sons, New Delhi, 2012.
4. G J Tuesen & H G Tuesen, *Engineering Economics*, PHI, New Delhi, 2008.
5. J. L. Riggs, D. D. Bedworth, S. U. Randhawa, *Engineering Economics*, Tata McGraw Hill, 2018.

MA2201: ENGINEERING MATHEMATICS IV [2 1 0 3]

Basic Set theory, Axioms of probability, Sample space, Conditional probability, total probability theorem, Baye's theorem. One dimensional and two dimensional random variables, mean and variance, properties, Chebyschev's inequality, correlation coefficient, Distributions, Binomial, Poisson, Normal and Chisquare. Functions of random variables: One dimensional and Two dimensional, F & T distributions, Moment generating functions, Sampling theory, Central limit theorem, Point estimation, MLE, Interval estimation, Test of Hypothesis: significance level, certain best tests; Chi square test.

References:

1. P. L. Meyer, *Introduction to probability and Statistical Applications*, (2e), Oxford and IBH publishing, 1980.
2. Miller, Freund and Johnson, *Probability and Statistics for Engineers*, (8e), Prentice Hall of India, 2011.
3. Hogg and Craig, *Introduction to mathematical statistics*, (6e), Pearson Education, 2012.
4. Sheldon M Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, Elsevier, 2010

IS2201: OPERATING SYSTEMS [3 1 0 4]

Introduction: evolution of operating system, classification of operating system, operating system structure, services, functions, design and implementation, system programs, system calls, virtual machines, system boot; processes: concept, process scheduling, operations on processes, inter- process communication; Linux threads: basic concepts, multithreaded models, thread libraries; CPU scheduling: scheduling criteria, scheduling algorithms, thread scheduling; Process synchronization: concept of synchronization, critical section problem, Dekker's algorithm, peterson's solution, synchronization hardware, semaphores, classical problems on synchronization, monitors; Deadlock: deadlock concept, deadlock characterization, methods for handling deadlock, prevention, avoidance, detection, recovery from deadlock; Memory management: concept of logical and physical memory, swapping, contiguous memory allocation, paging, page table structure, segmentation, paging combined with segmentation, working of intel- 32/64; Virtual memory management: demand paging, copy-on write, page replacement, allocation of frames, thrashing, memory mapped files, allocating kernel memory; Files: file concept, access methods, directory structure, file system mounting, file sharing; Disk: architecture, scheduling algorithms; Security problem: program threats, system and network threats; Case study: Linux / Solaris / Mac / Windows operating system.

References:

1. A. S. Tannenbaum, *Modern Operating Systems*, (4e), Pearson, 2016.
2. A. Silberschatz, P. B. Galvin, *Operating System Concepts*, (9e), Wiley, 2018.
3. W. Stallings, *Operating Systems: Internals and Design Principles*, (9e), Pearson, 2009.
4. H. Sibsankar, A. A. Alex, *Operating Systems*, (6e), Pearson, 2010.
5. Andrew S. Tanenbaum and Albert S. Woodhull, *Operating Systems: Design and Implementation*, (3e), Prentice Hall Software Series, 2015.
6. J. A. Harris, *Schaum's Outline of Operating Systems*, (2e), McGraw-Hill publications, 2002.

IS2202: RELATIONAL DATABASE MANAGEMENT SYSTEMS [3 1 0 4]

Introduction: database systems, RDBMS definition, data models, 3-schema architecture, challenges in building RDBMS, different components of a RDBMS. Relational data model: concept of relation and its characteristics, schema-instance, integrity constraints, E/R Model, Extended E/R model, converting the database specification in E/R and Extended E/R notation to the relational schema; Relational Query Language: relational algebra operators - selection, projection, cross product, various types of joins, division, example queries, tuple relation calculus, domain relational calculus; Introduction to SQL: data definition in SQL, table and different types of constraints definitions, data manipulation in SQL, nested queries, notion of aggregation; Relational Database Design: functional dependencies and normal forms, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, multi-valued dependencies and 4NF; Transaction Processing: concepts of transaction processing, ACID properties, concurrency control, locking based protocols, recovery and logging methods; Data Storage and Indexing: file organizations, primary, secondary index structures, hash-based indexing, dynamic hashing techniques, multi-level indexes, B-tree and B+ trees.

References:

1. A. Silberschatz, H. F. Korth, S. Sudarshan, *Database System Concepts*, (6e), McGraw Hill, 2013.
2. R. Elmasri, S. B. Navathe, *Fundamentals of Database Systems*, (6e), Addison-Wesley, 2010.
3. R. Ramakrishnan, J. Gehrke, *Database Management Systems*, (3e), McGraw Hill, 2014.
4. I. Bayross, *SQL, PL/SQL The Programming Language of Oracle*, (4e), BPB Publications, 2010.
5. C. J. Date, *An Introduction to Database Systems*, (8e), Prentice Hall of India, 2006.

IS2203: WEB TECHNOLOGIES [3 1 0 4]

Introduction: Web Development and Client Side Programming, Protocols Governing Web, Internet Services and Tools, Client-Server Computing; HTML: Basic Syntax, Standard HTML Document Structure, Basic Text Markup, Images, Hypertext Links, Lists, Tables, Forms, HTML5; CSS: Creating Style Sheets, Levels of Style Sheets, CSS Properties, Style Specification Formats, Selector Forms, The Box Model, Conflict Resolution; Javascript: Basic of Javascript, Variables, Arrays and Operators, Functions, Event Handlers, Built-in JS Objects, Form Validations, Conditional and Loops, Debugging and Testing; Introduction to AJAX: AJAX and Node.Js Server, The Xmlhttprequest Object, Handling The Response, Jquery, Passing Data, AJAX Application; PHP Programming: Introduction to PHP, Creating PHP Script, Running PHP Script, Variables and Constants, Data Types, Operators, Conditional Statements, Control Statements, Arrays, Functions, Working With Forms and Databases Connection, Introduction to Web-Server and XAMPP.

References:

1. Kogent Learning Solutions Inc,*Web Technologies (Black Book),* Dreamtech Press, 2009.

2. Jackson, *Web Technologies: A Computer Science Perspective*, (1e), Pearson Education India, 2007.
3. Srinivasan, *Web Technology: Theory and Practice*, (1e), Pearson Education India, 2012.
4. Godbole A., Khate A., *Web Technologies*, (3e), McGraw Hill Education, 2017.
5. Gopalan N. P., Akilandeswari J., *Web Technology: A Developer's Perspective*, (2e Revised), Prentice Hall India Learning, 2014.
6. Roy U. K., *Web Technologies*, Oxford Press, 2010.

IS2204: AUTOMATA THEORY AND COMPILER DESIGN [3 1 0 4]

Introduction to abstract models of computers: Chomsky hierarchy; regular languages:deterministic finite automata (DFA) and nondeterministic finite automata (NFA), their equivalence, minimizing FA, regular expressions, identifying non-regular languages; ContextFree languages (CFLs): Context-Free grammars, push down automata (PDA), nondeterministic PDA and CFLs, deterministic PDA and CFLs;
Introduction to Turing machine; Introduction to compiler design: lexical analysis, recognition of tokens, lexeme and patterns; Syntax analysis: LL(1) parsing, SLR parsers, LR parsers, LALR parsers, parser generators (Flex and Bison), parsing and ambiguity; Runtime environments.

References:

1. M. Sipser, *Introduction to the Theory of Computation*, (3e), Cengage Learning, 2012.
2. P. Linz, *An Introduction to Formal Languages and Automata*, (6e), Jones & Bartlett Learning, 2016.
3. J.E. Hopcroft, R. Motwani, J.D. Ullman, *Introduction to Automata Theory, Languages and Computation*, (3e), Pearson Education, 2013.
4. J. Martin, *Introduction to Languages and the Theory of Computation*, (4e), McGraw Hill, 2010.
5. A.V. Aho, M.S. Lam, R. Sethi, J.D. Ullman, *Compiler Design: Principles, Techniques and Tools*, (2e), Prentice Hall of India, 2006.

IS2230: OPERATING SYSTEMS LAB [0 0 2 1]

Testing the use of UNIX commands; Working with VI editor; Shell: UNIX shell commands, System Administration: user management, security, file management; Inter-process communication: shared memory, message passing, pipes; UNIX system calls: system calls for process management, file management; Process synchronization: bounded buffer problem, Peterson's solution, semaphore; Building multi-threaded and multi-process applications: multi- threading using pthread library; CPU scheduling algorithms; Deadlock: detection algorithms, deadlock avoidance algorithms; Page replacement algorithms; Memory allocation algorithms; Disk scheduling algorithms.

References:

1. S. Das, *Unix Concepts and Applications*, (4e), McGraw-Hill Publications, 2017.
2. R. Blum, C. Bresnahan, *Linux Command Line and Shell Scripting Bible*, (3e), Wiley India, 2015.

IS2231: RELATIONAL DATABASE MANAGEMENT SYSTEMS LAB [0 0 2 1]

Introduction to SQL and its different command categories i.e. DDL, DML, DQL and DCL; Data integrity constraints and built-in functions; Design and implementing the data requirements of a simple DB application; Experiments on views, indexing, triggers, stored procedures, transaction. Platforms: Oracle and/or MySQL.

References:

1. A. Silberschatz, H. F. Korth, S. Sudarshan, *Database System Concepts*, (6e), McGraw Hill, 2013.
2. R. Elmasri, S. B. Navathe, *Fundamentals of Database Systems*, (6e), Addison-Wesley, 2010.
3. R. Ramakrishnan, J. Gehrke, *Database Management Systems*, (3e), McGraw Hill, 2014.
4. I. Bayross, SQL, *PL/SQL The Programming Language of Oracle*, (4e), BPB Publications, 2010.

IS2232: WEB TECHNOLOGIES LAB [0 0 2 1]

Html tags, forms, web site structure. XHTML: XML, move to XHTML, meta tags, character entities, frames and frame sets, inside browser. Style Sheets: CSS1, CSS2, CSS3. JavaScript: variables, functions, conditions, loops and repetition. Advance Javascript: Javascript and objects, javascript own objects, the DOM and web browser environments, forms and validations. DHTML: Combining HTML, CSS and Javascript, events and buttons, controlling your browser. Ajax. XML: Introduction to XML, DTD and Schemas, Well formed, using XML with application. XSL: XML transformed simple example, XSL elements, transforming with XSLT. PHP: Starting to script on server side, arrays, function and forms, advance PHP. Databases: Connection to server, creating database, performing data and schema related operations, PHP myadmin and database bugs. Advanced topics:JQuery, WebRTC, Web socks, Angularjs, NodeJS, JSON, Bootstrap.

References:

1. R. Connolly, R. Hoar, *Fundamentals of Web Development,* Pearson Education India, 2015.
2. R. Nixon, *Learning PHP, MySQL & JavaScript with jQuery, CSS and HTML5*, (5e), O'Reilly Publications, 2018.
3. L. Welling, L. Thomson, *PHP and MySQL Web Development*, (5e), Pearson Education, 2017.
4. N. C. Zakas, *Professional JavaScript for Web Developers*, (3e), Wrox/Wiley India, 2019.
5. D. S. Mcfarland, *JavaScript & jQuery: The Missing Manual*, (3e), O'Reilly/Shroff Publishers & Distributors Pvt Ltd, 2014.

6. Z. R. A. Boehm, *Murach's HTML5 and CSS3*, (4e), Murach's/Shroff Publishers & Distributors Pvt Ltd, 2018.

IS3101: DESIGN AND ANALYSIS OF ALGORITHMS [3 1 0 4]

Algorithm analysis: a priori and a posteriori analysis, time space tradeoff, asymptotic notations, properties of asymptotic notations, recurrence equations, solving recurrence equations using substitution method and master's method; Divide and conquer: binary search, finding maximum and minimum, merge sort, quick sort, matrix multiplication; Greedy algorithms: knapsack problem, job sequencing with deadline, optimal merge pattern, single source shortest path, minimum cost spanning tree; Dynamic programming: multistage graphs, matrix chain multiplication, all-pair shortest paths, optimal binary search trees, 0/1 knapsack, travelling salesperson problem, graph traversals, connected components, spanning trees, bi-connected components; String matching algorithms; Complexity classes: introduction to NP-hard and NP completeness; Approximation algorithm; Randomized algorithm.

References:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, *Introduction to Algorithms*, (3e), Prentice Hall of India, 2010.
2. E. Horowitz, S. Sahni, S. Rajasekaran, *Computer Algorithms*, (2e), University Press, 2017.
3. A. V. Aho, J. E. Hopcroft, J. D. Ullman, *The Design and Analysis of Computer Algorithms*, (1e), Pearson Education, 1999.
4. S. S. Skiena, *The Algorithm Design Manual*, (2e), Springer, 2010.

IS3102: AI AND MACHINE LEARNING [3 0 0 3]

Artificial intelligence concepts: state space representation and search; Heuristic search techniques: hill climbing, best first search, A*, AO*, constraint satisfaction; Knowledge representation and reasoning; Formal logic and unification algorithms; Planning algorithms, goal stack planning, nonlinear planning using constraint posting, hierarchical planning; Case based reasoning; Optimization algorithms, genetic algorithm, ant colony optimization, particle swarm optimization, simulated annealing; Supervised machine learning algorithms: classification algorithms – KNN, decision tree, naïve bayes, support vector machine, regression, random forests; Un-supervised machine learning algorithms: principal component analysis, k-means; Machine learning performance evaluation metrics: classification accuracy, logarithmic loss, confusion matrix, area under curve, F1 score, mean absolute error, mean squared error.

References:

1. S. Russell, P. Norvig, *Artificial Intelligence: A Modern Approach*, (4e), Pearson Education, 2020.
2. T. M. Mitchell, *Machine Learning*, (1e), McGraw Hill, 2017.
3. D. Simon, *Evolutionary Optimization Algorithms*, (1e), Wiley, 2013.
4. D. Khemani, *A First Course in Artificial Intelligence*, (1e), McGraw Hill, 2015.
5. O. Richard, E. D. Peter, D. Hart, G. *Stork, Pattern Classification*, (2e), John Wiley, 2002.
6. C. Bishop, *Pattern Recognition and Machine Learning*, (1e), Springer, 2010.

IS3103: SENSORS AND MICROCONTROLLERS [3 1 0 4]

Sensors: physical principles & fundamentals of sensors, resistive, capacitive, inductive, piezoelectric, photoelastic, optical sensor, photo resistor, photodiode, thermistor, ultrasonic motion sensor, infrared motion sensor & various IoT sensors. Actuators: DC motors, stepper motors, relays and solenoids. Microcontrollers: Introduction to Microcontrollers, 8051 Microcontrollers, 8051 assembly language programming, I/O port programming, 8051 programming in C, Introduction to the Tiva ARM Microcontroller, microcontrollers interfacing to external memory, ADC, sensors & actuators.

References:

1. A. Silberschatz, P. B. Galvin, G. Gagne, *Fundamentals of Sensors for Engineering and Science*, (9e), Wiley, 2014.
2. C. W. de Silva, *Sensors and Actuators: Engineering System Instrumentation*, (2e), CRC Press, 2015.
3. C. Bell, *Beginning Sensor Networks with XBee, Raspberry Pi, and Arduino*, (2e),Apress, 2020 4. M. A. Mazidi, J Gillispie Mazidi, R. D. McKinlay, *The 8051 Microcontroller and Embedded Systems Using Assembly and C*, (2e), Pearson, 2007.
5. M. A. Mazidi, S. Chen & S. Naimi , *Ti Tiva Arm Programming for Embedded Systems: Programming Arm Cortex-M4 Tm4c123g with C*, (1e), Microdigitaled, 2017.

IS3104: IOT ARCHITECTURE AND ITS PROTOCOLS [3 1 0 4]

Introduction: What is the IoT and its important, Elements of an IoT ecosystem, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models. IoT protocols: Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols. Issues with IoT Standardization: Unified Data Standards Protocols, IEEE802.15.4, BACNet Protocol, Modbus, KNX, Zigbee, Network layer, Security. IoT Architecture: IoT Open source architecture (OIC), OIC Architecture & Design principles, IoT Devices and deployment models. IoTivity : An Open source IoT stack, Overview to IoTivity stack architecture, Resource model and Abstraction. Web of things: Web of Things versus Internet of Things, Two Pillars of the Web Architecture, Standardization for WoTPlatform Middleware for WoT. Sensing and power: Sensing devices, Smart IoT endpoints, Energy sources and power management. IoT applications: IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms, middleware etc.

References:

1. Honbo Zhou, *The Internet of Things in the Cloud: A Middleware Perspective*, CRC Press, (1e), 2012.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), *Architecting the Internet of Things*, Springer, (1e), 2011.
3. Olivier Hersent, David Boswarthick, Omar Elloumi, *The Internet of Things-Key applications and Protocols*, Wiley, (1e), 2012.

IS3105 : SOFTWARE ENGINEERING [3 1 0 4]

Software Engineering: introduction, importance, evaluation, characteristics and components; Software applications; Software development process models: waterfall model, prototyping model, spiral model, RAD model; agile modelling; Requirement engineering: problem analysis, requirement verification, requirement validation modularity; Software project management: cost estimation, project scheduling, risk management, quality assurance, project monitoring; Estimation techniques: size estimation- LOC estimation, function count, cost estimation, Halstead size estimation, Software design: analysis modeling, functional modeling, behavioral modeling; unified modeling language; Software architecture; Data design: data modeling, data structures; Software testing: white box (unit and integration), black box (system level, regression); Performance Testing, Quality Assurance, Quality Control and Testing, Software maintenance: maintenances characteristics, maintainability, maintenances tasks, maintenances side effects; Current trends in software engineering.

References:

1. R. S. Pressman, Software Engineering: A Practitioners Approach, (8e), McGraw Hill, 2016.
2. I. Sommerville, Software Engineering, (10e), Pearson Education, 2016.
3. R. Mall, Fundamental of Software Engineering, (5e), Prentice Hall of India, 2018.
4. P. Jalote, Software Engineering a Precise Approach, (1e), Wiley, 2010.

IS3130: DESIGN AND ANALYSIS OF ALGORITHMS LAB [0 0 2 1]

Implement a doubly linked list & BST, GCD Techniques, Bubble sort, Selection sort, Linear search, String Matching, sorting algorithms, DFS, BFS, Topological sorting, AVL tree, 2-3 tree, Horspool algorithm, Open hash table, Floyd's algorithm, Warshall's algorithm, Greedy Techniques, Dijkstra's algorithm, Backtracking.

References:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, *Introduction to Algorithms*, (3e), Prentice Hall of India, 2010.
2. E. Horowitz, S. Sahni, S. Rajasekaran, *Computer Algorithms*, (2e), University Press, 2017.
3. S. S. Skiena, *The Algorithm Design Manual*, (2e), Springer, 2010.

IS3131: AI AND MACHINE LEARNING LAB [0 0 2 1]

Implementation and/or use of libraries for application of algorithms: KNN, decision tree, naïve bayes, support vector machine, regression, random forests, logistic regression, cross validation, principal component analysis, k-means; Performance evaluation metrics: classification accuracy, logarithmic loss, confusion matrix, area under curve, F1 score, mean absolute error, mean squared error.

References:

1. A. Geron, *Hands-On Machine Learning with Scikit-Learn and TensorFlow*, (1e), O'Reilly, 2017.
2. S. Raschka, V. Mirjalili, *Python Machine Learning, (2e)*, Packt Publishing, 2015.
3. W. Richert, L. P. Coelho, *Building Machine Learning Systems with Python*, (3e), Packet Publishing Ltd., 2013.
4. P. Harrington, *Machine Learning in Action*, (1e), Manning Publications Co., 2012.
5. S. Marsland, *Machine Learning: An Algorithmic Perspective*, (2e), Chapman & Hall/Crc, 2014.

IS3132: SENSORS AND MICROCONTROLLERS LAB [0 0 2 1]

8051 assembly language programming, 8051 programming in C, Tiva ARM microcontroller , microcontrollers interfacing to external memory , ADC , I/O Port Programming, microcontrollers interfacing to sensors: resistive, capacitive, inductive, piezoelectric, photo elastic, optical sensor ,photo resistor, photodiode, thermistor, ultrasonic motion sensor, infrared motion sensor & various IoT sensors. Microcontrollers interfacing to Actuators: DC motors, stepper motors, relays and solenoids.

References:

1. A. Silberschatz, P. B. Galvin, G. Gagne, *Fundamentals of Sensors for Engineering and Science*, (9e), Wiley, 2014.
2. C. W. de Silva, *Sensors and Actuators: Engineering System Instrumentation*, (2e), CRC Press, 2015.
3. C. Bell, *Beginning Sensor Networks with XBee, Raspberry Pi, and Arduino*, (2e), Apress, 2020
4. M. A. Mazidi, J Gillispie Mazidi, R. D. McKinlay, *The 8051 Microcontroller and Embedded Systems Using Assembly and C*, (2e), Pearson, 2007.
5. M. A. Mazidi, S. Chen & S. Naimi , *Ti Tiva Arm Programming for Embedded Systems: Programming Arm Cortex-M4 Tm4c123g with C*, (1e), Microdigitaled,2017.

BB0026: ORGANIZATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower. Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit. Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

References:

1. Koontz, Harold, C. O'Donnell, H. Weihrich, *Essentials of Management*, (1e), McGraw Hill, 1978.
2. Robbins, P. Stephen, M. Coulter, *Management*, (2e), Prentice Hall of India, 1997.
3. E. S. Buffa, R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987.
4. H. J. Arnold, D. C. Feldman, *Organizational Behavior*, McGraw Hill, 1986.
5. K. Aswathappa , *Human Resource and Personnel Management*, McGraw Hill, 2005.
6. W. William, D. Keith , *Human Resource and Personnel Management*, McGraw Hill, 1986.

IS3201: CRYPTOGRAPHY AND SECURITY [3 1 0 4]

Introduction: confidentiality, integrity, availability, OSI security architecture; Number theory: finite fields, Galois field, primes, primality testing, factoring algorithms; Probability and information theory: Shannon's theory, perfect security; Classical ciphers; Block ciphers: DES, AES, electronic codebook mode, cipher block chaining mode, cipher feedback mode, output feedback mode, counter mode; Pseudorandom number generation; Stream ciphers; Cryptographic hash functions; Message authentication codes; Public-key cryptography: computational security, computational assumptions, RSA, ElGamal, elliptic curve cryptography, digital signatures, Diffie- Hellman key exchange; Operating systems security: security capabilities of different platforms, identification, authentication, user accounts, file permissions, backups, access control, firewalls, methods of protection, ownership, assessing and securing a system, information warfare, security administration, corporate espionage.

References:

1. W. Stallings, Cryptography and Network Security-Principles and Practice, (7e), Pearson Education, 2017.
2. B. A. Forouzan, D. Mukhopadhyay, Cryptography And Network Security, (3e), McGraw Hill, 2015.
3. D. Stinson, Cryptography: Theory and Practice, (4e), CRC Press, 2018.
4. J. Pieprzyk, T. Hardjono, J. Seberry, Fundamentals of Computer Security, (1e), Springer- Verlag Berlin Heidelberg, 2013.
5. C. P. Pfleeger, S. L. Pfleeger, J. Margulies, Security in Computing, (5e), Pearson Education, 2018.

IS3202 IOT DESIGN [3 0 0 3]

Introduction to IoT: IoT Architecture and Core IoT Modules, Sensing, Actuation. Sensor devices: Thermocouples and temperature sensing, Hall effect sensors and current sensors, Photoelectric sensors, PIR sensors, LiDAR and active sensing systems, MEMS sensors. Basics of Networking: Communication and information theory, RF energy and communication, 802.15, Bluetooth. Communication Protocols:

Bluetooth 5, IEEE 802.15.4, Zigbee, Z-Wave, WLAN, WAN and WPAN. Sensor Networks: WSN, Routing, VPN, VLAN, SDN (Software-Defined Networking). Interoperability in IoT: Introduction to IoT architecture, ESP8266, Arduino, intel Edison, particle.io, BeagleBone. Introduction to Arduino Programming: Arduino i/o Functions, Arduino display, Sensors integration, secondary integration, Arduino communication. Introduction to Python programming, Introduction to Raspberry Pi: IoT Applications based on Pi, Architecture, GPIO and input output, Installing and configuration IoT Framework, GPIO Control over Web Browser, Implementation of IoT with Raspberry Pi. Introduction to SDN: SDN for IoT, industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring

References:

1. Honbo Zhou, *The Internet of Things in the Cloud: A Middleware Perspective*, CRC Press, (1e),2012.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), *Architecting the Internet of Things*, Springer, (1e), 2011.

IS3203: DEEP LEARNING [3 0 0 3]

Introduction: Neural networks; Training a network: Loss functions, back propagation and stochastic gradient descent, neural networks as universal function; Convolutional Neural Networks: Introduction to Convnet, training a Convnet, weights initialization, batch normalization, pooling, padding, dropouts, hyper parameter optimization, CNN Architectures- AlexNet, VGG, Inception, ResNet; Recurrent neural network: Recurrent networks, long short-term memory(LSTM), gated recurrent units(GRU), recurrent neural network language models; Deep unsupervised learning: Auto encoders, variation auto encoders, generative adversarial networks(GAN), maximum entropy distributions; Applications: Deep learning applications to computer vision and natural language processing(NLP).

References:

1. L. Deng & D. Yu, *Deep Learning: Methods and Applications*, (1e), Now Publishers, 2014.
2. Goodfellow, Y. Bengio, A. Courville, *Deep Learning*, (1e), MIT Press, 2016.
3. M. Nielsen, *Neural Networks and Deep Learning*, (1e), Determination Press, 2015.
4. C. R. Shalizi, *Advanced Data Analysis from an Elementary Point of View*, (1e) Cambridge University Press, 2015.

IS3204: COMPUTER NETWORKS [3 1 0 4]

Network Layer: network layer design issues, routing algorithms, congestion control algorithms, Quality of Service (QoS), MPLS; Classful addressing, subnetting, classless addressing, variable length blocks, block allocation, NAT; IPV4: header format, fragmentation, options, checksum; ARP & DHCP: introduction, packet format, message types; ICMP: message format, message types; Dynamic routing protocols: RIP, OSPF & BGP, Multicasting Protocol: IGMP; Introduction to IPV6; Transport Layer: elements of transport protocols: addressing, connection establishment, connection release, congestion control, transport services, transport layer protocols, state diagrams; UDP: UDP datagram, UDP services, checksum; TCP: TCP services, TCP features, segment, TCP connection establishment, data transfer, connection termination, TCP window management, flow control, congestion control, timer management; Application Layer: DNS: Name space, domain resource records, Electronic Mail - SMTP, POP, IMAP, MIME, HTTP, HTTPS, SNMP.

References:

1. B. A. Forouzan, *TCP/IP Protocol Suite*, (4e), McGraw Hill, 2017.
2. A. S. Tenenbaum, *Computer Networks*, (5e), Pearson India, 2013.
3. D. E. Comer, *Internetworking with TCP/IP Principles, Protocols and Architecture*, (6e), Pearson Education, 2014.

4. W. Stallings, *Data and Computer Communications*, (10e), Pearson Education, 2014.

IS 3230 IOT DESIGN LAB [0 0 2 1]

Introduction to Arduino Programming: Arduino I/O Functions, Arduino display, Sensors integration, secondary integration, Arduino communication. Introduction to programming, Introduction to Raspberry Pi: IoT Applications based on Pi, Architecture, GPIO and input output, Installing and configuration IoT Framework, GPIO Control over Web Browser, Implementation of IoT with Raspberry Pi. Case Study: Agriculture, Healthcare, Activity Monitoring.

References:

1. Honbo Zhou, *The Internet of Things in the Cloud: A Middleware Perspective*, CRC Press, (1e), 2012.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), *Architecting the Internet of Things*, Springer, (1e), 2011.

IS 3231 DEEP LEARNING LAB [0 0 2 1]

Neural networks; Training a network: Loss functions, back propagation and stochastic gradient descent, neural networks as universal function; Convolutional Neural Networks: Introduction to Convnet, training a Convnet, weights initialization, batch normalization, pooling, padding, dropouts, hyper parameter optimization, CNN Architectures- AlexNet, VGG, Inception, ResNet, application to classification; Recurrent neural network:long short-term memory(LSTM), gated recurrent units(GRU), generative adversarial networks(GAN).

References:

1. L. Deng & D. Yu, Deep Learning: Methods and Applications, (1e), Now Publishers, 2014.
2. Goodfellow, Y. Bengio, A. Courville, Deep Learning, (1e), MIT Press, 2016.
3. François Chollet, Deep Learning with Python,(1e), Manning Publications, 2017.
4. C. R. Shalizi, Advanced Data Analysis from an Elementary Point of View, (1e) Cambridge University Press, 2015.

IS3232: COMPUTER NETWORKS LAB [0 0 2 1]

Experiment with Packet Tracer: Introduction to Packet tracer and networking device components; Router Mode, Switch/Router basic commands; designing of star topology using HUB and Switch, IP configuration of end devices; configuring DHCP server, static routing, RIP, OSPF, VLAN and NAT; Network programming: Transmission Control Protocol (TCP) socket and User Datagram Protocol (UDP) socket; Network Utilities: PING, NETSTAT, IPCONFIG, IFCONFIG, ARP, TRACE-ROUTE.

References:

1. B. A. Forouzan, *TCP/IP Protocol Suite*, (4e), McGraw Hill, 2017.
2. A. S. Tenenbaum, *Computer Networks*, (5e), Prentice Hall of India, 2013.
3. D. E. Comer, *Internetworking with TCP/IP Principles, Protocols and Architecture*, (6e), Pearson Education, 2014.
4. W. Stallings, *Data and Computer Communications*, (10e), Pearson Education, 2014.

Program Elective-I

IS3140: DATA ANALYTICS AND VISUALIZATION [3 0 0 3]

Steps in Data Analytics Projects, Data Analytics tasks, and methods, Data Gathering and Preparation: Data Formats, Parsing and Transformation, Scalability and Real-time Issues; Data Cleaning: Consistency Checking, Heterogeneous and Missing Data, Data Transformation and Segmentation;
Exploratory Analysis: Descriptive and comparative statistics, Hypothesis testing, Statistical Inference. Association rule mining, Clustering. Visualization: Visual Representation of Data, Gestalt Principles, Information Overloads; Creating Visual Representations: Visualization Reference Model, Visual Mapping, Visual Analytics, Design of Visualization Applications; Classification of Visualization Systems: Interaction and Visualization Techniques, Visualization of One, Two and Multi-Dimensional Data, Text and Text Documents; Visualization of Groups: Trees, Graphs, Clusters, Networks, Software, Metaphorical Visualization; Visualization of Volumetric Data: Vector Fields, Processes and Simulations, Visualization of Maps, Geographic Information, GIS systems, Collaborative Visualizations, Evaluating Visualizations; Recent Trends in Various Perception Techniques: Various Visualization Techniques, Data Structures used in Data Visualization.

References:

1. Glenn J. Myatt, Wayne P. Johnson, *Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining*, (2e), John Wiley & Sons Publication, 2014.
2. Glenn J. Myatt, Wayne P. Johnson, *Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications*, John Wiley & Sons Publication, (1e) 2011.
3. E. Tufte.,*The Visual Display of Quantitative Information*, (2e), Graphics Press, 2007.
4. Jules J., Berman D., *Principles of Big Data: Preparing, Sharing, and Analyzing Complex Information*, (2e), 2013.

IS3141: FOUNDATION OF DATA SCIENCE [3 0 0 3]

Basics of Data Science: Introduction, Typology of problems, Importance of linear algebra, statistics and optimization from a data science perspective, Structured thinking for solving data science problems; Linear Algebra: Matrices and their properties (determinants, traces, rank, nullity, etc.), Eigenvalues and eigenvectors, Matrix factorizations, Inner products, Distance measures, Projections, Notion of hyper planes, half-planes; Probability, Statistics and Random Processes: Probability theory and axioms, Random variables, Probability distributions and density functions (uni-variate and multivariate), Expectations and moments, Covariance and correlation, Statistics and sampling distributions, Hypothesis testing of means, proportions, variances and correlations, Confidence (statistical) intervals, Correlation functions, White-noise process; Optimization: Unconstrained optimization, Necessary and sufficiency conditions for optima, Gradient descent methods, Constrained optimization, KKT conditions, Introduction to non- gradient techniques, Introduction to least squares optimization, Optimization view of machine learning; Introduction to Data Science Methods: Linear regression as an exemplar function approximation problem, Linear classification problems.

References:

1. G. Strang, *Introduction to linear algebra, Wellesley*, (5e), MA: Wellesley-Cambridge Press, 2016.
2. J. S. Bendat, A. G. Piersol, *Random Data: Analysis and Measurement Procedures*, (4e), John Wiley & Sons. 2010.
3. D. C. Montgomery, G. C. Runger, *Applied Statistics and Probability for Engineers*, (5e), John Wiley & Sons, 2011.

4. C. O'Neil, R. Schutt, *Doing Data Science: Straight Talk from The Frontline*,(1e), O'Reilly Media, Inc., 2016.

IS3142: DATA PRIVACY AND SECURITY [3 0 0 3]

Introduction to Data Privacy, types of privacy attacks, Data linking and profiling, access control models, role-based access control, privacy policies, their specifications, privacy policy languages, privacy in different domains-medical, financial, etc. Mathematical model for comparing real-world data sharing practices, computing privacy and risk measurements. Demographics and Uniqueness. Protection Models-Null-map, k-map, Wrong map. Survey of techniques-Protection models (null-map, k-map, wrong map), Disclosure control, Inferring entity identities, entry specific databases. Computation systems for protecting delimited data-Min Gen, Datafly, Mu-Argus, k-Similar. Introduction to Security: The OSI Security Architecture, Security Attacks, Services and Mechanisms, Model for Network Security, Number theory, Cryptographic Hash Functions, Digital Signatures, System Security, Symmetric Encryption and Message Confidentiality, Substitution ciphers, Stream ciphers, Public-key cryptography and Message Authentication, Key Distribution and Authentication, Transport Layer Security, Wireless Network Security, E-mail Security, IP Security, Security Management Systems, Need for IT Security, Intrusion Prevention and Detection Systems, Cyber Security. Security metrics: Design, Data sources, Analysis of security metrics data, Measuring security cost and value, Different context for security process management. Acquisition and Duplication: Sterilizing Evidence Media, Acquiring Forensics Images, Acquiring Live Volatile Data, Data Analysis, Metadata Extraction, and File System Analysis.

References:

1. Ronald Leenes , Rosamunde van Brakel , Serge Gutwirth , De Hert, Paul, *Data Protection and Privacy: The Age of Intelligent Machines (Computers, Privacy and Data Protection*), (1e), Hart Publishing, 2017.
2. B. Raghunathan, *The Complete Book of Data Anonymization: From Planning to Implementation*,(1e), Auerbach Pub, 2016.
3. L. Sweeney, *Computational Disclosure Control: A Primer on Data Privacy Protection*, MIT Computer Science,(1e), 2017
4. William Stallings, *Cryptography and Network Security: Principles and Practice*, (7e), Pearson Education, 2017.
5. William Stallings, *Network Security Essentials: Applications and Standards*, (6e),Pearson Education, 2014.

Program Elective-II, III, IV

Special Track-1: Smart Healthcare

IS3240: MEDICAL IMAGE PROCESSING [3 0 0 3]

Introduction: Medical image formation principles for X-ray, MRI, Ultrasound and CT imaging, Design optimum protocol for raw data acquisition, Biomedical applications, Introduction to Medical Imaging and Analysis Software. Pre-processing: Image reconstruction from raw data, Noise and artifact reduction in raw data space, Contrast manipulation, histogram equalization, pixel brightness transformations, Geometric transformations, Imaging filters. Image segmentation: Deep learning techniques for segmentation such as UNet, VNet, VBNet. Image Classification: Different types of neural networks such as ResNet, VGG, InceptionNet etc for classification. Visualization: Neural network based strategies such as GradCam, Saliency Maps, GradCam++ etc. for feature visualization.

References:

1. P. Suetens , *Fundamentals of Medical Imaging*,(2e)Cambridge University Press, 2009.
2. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, (4e),Pearson, 2018.

3. Toennies, Klaus D, *Guide to Medical Image Analysis*, , Springer, 2017.
4. S. Kevin Zhou Hayit Greenspan Dinggang Shen, *Deep Learning for Medical Image Analysis*, (1e) , Elsevier 2017.

IS4140: COMPUTER VISION IN DISEASE VISUALIZATION [3 0 0 3]

Introduction: Overview of computer vision in healthcare, Medical imaging, image processing, pattern recognition, surgical simulation and surgical assistance, augmented reality in real-life surgeries, Automatic analysis of 3D radiological images Visualization, Role of machine learning and deep learning in disease visualization. Visual Analytics: Developing, training and testing the Convolution Neural Network Model for medical image analysis. Object Detection: Applications of deep learning in object recognition, Unsupervised or generative feature learning, Supervised feature learning, Recurrent and faster recurrent neural networks for disease detection and visualization, tracing the visualization of features at each layer, Feature visualization to disease visualization a case study on chest X-rays/CT Scan.

References:

1. Kevin Patrick Murphy , *Machine Learning: A Probabilistic Perspective*, (1e), MIT Press, 2012.
2. Christoph Molnar, *Interpretable Machine Learning: A Guide for Making Black Box Models Explainable*, https://christophm.github.io/interpretable-ml-book/
3. Tamara Munzner, *Visualization Analysis and Design (A K Peters Visualization Series)*,(1e), CRC Press, 2014.
4. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*,(1e), MIT Press, 2017.
5. Simone Baloco, Maria A. Zuluaga, *Computing and Visualization for Intravascular Imaging and Computer-Assisted Stenting*,(1e), Academic Press, 2017.

IS4141: SMART PATIENT MONITORING [3 0 0 3]

Introduction: Applications and challenges in implementing smart monitoring systems. Monitoring devices: Personal alarm, Epilepsy sensor, Enuresis sensor, Smart mat, Independa, InTouch, Vivify, Sotera etc., Health monitoring systems: Structure of remote health monitoring systems, Problems related to hardware development, The basics of Analog-to-Digital Conversion, Basics of Arduino/Raspberry Pie platform programming. Data transfer: COM-Port Setup in MATLAB/any other suitable platform, Package data transferring, Connecting Arduino/Raspberry pie via virtual COM-Port, Working with Arduino hardware support package for MATLAB/Python. Pre-Processing: Noise removal in biomedical signals, Spectral analysis basics, The fourier transform, Alternative spectral estimation, Spectral analysis, Digital filters, Filter design. Visualization: Plotting real-time data with Arduino hardware package, Saving data from Arduino Virtual COM-Port. Event Detection: Feature extraction based on signal spectral characteristics, Statistical signal processing methods, Data Interpretation techniques for event detection, Results visualization and alert generating systems.

References:

1. Rudansky, Alex, *Remote Patient Monitoring: 9 Promising Technologies*, Information Week 30 July 2013. Web. 10 March 2015.
2. Balageas D L, Structural health monitoring R & D at the European Research Establishment in Aerospace (EREA), Structural Health Monitoring–The Demands and Challenges, Third International Workshop on Structural Health Monitoring, p12-29, Stanford, CA. 2001.
3. Mobile Health Monitoring System, coursera MOOC Course available at https://www.coursera.org/learn/mobile-health-monitoring-systems.

Special Track-2: Smart Cities

IS3242 : SMART CITY DESIGNING [3 0 0 3]

Introduction: Smart City Framework, Challenges for Smart Cities, Introduction to Smart Solutions, Global Trends, Organizational Models, Global Trends, Smart Community; Fundamental Technologies: Networking, Internet of Things, Cloud Computing Framework, Service-Oriented Architecture, Ubiquitous Computing, Big Data, AI for Smart Cities, IoT Devices and Sensors; ICT Fundamentals for Smart Cities: ICT Infrastructure Modelling, IoT Centric Approach; IoT Protocols: Wi-Fi, 6lowpan, Cellular, NFC, Lora, Sigfox, Neul, RFID; Opportunities: Smart Street Lighting, Smart Parking, Traffic Monitoring and Control, Vehicular Tracking, Designing Mobile Application, Wearable Monitoring Systems And Design, Digital Signage And Integrated Systems; Sustainable Development: Green Building, Energy Efficient Building. Case Studies: Mobile/web application for smart city.

References:

1. Stephen Goldsmith, Susan Crawford, *The Responsive City: Engaging Communities Through DataSmart Governance*, (1e), Wiley,2014.
2. Carlo Ratti and Matthew Claudel, *The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life (The Future Series)*, Yale University Press,2016.
3. Oliver Gassmann, Jonas Böhm, Maximilian Palmié, *Smart Cities: Introducing Digital Innovation to Cities*, (1e), Emerald Publishing, 2019.

IS4142: SMART URBAN INFRASTRUCTURE AND MANAGEMENT [3 0 0 3]

Smart Cities Notion: Smart Community Concepts, Global Principles and Benchmark, Governance and Policies; Technology: Spatial Intelligence, IoT Sensors and Smart Cities, Bigdata Insights, Semantic Web, Future Media, Cloud Computing and Smart Cities, Artificial Intelligence (AI) Applications for Smart Cities, Data Acquisition and Analysis; Urban Intelligence and Infrastructure: AI Powered Computer Vision for Smart Community, Smart Parking, IoT Ecosystem, Sensors, Actuators, Cloud and Analytics, Geo Spatial Data Collection and Analysis, Augmented Reality and Geolocation, Research Trends in Smart City; Smart Ecosystem: Waste Management and Disposal, Water Management, Fire Detection, Earthquake and Tsunami Detection, Green Energy, Governance for Smart City Ecosystem, Case Studies: European Smart Cities.

References:

1. Nicos Komninos, *The Age of Intelligent Cities Smart Environments and Innovation-for-all Strategies*, (1e), Routledge, 2018.
2. Carlo Ratti and Matthew Claudel, *The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life (The Future Series)*, Yale University Press,2016.
3. *Antoine Picon, Smart Cities: A Spatialised Intelligence, (1e), Wiley, 2015.*
4. Yoshiki Yamagata Perry Yang, *Urban Systems Design- Creating Sustainable Smart Cities in the Internet of Things Era*, (1e), Elsevier, 2020.

IS4143: SMART TRANSPORT SYSTEM [3 0 0 3]

Introduction: Intelligent Transportation System (ITS) Overview, ITS Framework, Intelligent Sensing; Data Collection Methods: Detectors, Geographical Information System (GIS). Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI); Vehicular Communication: Autonomous and Connected Vehicles, V2I And V2V Framework, Vehicular Ad-Hoc Network, Roadside Infrastructure for Wireless Vehicular Communications, AI with Self-Driven Car; Surveillance in ITS and Sensor Network: Visual Sensors Networks (VSN), IoT Protocols, Smart Parking Lot Monitoring, Computer

Vision In ITS; ITS Services: Advanced Traffic Management Systems (ATMS), Advanced Traveller Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS); ITS Risk: Cyber Risk In ITS, Cyber Risk Management For ITS; Case Study: ITS in Developing Countries.

References:

1. Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola, *Intelligent Transport Systems*, (1e), Wiley, 2015.
2. Lawrence A. Klein, *Sensor Technologies and Data Requirements for ITS,* Artech House Publishers, 2001.
3. *Mashrur A. Chowdhury, Adel Wadid Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House Publishers, 2003.*

Special Track-3: Smart Farming

IS3242: PRECISION AGRICULTURE [3 0 0 3]

Introduction: Scope, Overview of Technologies, Historic Perspectives, Applications. Tools and Methodologies: Global Positioning Systems (GPS), Geographic Information System (GIS), Remote Sensing, Sensors, Autonomous Vehicles. Crop Yield Monitoring: Introduction, Tools and Technologies for Yield Monitoring, Site Specific Yield Monitoring (SSYM). Land Management: Overview and Applications, Site Specific Land Management (SSLM), Soil Monitoring. Nutrient Management: Overview of Plant Nutrients, Tools and Techniques for Nutrients Management, Site Specific Nutrient Management (SSNM). Water Management: Introduction to Precision Irrigation, Advantages of Precision Irrigation, Tools and Technologies for Precision Irrigation. Weed Management: Introduction, Tools and Technologies, Site Specific Water Management (SSWM). Crop Protection: Introduction to Plant Disease Management, Tools and Techniques for Disease Management, Site Specific Disease Management (SSDM), Computer Aided Disease Managment. Challenges in Adoption of Precision Agriculture, Case Study, Software for Precision Agriculture.

References:

1. A. B. Zachariah, *Precision Agriculture: The Future of Farming*, (1e), Delve Publishing, 2019
2. Q. Zhang, *Precision Agriculture Technology for Crop Farming*, (1e), CRC Press, 2016
3. K. R. Krishna, *Precision Farming: Soil Fertility and Productivity Aspects*, (2e), Apple Academic Press, 2013
4. J. E. Addicott, *The Precision Farming Revolution Global Drivers of Local Agricultural Methods* (1e), Palgrave Macmillan, 2020
5. J. Singh, *Precision Farming in Horticulture, (1e),* New India Publishing Agency, 2013

IS4144: DATA ANALYTICS FOR SMART FARMING [3 0 0 3]

Agricultural Big Data: Introduction, Structure & Conceptual Framework. Web-Based Solutions for Smart Farming. Management Information Systems: Introduction, Benefits, Challenges, Case Study. Applications of Data Analytics for Smart Farming: Digital soil, Crop Mapping, Weather Prediction, Disease Detection and Pest Management. Data Generation and Storage: Data Collection, Processing, and Interpretation; Vegetation Indices. Modern Data Analysis Tools and Techniques. Statistical Methods: Data Collection, Classification, Frequency Distribution, Measures of Location and Dispersion, Elementary Probability, Data Distributions, Test of Hypothesis, Multiple Regression and Correlation, Multivariate Statistical Methods. Data Analytics Mobile Apps for Smart Farming. Introduction to Data Analysis Software.

References:

1. H. Karau, A. Konwinski, P. Wendell, M. Zaharia, *Learning Spark: Lightning Fast Big Data Analysis, (1e)*, O'Reilley Media Inc, 2015.
2. G. N. Rao, Statistics for Agricultural Sciences, (2e), B S Publications, 2007.
3. M Rana, and D. Prasad, *Agro-informatics*, (1e), Bioscientific Publisher, 2017.
4. A. K. Gupta, D. Goyal, V. Singh, and H. Sharma, *Smart Agricultural Services Using Deep Learning, Big Data, and IoT*, (1e), IGI Global, 2020.

IS4145: SMART AGRICULTURE SYSTEMS [3 0 0 3]

Smart Agriculture: Introduction, Goals, Elements, Advantages. The Smart Concept: Smart Consumer, Smart Farmer, Smart Farms. Socio Economic Challenges in Smart Agriculture. Automation in Smart Agriculture: Smart Irrigation system. Smart Agricultural Framework using Modern Tools and Technologies. Smart Water Management: Groundwater Growth, Degradation & Overexploitation, Conservation, Artificial Recharge, IoT based solution for smart water management system, Soil Monitoring & Wasteland Management using IoT. Energy and Agricultural Sustainability, Biomass Energy sytem. Smart Farming towards Agriculture 5.0: Introduction, Case Study. Smart livestock management system: Intoduction,benefits, case study. IoT enabled smart greenhouse system. Smart crop health monitoring system.

References:

1. A. U. Rehman, *Smart Agriculture: An Approach towards Better Agriculture Management*, (1e), OMICS Group eBooks, 2015.
2. A. Castrignanò, G. Buttafuoco, R. Khosla, A. M. Mouazen, D. Moshou, and O. Naud, *Agricultural Internet of Things and Decision Support for Precision Smart Farming*, (1e), Academic Press Elsevier, 2020.
3. N. Nhamo, D. Chikoye, and T. Gondwe, *Smart Technologies for Sustainable Smallholder Agriculture*, Academic Press Elsevier, 2017.
4. R. C. Poonia, X. Z. Gao, L. Raja, and S. Sharma, *Smart Farming Technologies for Sustainable Agricultural Development*, (1e), IGI Global, 2019.

Program Elective-V, VI, VII

IS4151: BIG DATA ANALYTICS [3 0 0 3]

Data definitions and analysis techniques: Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing. Descriptive Statistics: Measures of central tendency, Measures of location of dispersions, Basic analysis techniques: Relationship analysis, Correlation analysis Statistical hypothesis generation and testing, z-test, t-test, chi-square test, f- test, Analysis of variance, Maximum likelihood test. Data analysis techniques: Regression analysis, Classification techniques, Clustering, Association rules analysis. Unsupervised Learning, Recommendation Systems. Streaming Algorithms, Hadoop: Distributed Architecture, HDFS, MapReduce, Spark, Similarity Search, Link Analysis. Case studies and projects: Understanding business scenarios, Feature engineering and visualization, Sensitivity Analysis.

References:

1. R. E. Walpole, R. H. Myers, S. L. Myers, K. Ye, Probability and statistics for engineers and scientists, (9e), Pearson Education, 2014.
2. G. James, D. Witten D, T. Hastie, R. Tibshirani, Statistical Learning. In: An Introduction to Statistical Learning. Springer Texts in Statistics, vol 103, Springer, New York, 2013.

3. H. Trevor, T. Robert, F. Jerome, The elements of statistical learning: data mining, inference, and prediction, (2e), Springer-Verlag New York, 2009.
4. J. Leskovec, A. Rajaraman, J. D. Ullman, Mining of massive datasets, (2e), Cambridge university press, 2014.

IS4152: DEVOPS [3 0 0 3]

Introduction: overview of DevOps, market trends, skills, delivery pipeline, ecosystem; Version Control: concept of Git, common commands, working with remote repositories; Continuous Integration (CI): branching and merging in Git, workflows, Git cheat sheet, introduction to Jenkins, Jenkins management, adding a slave node to Jenkins, building delivery pipeline, pipeline as a code, introduction to Maven; Continuous Testing (CT): need, Selenium and Webdriver, creating test cases, handling different controls on webpage, frameworks; Continuous Deployment: introduction to container, life cycle, sharing and copying, understanding images and containers, working with docker, publishing image; Docker ecosystem, compose, Swarm, managing and running containers, Docker networking, network types, Kubernetes; Continuous Deployment (Configuration Management (CM)): Puppet installation and configuration, master and agent setup, puppet module, node classification, puppet environment and classes, automation and reporting; Ansible: installation and configuring, roles, write playbooks; Continuous Monitoring: Nagios installing, Plugins(NRPE) and objects, Nagios commands and notification; DevOps on Cloud: introduction to cloud computing, why DevOps on cloud, Introduction to AWS, various AWS services, DevOps using AWS. **References:**

1. L. Bass, DevOps: A Software Architect's Perspective, Pearson Education, 2016.
2. N. Felson, Effective DevOps with AWS, Packet Publishing Limited, 2017.
3. J. Davis, R. Daniels, Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale, O'Reilly Media 2016.

IS4153: EMBEDDED SYSTEMS [3 0 0 3]

Introduction to embedded systems, with/without communication, chargeable and storage battery; Design and implementation: typical requirements and their representation, generation of specifications, executable specs, behavioural models, hardware software partitioning, embedded software synthesis, mapping of hardware to standard micros; Building blocks of embedded systems: RISC/CISC architectures, multicore, variants of micros, typical building blocks of micros; Memory: RAM, ROM, NVROM, flash memory, DDR, cache; Timers, PIC, ADC, DAC, MUX; Serial communication: USB, I2C, CAN, SPI RF controllers, Bluetooth, ZigBee, WiFi, ethernet; Custom building blocks: TDC, FFT, DCT, FPGAs/PLDs; sensors and actuator, displays, low power modes, battery management; Programming of micros: IDEs, emulators, debuggers, instruction set emulators, MISRA, WELMEC; embedded system development using MATLAB and LabVIEW, low-end applications: custom manager; Kernels & RTOS: kernels, Windows CE, embedded Linux, Android and iOS; embedding real time capabilities: RTK, RTOS, multi-tasking, task scheduler; Networked embedded systems: Wireless Sensor Networks and IoT, Case studies and projects.

References:

1. F. Vahid, T. Givargis, Embedded System Design-A Unified Hardware/Software Introduction, (3e), Wiley, 2009.
2. K. V. Shibu, Introduction to Embedded Systems, (2e), McGraw Hill, 2017.
3. D. E. Simon, An Embedded Software Primer, (1e), Pearson Education, 2014.
4. S. Heath, Embedded System Design, (2e), Elsevier, 2005.
5. J. K. Peckol, Embedded Systems – A Contemporary Design Tool, Wiley Student Edition, 2009.
6. J.W. Valvano, Embedded Microcomputer Systems: Real Time Interfacing, (3e), Cengage Learning, 2011.

IS4154: HUMAN COMPUTER INTERACTION [3 0 0 3]

Foundations of HCI: The human: I/O channels, memory, reasoning and problem solving; The computer: devices, memory, processing and networks; Interaction: models, frameworks, ergonomics styles elements, interactivity, paradigms; Design & software process: interactive design basics, process, scenarios, navigation, screen design, iteration and prototyping; HCI in software process: software life cycle, usability engineering, prototyping in practice, design rationale; Design rules: principles, standards, guidelines, rules; Evaluation techniques, universal design; Models and Theories: cognitive models, socio-organizational issues and stake holder requirements, communication and collaboration models, hypertext, multimedia and www; Mobile HCI: mobile ecosystem, platforms, application frameworks, types of mobile applications: widgets, applications, games mobile information architecture, mobile 2.0; Mobile design: elements of mobile design, tools; Web interface design: designing web interfaces, drag & drop, direct selection, contextual tools, overlays, inlays and virtual pages, process flow; Case studies.

References:

1. Dix, J. E. Finlay, G .D. Abowd, R. Beale, Human Computer Interaction, (3e), Pearson Education, 2004.
2. S. Ben, P. Catherine, Designing the user interface Strategies for effective human-computer interaction, (5e), Pearson Education, 2014.
3. T.K. Prabhu, Research methods in human computer interaction, (2e), Oxford Book Company, 2017.
4. Fling, Mobile Design and Development, (1e), O'Reilly Media Inc., 2009.
5. David, Linear Algebra and applications, (3e), Pearson Education, 2009.

IS4155: INDUSTRY 4.0 [3 0 0 3]

Introduction to Industry 4.0, Basic principles and technologies of a Smart Factory, Cyber-Physical Systems (CPS) and Cyber-Physical Production Systems (CPPS), The smart workpiece, Digital Twins in Production, Assistance systems for production, Human-Robot Collaboration, Interoperability: Communication systems and standards for Industry 4.0 and cloud applications, Cloud Manufacturing and the connected factory, Introduction to Cloud Development Environments & a Predictive Maintenance Case, Artificial Intelligence in Production, Safety and Security in networked Production Environments, Cyber-Physical Systems and new Business Models, use-cases for Augmented Reality in Manufacturing

References:

1. Alasdair Gilchrist, *Industry 4.0: The Industrial Internet of Things*,(1e) , APress, 2019.
2. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, *Industrial Internet of Things: Cybermanufacturing Systems*, (1e), Springer, 2017.

IS4156: IOT CLOUD AND EDGE COMPUTING [3 0 0 3]

Internet of Things (IoT) and New Computing Paradigms: Introduction, Relevant Technologies, Fog and Edge Computing Completing the Cloud, Hierarchy of Fog and Edge Computing, Opportunities and Challenges. Integrating IoT + Fog + Cloud Infrastructures: System Modeling and Research Challenges, The Networking Challenge, The Management Challenge, Miscellaneous Challenges, Integrating C2F2T. Management and Orchestration: Network Slicing in 5G, Network Slicing in Software Defined Clouds, Network Slicing Management in Edge and Fog. Fog and Edge Computing: Design Issues: Need for Fog and Edge Computing Middleware, Design Goals, State of the Art Middleware Infrastructures, System Model, Proposed Architecture, Case Study Example. Architecture Management: IoT Integration, Clusters for Lightweight Edge Clouds, Security Management for Edge Cloud Architectures.

Optimization Problems in Fog and Edge Computing: Optimization in Fog Computing, Formal Modeling Framework for Fog Computing, Metrics, Optimization Problems in Fog Computing Architecture, Optimization Techniques. Predictive Analysis to Support Fog Application Deployment: Introduction, Motivating Example: Smart Building, Predictive Analysis with Fog, Machine Learning in Fog Computing for Security and Privacy, Optimization with machine learning. Modeling and Simulation of Fog and Edge: Introduction, iFogSim Simulator and Its Components, simulating a Case Study in Smart Healthcare, Model for Evolving Smart Transportation Applications

References:

1. R. Buyya, S. N. Srirama, Fog and Edge Computing, (1e), Wiley, 2019.
2. Wei Chang, Jie Wu. Bos, Modern Fog/Edge Computing For Security, Privacy, and Applications, (1e), Springer, 2021.

IS4157: MULTIAGENT SYSTEMS [3 0 0 3]

Intelligent Agents: Environments, Intelligent Agents, Agents and Objects, Agents as Intentional Systems, Abstract Architectures for Intelligent Agents, Reactive Agents, Perception, Agents with State, How to Tell an Agent What to Do, Utility Functions. Practical Reasoning Agents: Practical Reasoning, MeansEnds Reasoning, The Blocks World, Implementing a Practical Reasoning Agent, Commitment to Ends and Means, The Procedural Reasoning System. Reactive and Hybrid Agents: Brooks and the Subsumption Architecture, The Limitations of Reactive Agents, Hybrid Agents. Multiagent Interactions: Utilities and Preferences, Multiagent Encounters, Dominant Strategies and Nash Equilibria, Competitive and Zero-Sum Interactions, The Prisoner's Dilemma. Reaching Agreements: Mechanism Design, Auctions, Negotiation, Task-Oriented Domains, Worth-Oriented Domains, Argumentation. Communication: Speech Acts, Agent Communication Languages, KIF, KQML, The FIPA Agent Communication Languages, Ontologies for Agent Communication. Working Together: Cooperative Distributed Problem Solving, Coherence and Coordination, Task Sharing and Result Sharing, Handling Inconsistency, Multiagent Planning and Synchronisation.

References:

1. Michael Wooldridge, *An Introduction to MultiAgent Systems*, (2e), John Wiley & Sons, 2009.
2. G. Weiss. Multiagent Systems, *A Modern Approach to Distributed Artificial Intelligence*, (2e),MIT Press, Cambridge, MA, 2013.
3. Y. Shoham and K. Leyton-Brown, Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations,(1e), Cambridge University Press,2008.
4. S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, (3e), Pearson Education, 2015.

IS4158: NATURAL LANGUAGE PROCESSING [3 0 0 3]

Introduction: Natural language processing tasks in syntax, semantics, and pragmatics, role of machine learning, probability basics, information theory, collocations, N-gram language models, estimating parameters and smoothing, evaluating language models; Part of Speech (POS) tagging: Rule-based Part of Speech tagging, Markov models, Hidden Markov Models, transformation based models, maximum entropy models; Parsing: Parsing algorithms, grammar formalisms and treebanks, parsing with context free grammars, parser comparison, constituency, parse tree construction; Semantic analysis: Wordsense disambiguation, supervised, dictionary based and unsupervised approaches, compositional semantics, semantic role labeling and semantic parsing; Machine translation: Basic issues, statistical translation, phrase-based translation, phonetics and phonology.

References:

1. D. Jurafsky, J. H. Martin, Speech and Language processing, (3e), Prentice Hall of India, 2018.
2. J. Allen, Natural Language Understanding, (2e), Pearson Education, 2002.
3. C. D. Manning, H. Schuetze, Foundations of Statistical Natural Language Processing, (1e), MIT Press, 1999.
4. S. Bird, E. Klein, E. Loper, Natural Language Processing with Python, (1e) O'Reilly Media, 2009.
5. R. Hausser, Foundations of Computational Linguistics: Human-Computer Communication in Natural Language, (2e), Springer, 2012.

IS4159: NEXT GENERATION TELECOM NETWORKS [3 0 0 3]

Introduction to 1G/2G/3G/4G/5G terminology; evolution of public mobile services; Motivation for IP based wireless networks: requirements and targets for long term evolution (LTE); Technologies for LTE- 4G advanced features and roadmap evolutions from LTE to LTEA - wireless standards; Review of cellular technologies; Wireless next generation technologies; Next generation networks; GSM technology; Introduction to next generation networks (NGN); Broadband wireline and wireless alternatives; Wireless access technologies; Overview of TCP/IP and packet core; Advanced IP networking; Overview of voice and video transport over IP; NGN requirements; Architecture and protocols; Next generation network and service management; NGN architectural components; NGN standards and protocols; NGN applications and architecture; SATCOM and broadband wireless architecture; NGN operations and management; Understand 5GPP & NGMN; 5G architecture and design objective; ITU-R IMT-2020 vision for 5G; 5G spectrum requirements; 5G RAN & dynamic CRAN; 5G NR logical architecture; 5G mobile edge computing & fog computing; millimeter wave propagation; Distributed massive MIMO principle; 5G ultra dense networks; 5G CoMP; 5G air interface; 5G protocol stack.

References:

1. N. Wilkinson, Next Generation Networks Services, Technologies and Strategies, (1e), Wiley, 2002.
2. R. Wood, Next Generation Network Services, Pearson Education, 2005.
3. S. Misra, Wireless Communication and Networks 3G and beyond, (2e), McGraw Hill, 2013.
4. K. Pahlavan, P. Krishnamurthy, Principle of wireless Networks, Pearson Education, 2002.
5. Dulaimi, X. Wang, C.Lin, 5G Networks: Fundamental Requirements, Enabling Technologies, and Operations Management, (1e), John Wiley & Sons, 2018.
6. T. V. Chien, E. Björnson, 5G Mobile Communications, Springer, 2017.

IS4160: NOSQL DATABASES [3 0 0 3]

Introduction: The Emergence of NoSQL, Aggregate Data Models; Aggregates, Example of Relations and Aggregates, Consequences of Aggregate Orientation, Key-Value and Document Data Models, Column-Family Stores, Summarizing Aggregate-Oriented Databases. Distribution Models: Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication. Consistency, The CAP Theorem, Relaxing Durability, Quorums. Version Stamps, Business and System Transactions. Map-Reduce: Partitioning and Combining, Composing Map-Reduce Calculations, A Two Stage Map-Reduce Example, Incremental Map-Reduce Key-Value Databases, Consistency, Transactions, Query Features, Storing Session Information, User Profiles, Preference.
Document Databases: Features, Consistency, Transactions, Availability, Query Features, Scaling, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, ECommerce Applications. Graph Databases: Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Connected Data, Routing, Dispatch, and Location-Based Services, Recommendation Engines

References:

1. Sadalage, P. & Fowler, *NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence*,(ie), Pearson Addision Wesley, 2012
2. Dan Sullivan, *NoSQL For Mere Mortals*, (1e), Pearson Education India, 2015.
3. Kristina Chodorow, *Mongodb: The Definitive Guide- Powerful and Scalable Data Storage*, (2e), O'Reilly Publications, 2013.

IS4161: ROBOTIC PROCESS AUTOMATION [3 0 0 3]

Introduction: Making the Case for Robotic Process Automation, Leveraging Digital Transformation to Drive Value. RPA: Concepts, Importance, and Definitions, Definition of RPA. Levels of Automation: Overview of the Basic Concepts Behind Robotic Process Automation, Discussion Prompt Debrief, Six Sigma, Concepts of Robotic Process Improvement, Application of the RPA Process. RPA Candidates, Applying Automation: Steps in Applying Automation, Data Transformation, RPA Use Case, Exercise - Identifying Data Elements. RPA Candidate Processes: Making the Case for RPA – Summary. Building an RPA Business Case: Key Steps to Build a Business Case, Assess Requirements, Identify Processes for RPA, Assess Key Risks, Gain Commitment and Support, Controls and Security, Methodology and Tool Choice, POC Does Not Achieve Desired Results, Define Alternatives, Develop a Proof of Value. Prioritization Considerations: Discussion Prompt Debrief - Prioritization Considerations, Define Success Metrics and Assess Impact, Assess Impact: Revenue, Define the Roadmap, Build a Plan, RPA Tool Decision Criteria, Document the Process, Ongoing Process Capture Process, Operating Model Approach. Discussion Prompt Debrief: Operating Model Approach, People & Key Roles, Ability to Scale Processes, Operating Model Approach – Process, Execute a POC, Test and Validate, Evaluate Results, Aim for Continuous Improvement, Strategic Road Map and Summary.

References:

1. Tom Taulli, *The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems*, (1e), Apress, 2020.
2. Richard Murdoch*: Guide to Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant*, (1e), Independently published, 2018.
3. Lim Mei Ying, *Robotic Process Automation with Blue Prism Quick Start Guide: Create software robots and automate business processes*, (9e), Packt Publishing, 2018.

IS4162: SECURITY AND TRUST MANAGEMENT IN IoT[3 0 0 3]

Introduction: Cyber Space for IoT networks, Cyber Défense Systems and Cyber Attacks in IoT networks. Definitions: Security and Trust, Attacks, Internal and External Attacks in IoT enabled networks. Evaluation: Understanding IoT-enabled technologies and devices, Issues of Authentication and Authorization in IoT systems. Designing: Intrusion Detection Systems, Cyber security based Heterogeneous Systems, Cloud, Fog and Edge based IoT Systems security needs and requirements, Security and Trust integration in IoT based Systems. Next Generation firewall for IoT Networks. Blockchain concept for IoT systems. Analysis: Cyber Attack Analysis for IoT Enabled Technologies. Issues of security of Software Defined Networks, Layers Security in IoT Networks. Trust and trust management Trust Models, and user acceptance of IoT networks, RFID Related technologies and crowed sensing and self-adaptive cyber physical systems. Vulnerabilities and Risks in IoT Networks. Mechanisms for security, privacy, trust, and authentication. Panning case study: Success indicators, performance metrics and future directions.

References:

1. Souvik Pal, Vicente García Díaz and Dac-Nhuong Le, IoT Security and Privacy Paradigm, (1e), CRC Press, 2020.
2. Mahmood, Zaigham (Ed.), "Security, Privacy and Trust in the IoT Environment, Springer International Publishing, Year: 2019
3. Avani Sharma, Pilli Emmanuel, Shubhakar, Arka Prokash Mazumdar, "Trust Management in IoT", 1st Edition, Chapman and Hall/CRC 2017.

IS4163: SOCIAL NETWORK ANALYSIS [3 0 0 3]

Introduction to Social Web: Nodes, Edges and Network measures, Describing Nodes and Edges, Describing Networks, Layouts; Visualizing Network features: The role of Tie Strength, Measuring Tie Strength, Tie Strength and Network Structure, Tie Strength and Network Propagation, Link Prediction, Entity Resolution; Link Prediction: Case Study Friend Recommendation, Introduction to Community Discovery, Communities in Context, Quality Functions; Algorithms: The Kernighan-Lin algorithm, Agglomerative Algorithms, Spectral Algorithms, Multi-level Graph Partitioning, Markov Clustering, Other Approaches; Introduction to Social Influence: Influence Related Statistics, Social Similarity and Influence, Homophile, Existential Test for Social Influence, Influence and Actions, Influence and Interaction, Influence Maximization in Viral Marketing.

References:

1. J. Goldbeck, *Analyzing the Social Web*, Morgan Kaufmann, 2013.
2. C. C. Aggarwal, *Social Network Data Analytics*, Springer, 2011.
3. J. Scott, *Social Network Analysis*, (3e), SAGE Publications, 2013.
4. Jay Goldman, *Facebook Cookbook*, O'Reilly, 2009.
5. S.Kumar, F. Morstatter, H. Liu, *Twitter Data Analytics*, Springer, 2013.

IS4164: SOFTWARE TESTING [3 0 0 3]

Basics of software testing: Introduction to software Testing, Testing and debugging, Test metrics and measurements, Verification, Validation and Testing, Types of testing, Software defect tracking; Structural testing techniques: Path testing, DD-Paths, Cyclomatic Complexity, Graph Metrics, Data Flow Testing; Functional testing techniques: Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique, Ad hoc Testing; Top down and Bottom up integration: Bi-directional integration, System integration, Scenario Testing, Defect Bash, Design/Architecture verification, Deployment testing, Beta testing, Scalability testing, Reliability testing, Stress testing; Acceptance testing; Regression testing, Test Planning; Software Test Automation: Scope of automation, Design & Architecture for automation, Generic requirements for test tool framework, Test tool selection, Testing in Object Oriented Systems, Case study on software testing; Advanced Topics on Testing: Prioritizing the Test-cases, Testing event driven applications, Testing Offthe-shelf component, Testing security, Testing Data-warehouse; Introduction to DevOps.

References:

1. R. Mall, Fundamentals of Software Engineering, (4e), Prentice Hall of India, 2014.
2. K. K. Aggarwal, Y. Singh, Software Engineering, (3e), New Age International Publication, 2008.
3. K. Perry, Effective Methods for Software Testing, (3e), Wiley, 2006.
4. B. Beizer, Software Testing Techniques, (2e), Wiley, 2008.
5. S. Desikan, G. Ramesh, Software Testing: Principles and Practices, Pearson Education, 2006.
6. P. C. Jorgenson, Software Testing: A Craftsman's Approach, (4e), CRC Press, 2014.
7. P. Mathur, Fundamentals of Software Testing, (2e), Pearson Education, 2014.

IS4165: WIRELESS COMMUNICATION [3 0 0 3]

Introduction to Wireless Communications, Types of Wireless Services, Requirements for the Wireless services, Multipath propagation, Parameters of mobile multipath channels, Spectrum Limitations, Principles of Cellular networks, Multiple Access Schemes, Path Loss models, Signal Fading. Wireless Transceivers, Structure of a wireless communication link, Modulation and demodulation Schemes, Signal Processing in Wireless Systems, Principle of Diversity, Equalizers- Linear and Decision Feedback equalizers, Review of Channel coding and Speech coding techniques. Cellular Communications: 1G, 2G, 3G / LTE, 4G / LTE-A, 5G; New air interface and radio access virtualization.

References:

1. T. S. Rappaport, Wireless Communications - Principle and Practice, (2e), Prentice Hall of India, 2012.
2. F. Molisch, Wireless Communications, (2e), Wiley, 2011.
3. D. P. Agrawal, A. Zeng, Introduction to Wireless and Mobile Systems, (3e), Thomson Press , 2012.

IS4166: WIRELESS SENSORS & ADHOC NETWORKS [3 0 0 3]

Introduction to ad-hoc networks: definition, characteristics features, applications, characteristics of wireless channel; Ad-hoc mobility models: indoor and outdoor models, MAC protocols: design issues, goals and classification; Contention based protocols: with reservation, scheduling algorithms, protocols using directional antennas; IEEE standards: 802.11a, 802.11b, 802.11g, 802.15, hiperlan; Routing protocols: design issues, goals and classification, proactive vs reactive routing, unicast routing algorithms, multicast routing algorithms, hybrid routing algorithm, energy aware routing algorithm, hierarchical Routing, QoS aware routing; Transport layer: issues in designing, transport layer classification, ad-hoc transport protocols; Security issues in ad-hoc networks: issues and challenges, network security attacks, secure routing protocols; Cross layer design: need for cross layer design, cross layer optimization, parameter optimization techniques, cross layer cautionary perspective; Integration of ad-hoc with mobile IP networks; Mesh networks; vehicular area networks; Ad-hoc networks: cellular and ad-hoc networks, routing, quality of service provisioning; Wireless sensor networks: design constraints and challenges, sensor network architecture; MAC protocols: Issues in designing MAC protocols for wireless sensor networks, MAC protocols for sensor network, S-MAC, IEEE 802.15.4; Routing protocols: table-driven, on- demand, hybrid, flooding, hierarchical, and power aware routing protocols; QoS and energy management: Issues and challenges in providing QoS, need for energy management; Sensor network platforms and tools: sensor node hardware berkeley motes, programming challenges, node-level software platforms, node-level simulators.

References:

1. F. Zhao, L. J. Guibas, Wireless Sensor Networks - An Information Processing Approach, Elsevier, 2007.
2. H. Karl, A. Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley, 2005.
3. K. Sohraby, D. Minoli, T. Znati, Wireless Sensor Networks- Technology, Protocols, and Applications, John Wiley, 2007.
4. C. K. Toh, Ad-Hoc Mobile Wireless Networks – Protocols and Systems, (1e), Prentice Hall of India, 2001.
5. S. R. Murthy, Ad-Hoc Wireless Networks - Architectures and Protocols, (1e), Pearson Education, 2006.
6. A. Hac, Wireless Sensor Network Designs, (1e), John Wiley, 2003.

Open Electives

IS2280: INTRODUCTION TO INTELLIGENT SYSTEMS [3 0 0 3]

Introduction to Artificial Intelligence: definition of AI; Turing test; brief history of AI. Problem solving and search: problem formulation; search space; states vs. nodes; tree search: breadth-first, uniform cost, depth-first, depth-limited, iterative deepening; graph search. Local search: hill-climbing; simulated annealing; genetic algorithms; local search in continuous spaces. Informed search: greedy search; A* search; heuristic function; admissibility and consistency. Planning: the STRIPS language; forward planning; backward planning; planning heuristics; partial-order planning; planning using propositional logic; planning vs. scheduling. Constraint satisfaction problems (CSPs): basic definitions; finite vs. infinite vs. continuous domains; constraint graphs. Solving CSPs: constraint satisfaction as a search problem; backtracking search; constraint propagation; dependency-directed backtracking. Playing games: game tree; utility function; optimal strategies; minimax algorithm; alpha-beta pruning; games with an element of chance. Beyond classical search: searching with nondeterministic actions; searching with partial observations; online search agents; dealing with unknown environments.

References:

1. S.J. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach* (3e), Prentice-Hall, 2010.
2. Luger, Artificial Intelligence, (6e), Addison Wesley, 2009
3. Geoff Hulten, *Building Intelligent Systems: A Guide to Machine Learning Engineering,(*1e), Apress, 2018.

IS3180: INTRODUCTION TO SMART CITIES [3 0 0 3]

Introduction: Smart Cities Concepts, Current Challenges for Smart Cities; Smart Community: Concept of Smart Community, Smart Mobility, Smart Living, Smart Health, Smart Energy and Water, Smart Environment, Smart Government, Smart Economy; Technical Aspects: ICT Fundamentals, AI for Smart Cities, IoT Devices for Smart Cities, Sensors and Protocols; Models: Business Model, Management Model for Smart Cities; Guidelines: Principles for Smart City Transformations, Urban Planning, City Models; Sustainability: Smart Eco-Cities, Environment Sensing Smart Cities; Case Study: Smart Cities in Europe.

References:

1. Oliver Gassmann Jonas Böhm Maximilian Palmié, *Smart Cities: Introducing Digital Innovation to Cities*, (1e), Emerald Publishing, 2019.
2. Katharine S. Willis, Alessandro Aurigi, *The Routledge Companion to Smart Cities*, (1e), Routledge, 2020.
3. Carlo Ratti and Matthew Claudel, *The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life (The Future Series),* Yale University Press,2016.

IS3280: INTRODUCTION TO INDUSTRY 4.0 [3 0 0 3]

Introduction to Industry 4.0, Basic principles and technologies of a Smart Factory, Cyber-Physical Systems (CPS) and Cyber-Physical Production Systems (CPPS), The smart workpiece, Digital Twins in Production, Assistance systems for production, Human-Robot Collaboration, Interoperability: Communication systems and standards for Industry 4.0 and cloud applications, Artificial Intelligence in Production, Safety and Security in networked Production Environments, Cyber-Physical Systems and new Business Models, Use-cases for Augmented Reality in Manufacturing.

References:

1. Alasdair Gilchrist, *Industry 4.0: The Industrial Internet of Things*,(1e) , APress, 2019.
2. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, *Industrial Internet of Things: Cybermanufacturing Systems*, (1e), Springer, 2017.

IS 2170: PROJECT BASED LEARNING -I, IS2270: PROJECT BASED LEARNING -II, IS3170: PROJECT BASED LEARNING -III

These courses encourage to develop Project Based Learning at the early stage of the course. A group of students (Mentees) will do a project based upon the learning of previous/current semester under the same faculty member (Mentor). This will prepare the students to take up significant problem in Minor and Major projects. The work done in PBL will be evaluated by the mentor internally and by expert panel externally.

IS3270: MINOR PROJECT [0 0 6 3]

In this course student has to select a project work based on a topic of interest. Periodically the supervisor will evaluate the implementation. This work, started in sixth semester of which, the student will be evaluated internally and externally.

IS4170: INDUSTRIAL TRAINING [0 0 2 1]

In this course the student, undergo in reputed Private / Public Sector / Government organization / companies as industrial training for minimum 45 days to be undergone by the student in the summer vacation of the VI semester.

IS4270: MAJOR PROJECT [- - - 12]

In this course student has to select a project work based on a topic of interest. Periodically the supervisor will evaluate the implementation. This work, started in eighth semester of which, the student will be evaluated internally and externally.