Integrated Postgraduate in Information Technology (B.Tech. + M.Tech.) (213 credits)

SEMESTER -1

Sl no	Course Code	Subjects	Credits	L-T-P
1	EE101	Fundamentals of Electrical and Electronics	4	3-0-2
2	ES101	Engineering Physics	4	3-0-2
	ES102	Engineering Mathematics	4	3-1-0
4	EE102	Engineering Design Principles	3	2-0-2
5	IT101	Principles of Computer Programming	4	3-0-2
6	HS101	Freshman Skills	2	2-0-0
7	HS102	Sports and Physical Education	2	0-1-2
		Total	**23 Credits**	

SEMESTER -2

Sl no	Course Code	Subjects	Credits	L-T-P
1	EE103	Digital Electronics	4	3-0-2
2	ES103	Probability and Statistics	4	3-1-0
3	IT102	Data Structures	4	3-0-2
4	EE104	Hardware Workshop	3	1-0-4
5	IT103	Object Oriented Programming	4	3-0-2
6	HS103	Ecology and Environment Sciences	2	2-0-0
7	CS104	Mobile Application Technologies	2	0-1-2
		Total	**23 credits**	
	MO101	MOOC-1 (Optional in summer)	2/3	

EXIT AFTER YEAR – 1. **Certificate in Engineering Sciences (46 credits)**

SEMESTER -3

Sl no	Course Code	Subjects	Credits	L-T-P
1	HS201	Indian Culture, Ethics and Moral Values	2	2-0-0
2	IT201	Discrete Structures	4	3-1-0
3	IT202	Computer Organization and Architecture	4	3-0-2
4	IT203	Design and Analysis of Algorithms	4	3-0-2
5	IT204	Data Communications	4	3-0-2
6	IT205	Database Systems	4	3-0-2
		Total	**22 credits**	

SEMESTER -4

Sl no	Course Code	Subjects	Credits	L-T-P
1	MS619	Entrepreneurship and Innovation	2	2-0-0
2	IT206	Theory of Computation	3	3-0-0
3	IT207	Operating Systems	4	3-0-2
4	IT208	Computer Networks	4	3-0-2
5	EE201	Signals and Systems	4	3-1-0
6	IT209	Graph Theory	4	3-0-2
		Total	21 credits	
	MO201	MOOC-2 (Optional in summer)	2/3-0-0	

EXIT AFTER YEAR - 2 → **Diploma in Information Technology (89 credits)**

SEMESTER -5

Sl no	Course Code	Subjects	Credits	L-T-P
1	MS603	Business Economics	3	3-0-0
2		Multidisciplinary/Open Elective- 1	3	3-0-0
3	EE303	Microprocessor and Interfacing	4	3-0-2
4	IT302	Compiler Design	4	3-0-2
5	IT303	Computer Graphics	4	3-0-2
6	IT304	Trustworthy Artificial Intelligence	4	3-0-2
		Total	**22 credits**	

SEMESTER -6

Sl	Course	Subjects	Credits	L-T-P
1	ENXXX	Art of Engineering Research	2	2-0-0
2		Multidisciplinary/Open Elective- 2/MOOC 1[$]	3	3-0-0
3	IT0XX	Department Elective-1	3	3-0-0
4	IT305	Optimization Techniques	4	3-1-0
5	IT306	Machine Learning	4	3-0-2
6	IT307	Wireless Communication Technologies	4	3-0-2
		Total	**20 credits**	

BTech Project allocation to be done during 6th Semester

[$] MOOC 1 can also be taken in summer after 2nd semester if the student wishes to finish it earlier.

EXIT AFTER YEAR - 3 → **B.Sc. in Information Technology (131 credits)**

SEMESTER -7

Sl no	Course Code	Subjects	Credits	L-T-P
1		Multidisciplinary/Open Elective- 3/MOOC	3	3-0-0
2	IT0XX	Department Elective -2	3	3-0-0
3	EE404	Integrated Circuit Technology	4	3-0-2
4	IT401	Cloud Computing	4	3-0-2
5	IT402	Digital Image Processing	4	3-0-2
6	IT403	Cryptography	3	3-0-0
7	IT399	BTech Summer Project	6	0-0-12
		Total	**27 credits**	

[$] MOOC 2 can also be taken in summer after 4th semester if the student wishes to finish it earlier

SEMESTER -8

Sl no	Course Code	Subjects	Credits	L-T-P
1	IT404	Software Engineering	4	3-0-2
2	IT405	Data Mining	4	3-0-2
3.	IT406	IoT and Applications	4	3-0-2
4.	IT407	Mobile Computing	3	3-0-0
5.	IT0XX	Department Elective – 3	3	3-0-0
6		Multidisciplinary/Open Elective- 4/MOOC 3	3	3-0-0
		Total	**21 credits**	

Colloquium of 3 credits in summer semester (MOOC, NPTEL etc. in place of colloquium)

EXIT AFTER YEAR - 4 **B.Tech.[$]/B.Sc. (Hons.)[#] in Information Technology (179 credits)**

SEMESTER -9

Sl no	Course Code	Course	Credits	L-T-P
1.	IT501	Natural Language Processing	4	3-0-2
3.	IT498	Colloquium	3	0-0-6
4.	IT598	MTech Thesis – Part 1	12	0-0-24
		Total	**19 credits**	

SEMESTER -10

Sl no	Course	Course	Credits	L-T-P
1.	IT0XX	Department Elective – 4/MOOC 4	3	3-0-0
2.	IT599	MTech Thesis – Part 2	12	0-0-24
		Total	**15 credits**	

FINAL EXIT AFTER YEAR – 5 **B.Tech. + M.Tech. in Information Technology (213 credits)**

NOTE-1:

[$] BTech. in Information Technology: If a candidate opts for an early exit after 4th year in the beginning of 3rd year or termed as Planned Exit. In such a case the course structure is different form the above. Please refer to the course structure of BTech. In Information Technology.

[#] BSc (Honours) in Information Technology: If a candidate opts for an abrupt exit after 4th year without exercising an option for exit in the beginning of 3rd year or termed as Abrupt Exit. In such a case the student exits with BSc. In Information Technology.

NOTE-2:

A candidate from IT can receive a Minor Degree in CSE/EEE/Mathematics & Scientific Computing if he/she earns the prescribed credits (Over and above) the credits prescribed by the respective major programme.

Minor in Information Technology (Total 23 credits required)

Sl no	Code	Courses	Credits	L-T-P
1	IT207	Operating System	4	3-0-2
2	IT208	Computer Networks	4	3-0-2
3	IT404	Software Engineering	4	3-0-2
4	IT205	Database Systems	4	3-0-2
5	IT401	Cloud Computing	4	3-0-2
6	IT0XX	IT Elective Courses	3	3-0-0
		Total	**23 Credits**	

NOTE-3: A Minor in Information Technology is open to student(s) from other discipline subject to successful completion of the above credits with a minimum of 6 CGPA. A student can opt for the courses depending on the convenience. For example: IT207 and IT208 are offered in 4th semester. A student can opt for these courses along with his regular courses in 4th semester OR he can take one of the two courses in 4th semester and the other in his 6th semester. This reduces the credit load in a particular semester. In addition, if a given course is floated in summer semester, the student can also opt for the same in summer semester.

B.Tech. in Information Technology (170 credits)

SEMESTER -1

Sl no	Course Code	Subjects	Credits	L-T-P
1	EE101	Fundamentals of Electrical and Electronics	4	3-0-2
2	ES101	Engineering Physics	4	3-0-2
	ES102	Engineering Mathematics	4	3-1-0
4	EE102	Engineering Design Principles	3	2-0-2
5	IT101	Principles of Computer Programming	4	3-0-2
6	HS101	Freshman Skills	2	2-0-0
7	HS102	Sports and Physical Education	2	0-1-2
		Total	**23 Credits**	

SEMESTER -2

Sl no	Course Code	Subjects	Credits	L-T-P
1	EE103	Digital Electronics	4	3-0-2
2	ES103	Probability and Statistics	4	3-1-0
3	IT102	Data Structures	4	3-0-2
4	EE104	Hardware Workshop	3	1-0-4
5	IT103	Object Oriented Programming	4	3-0-2
6	HS103	Ecology and Environment Sciences	2	2-0-0
7	CS104	Mobile Application Technologies	2	0-1-2
		Total	**23 credits**	
	MO101	MOOC-1 (Optional in summer)	2/3	

EXIT AFTER YEAR – 1. **Certificate in Engineering Sciences (46 credits)**

SEMESTER -3

Sl no	Course Code	Subjects	Credits	L-T-P
1	HS201	Indian Culture, Ethics and Moral Values	2	2-0-0
2	IT201	Discrete Structures	4	3-1-0
3	IT202	Computer Organization and Architecture	4	3-0-2
4	IT203	Design and Analysis of Algorithms	4	3-0-2
5	IT204	Data Communications	4	3-0-2
6	IT205	Database Systems	4	3-0-2
		Total	**22 credits**	

SEMESTER -4

Sl no	Course Code	Subjects	Credits	L-T-P
1	MS619	Entrepreneurship and Innovation	2	2-0-0
2	IT206	Theory of Computation	3	3-0-0
3	IT207	Operating Systems	4	3-0-2
4	IT208	Computer Networks	4	3-0-2
5	EE201	Signals and Systems	4	3-1-0
6	IT209	Graph Theory	4	3-0-2
		Total	**21 credits**	
	MO201	MOOC-2 (Optional in summer)	2/3-0-0	

EXIT AFTER YEAR - 2 → **Diploma in Information Technology (89 credits)**

SEMESTER -5

Sl no	Course Code	Subjects	Credits	L-T-P
1	MS603	Business Economics	3	3-0-0
2		Multidisciplinary/Open Elective- 1	3	3-0-0
3	EE303	Microprocessor and Interfacing	4	3-0-2
4	IT302	Compiler Design	4	3-0-2
5	IT303	Computer Graphics	4	3-0-2
6	IT304	Trustworthy Artificial Intelligence	4	3-0-2
		Total	**22 credits**	

SEMESTER -6

Sl no	Course Code	Subjects	Credits	L-T-P
1	ENXXX	Art of Engineering Research	2	2-0-0
2		Multidisciplinary/Open Elective- 2/MOOC 1[$]	3	3-0-0
3	IT0XX	Department Elective-1	3	3-0-0
4	IT305	Optimization Techniques	4	3-1-0
5	IT306	Machine Learning	4	3-0-2
6	IT307	Wireless Communication Technologies	4	3-0-2
		Total	**20 credits**	

BTech Project allocation to be done during 6th Semester

[$] MOOC 1 can also be taken in summer after 2nd semester if the student wishes to finish it earlier.

EXIT AFTER YEAR - 3 → **B.Sc. in Information Technology (131 credits)**

SEMESTER -7

Sl no	Course Code	Subjects	Credits	L-T-P
1		Multidisciplinary/Open Elective- 3/MOOC 2	3	3-0-0
2	IT0XX	Department Elective -2	3	3-0-0
3	EE404	Integrated Circuit Technology	4	3-0-2
4	IT401	Cloud Computing	4	3-0-2
5	IT402	Digital Image Processing	4	3-0-2
6	IT403	Cryptography	3	3-0-0
7	IT498	Colloquium (Based on industrial	3	0-0-6/
		Total	**24 credits**	

[$] MOOC 2 can also be taken in summer after 4th semester if the student wishes to finish it earlier

SEMESTER -8

Sl no	Course Code	Subjects	Credits	L-T-P
1	IT499	BTech Project/Internship	12	0-0-24
2	IT0XX	Department Elective – 3/MOOC 4	3	3-0-0
		Total	**15 credits**	

FINAL EXIT AFTER YEAR - 4 → **B.Tech. in Information Technology (170 credits)**

Electives courses

1. **Visual Information Processing**

Sl.No	Course Name	Code	L-T-P	
1	Computer Vision	IT001	3-0-0	3
2	Digital Signal Processing	IT002	3-0-0	3
3	Pattern Recognition	IT003	3-0-0	3
4	Information Retrieval and Extraction.	IT004	3-0-0	3
5	Human Computer Interaction	IT005	3-0-0	3
6	Digital Video Processing	IT006	3-0-0	3
7	Advanced Machine Learning	IT007	3-0-0	3
8	Multimedia Processing	IT008	3-0-0	3
9	Digital Watermarking	IT009	3-0-0	3
10	Applied Image Processing	IT010	3-0-0	3

2. **Communication and Networks**

Sl.No	Course Name	Code	L-T-P	Credits
1	Cognitive Radio	IT011	3-0-0	3
2	Next Generation Networks	IT012	3-0-0	3
3	Queuing Theory	IT013	3-0-0	3
4	Network design and Optimization	IT014	3-0-0	3
5	Advanced Wireless	IT015	3-0-0	3
6	Multimedia Networks	IT016	3-0-0	3
7	Industrial IoT Communication	IT017	3-0-0	3
8	Detection and Estimation Theory	IT018	3-0-0	3
9	Distributed Systems	IT019	3-0-0	3
10	Information Theory and Coding	IT020	3-0-0	3
11	Convex Optimization	IT021		3

3. **Information Security**

Sl.No	Course Name	Code	L-T-P	Credits
1	Digital Watermarking and Steganalysis	IT022	3-0-0	3
2	Cryptography and Network Security	IT023	3-0-0	3
3	Distributed System Security	IT024	3-0-0	3
4	Cyber Security and Laws	IT025	3-0-0	3
5	Advanced cryptography	IT026	3-0-0	3
6	Information Security and Secure Coding	IT027	3-0-0	3
8	Malware Analysis	IT028	3-0-0	3
9	Formal methods for Security	IT029	3-0-0	3
10	IoT and its security	IT030	3-0-0	3
11	Blockchain Technologies	IT031	3-0-0	3

4. **Computing and Data Sciences**

Sl.No	Course Name	Code	L-T-P	Credits
1	Convex Optimization	IT032	3-0-0	3
2	Parallel and Concurrent Programming	IT033	3-0-0	3
3	Scientific Computing and Numerical	IT034	3-0-0	3

CODE WITH ITxxx

1	**Code of the subject**	IT101
2	**Title of the subject**	Principles of Computer Programming
3	**Prerequisite**	No
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To understand the basic principles of programming languages. To provide design & development of C and Python programming skills. To introduce problem solving methods and program development.
6	**Brief Contents**	Basics of Computer Languages C, Compilers, Interpreter, Programming Environments and Debugging: types of errors and debugging techniques. Programming features: Data types, Expressions and Operators, Control statements, Iterations. Functions: Scope of variables, call by value, call by reference, Recursion, Pointers. Array, String, Structures and Unions. File handling, File redirection, File pointers. Applications of C programming concepts in different data structures. Python: Introduction, Program Organization, Functions, Modules and Libraries.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text/references**	1. Kernighan, B.W. and D. M. Ritchie (1998): The C programming language, 2nd ed. Prentice Hall of India. 2. Kanetkar, Y (2016): Let us C, 15thed .BPB Publications. 3. King K.N (2008): C Programming: A Modern Approach. 2nd ed. W. W. Norton & Company.

1	**Code of the subject**	IT102
2	**Title of the subject**	Data Structures
3	**Any prerequisite**	Basic Computer Programming
4	**L-T-P**	3-0-2
5	**Learning Objectives**	*To enable* students to learn how to store data while maintaining the data correctness and efficiency in a computer program.
6	**Brief Contents**	Objected oriented programming, List, Sequence, Stack Queue, Program correctness and analysis, Dictionaries, Searching, Trees, traversals, binary search trees, optimal and average BSTs. Balanced BST: AVL Trees, 2-4 trees, red-black trees, B-trees. Sorting, Graphs and Traversal, Graphs algorithms, Geometric data structures, etc.
7	**Contents for lab**	Experiments will be conducted based on the topics covered.
8	**List of text books/references**	1. Data Structures and Algorithm Analysis in C++, by Mark Allen Weiss (Pearson 2007).

		2. Goodrich, M. and Tamassia, R. *Data Structures and Algorithms in Java* , John Wiley and Sons, Inc. 3. Fundamentals of Data Structures in C -- by Horowitz, Sahni and Anderson-Freed (Silicon Press 2007). 4. Data Structure Using C and C++ -- by Y. Langsam, M. J. Augenstein and A. N. Tanenbaum (Pearson Education, 2nd Edition, 2015).

1	**Code of the subject**	IT103
2	**Title of the subject**	Object Oriented Programming
3	**Prerequisite**	Programming concepts
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To develop programming skill and to solve engineering related problems using Object Oriented Programming Concepts.
6	**Brief Contents**	Object oriented thinking: Need for OOP Paradigm, Procedural programming vs object oriented programming, object oriented concepts. Class and object concepts: Difference between C structure and class, specifying a class, Defining members inside and outside class, etc. Constructor and destructor concepts, Operator overloading and Type Conversion, Inheritance and polymorphism concepts Working with files: Classes for file stream operations, opening and closing files, File opening modes, file Pointers, Error handling during file operations, command line arguments. Templates: Class template, class template with parameter, function template, function template with parameter and Exception handling
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**List of text books/references**	1. HM Deitel and PJ Deitel ―C++ How to Program, Seventh Edition, 2010, Prentice Hall. 2. Brian W. Kernighan and Dennis M. Ritchie, ―The C programming Language, 2006, Prentice-Hall. 3. E Balagurusamy, ―Object oriented Programming with C++, Third edition, 2006, Tata McGraw Hill. 4. Bjarne Stroustrup, ―The C++ Programming language, Third edition, Pearson Education. 5. Horstmann ―Computing Concepts with C++ Essentials,Third Edition,2003, John Wiley. 6. Robert Lafore, ―Object Oriented Programming in C++, 2002, Pearson education.

1	**Code of the subject**	IT201
2	**Title of the subject**	Discrete Structures
3	**Prerequisite**	Engineering Mathematics
4	**L-T-P**	3-1-0

5	**Learning Objectives**	To prepare for a background in abstraction, notation, and critical thinking for the mathematics most directly related to computer science. To foster rigorous thinking skills that can enhance the quality of work of computing professionals. To relate and apply these concepts to practical applications of computer science.
6	**Brief Contents**	Fundamentals of Logicand their use in program proving, resolution principle. Set Theory and Functions, Graph Theory, Group Theory, Elementary Combinatorics etc.
7	**Text/references**	1.Bernanrd Kolman, Robert C Busby, S.Ross, Discrete Mathematical Structures, PHI Learning 2. Kenneth H. Rosen, Discrete Mathematics and Its Appications, Tata McGraw-Hill Edition 3. I.N. Herstein, Topics in Algebra, John Wiley Publications 4. Ralph P. Grimaldi, B.V. Ramana, Discrete and Combinatorial Mathematics, Pearson Education

1	**Code of the subject**	IT202
2	**Title of the subject**	Computer Organisation and Architecture
3	**Any prerequisite**	Digital Electronics, Principles of computer programming
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To understand the Organization and architecture aspects of computer followed by the Application Binary Interfaces.
6	**Brief Contents**	Basic functional blocks of a computer, introduction to Instruction set architecture of a CPU and instruction sets of some common CPUs. Data representation, Computer arithmetic, Control unit design, Memory system, Peripheral devices and their characteristics, Performance enhancement techniques Pipelining, Memory organization.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text/references**	1. Computer Organization and Design: The Hardware/Software Interface, David A Patterson, John L. Hennessy, 4th Edition, Morgan Kaufmann. 2. Computer Architecture and Organization by William Stallings, PHI Pvt. Ltd., Eastern Economy Edition.

1	**Code of the subject**	IT203
2	**Title of the subject**	Design and Analysis of Algorithms
3	**Prerequisite**	Data Structures, Principles of Computer Programming, Engineering Mathematics
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To understand the performance aspects of algorithms in programming the computing systems

6	**Brief Contents**	Introduction, Asymptotic complexity, Searching in list, Concepts of graphs and shortest path estimation algorithms, Divide and conquer approaches, Search Trees, Greedy : Interval scheduling, Greedy :Proof strategies,Greedy : Human coding, Dynamic Programming: weighted interval scheduling Dynamic Programming, Intractability: NP completeness, Intractability :reductions and examples
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text/references**	1. Introduction to Algorithms (Eastern Economy Edition) by Thomas H Cormen and Charles E Leiserson. 2. Design and Analysis of Algorithms by S Sridhar. 3. Design and Analysis of Computer Algorithms by AHO.

1	**Code of the subject**	IT205
2	**Title of the subject**	Database Systems
3	**Prerequisite**	No
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To understand a Database application, the design and performance aspects from the perspective of Database systems of the past, present and future.
6	**Brief Contents**	Introduction to Databases, Relational Data Model, Relational Algebra, SQL and NoSQL concepts, Database Normalization, Indexing, Database Transactions, Recovery Systems, Transaction Schedules, Concurrency Control, Query Processing and Query Optimization.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text /references**	1. Abraham Silberschatz, Henry Korth, and S. Sudarshan. Database Systems Concepts (5ed.). McGraw-Hill, New York, USA. 2. Ramez A. Elmasri, Shankrant B. Navathe. Fundamentals of Database Systems Addison-Wesley Longman Publishing Co. 3. Paul DuBois. Mysql. New Riders Publishing 4. C. J. Date. Database in Depth: Relational Theory for Practitioners. O'Reilly Media, Inc. 5. Bipin C. Desai. An Introduction to Database Systems. West Publishing Co.

1	**Code of the subject**	IT206
2	**Title of the subject**	Theory of Computation
3	**Prerequisite**	No
4	**L-T-P**	3-0-0
5	**Learning Objectives**	To introduce the mathematical foundations of computation, develop the ability to understand and conduct mathematical proofs for computation and algorithms.

6	**Brief Contents**	Finite Automata, Finite State system concepts, Regular Languages, Equivalence of NFA and DFA, Minimization of DFA- – Pumping Lemma for Regular. Grammars, Pushdown Automata, Turing Machines, Unsolvable Problems and Computable functions, Measuring and classifying complexity: Tractable and Intractable problems- Tractable and possibly intractable problems – P and NP completeness – Polynomial time reductions.
7	**Text /references**	1. Hopcroft J.E., Motwani R. and Ullman J.D, Introduction to Automata Theory, Languages and Computations, Pearson Education. 2. John C Martin, Introduction to Languages and the Theory of Computation, TMH, New Delhi.

1	**Code of the subject**	IT207
2	**Title of the subject**	Operating Systems
3	**Prerequisite**	Computer Organization; Data Structures and Computer Programming
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To study the importance of the operating system and its function, techniques of the operating system to achieve its goals as resource manager. Application interaction with the operating system and the operating systems interaction with the machine.
6	**Brief Contents**	Introduction and history of Operating systems, Process concepts and scheduling, Storage management, Processor management, Interprocess communication, CPU scheduling, Process Synchronization, Memory Management, Virtual memory concepts, Deadlocks, Device management, File management, File Systems, Free space Management: Bit vector, Linked list. Some case Studies of traditinal and modern operating systems.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text /references**	1. A. Silberschatz & P.B. Galvin, Operating System concepts and principles, Wiley India. 2. A. Tanenbaum, Modern Operating Systems‘, Prentice Hall India 3. W. Stallings, _Operating Systems: Internals and design Principles, Pearson Ed. 4. M.J. Bach, Design of Unix Operating system‘, Prentice Hall. Additional Reading: 1. D.M. Dhamdere, Operating Systems: a concept based approach‘, Tata McGraw-Hill Pubs. 2. G. Glass, Unix for programmers and users-a complete guide, Pearson Ed.

1	**Code of the subject**	IT208
2	**Title of the subject**	Computer Networks
3	**Prerequisite**	User applications and some aspects of process and their interaction

4	**L-T-P**	3-0-2
5	**Learning Objectives**	The understand the purpose and overview of the Internetworking technology, issues, and approaches using top-down philosophy.
6	**Brief Contents**	Computer Networks and the Internet, Network Application Architectures, Processes Communication, Transport Services, Application-Layer Protocols, The Web and HTTP, Case Study: P2P Internet Telephony with Skype, Socket Programming with TCP and UDP; Transport Layer: Relationship Between Transport and Network Layers, Overview of the Transport Layer in the Internet, Principles of Reliable Data Transfer Services, Multiple Access protocols, Link-Layer concepts; Wireless and Mobile Networks, Cellular Internet Access, Mobile IP.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text /references**	Computer Networking: A top-down approach featuring the Internet / James F. Kurose , Keith W. Ross., 7th edition, Pearson.

1	**Code of the subject**	IT209
2	**Title of the subject**	Graph Theory
3	**Any prerequisite**	N/A
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To develop ability to solve real life problems, translating them one form to another, using appropriate mathematical and computational techniques. To prepare abstract and critical mathematical thinking, most directly related to computer science
6	**Brief Contents**	Introduction to graphs, connected graphs and shortest paths, trees, independent set coverings and matchings, vertex colorings, planar graphs, directed graphs, tournaments, spanning tree, cut-set, vector space of a graph, Applications of graph theory.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. J.A. Bondy and U.S.R. Murty: Graph Theory and Applications. 2. West, Douglas B., Introduction to Graph Theory, Pearson Education, 2002. 3. Mott J.L., Kandel, A. and Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 2001. 4. Reinhard Diestel, Graph Theory, Springer International Edition, 2004. 5. D.B. West: Introduction to Graph Theory, Prentice-Hall of India/Pearson, 2009 6. Deo Narsingh, Graph Theory With Applications To Engineering And Computer Science, PHI, 1992.

1	**Code of the subject**	IT302
2	**Title of the subject**	Compiler Design
3	**Prerequisite**	Theory of Computation
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To design the front end of the compiler, scanner, parser, intermediate code generator, objectcode generator, and the parallel compilation strategies. To gain the ability to implement a parser etc.
6	**Brief Contents**	The structure of Compiler – Lexical analysis, Syntax analysis, LR parsers; Intermediate code generation concepts, Object code generation, Code optimization, Parallelizing compiler etc.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text /references**	1. Alfred V. Aho, Monica S.Lam, Ravi Sethi, Jeffrey D.Ullman, Compilers : Principles, Techniques and Tools, Second Edition, Pearson Education. 2. Randy Allen, Ken Kennedy, Optimizing Compilers for Modern Architectures: A Dependence-based Approach, Morgan Kaufmann Publishers. 3. Steven S. Muchnick, Advanced Compiler Design and Implementation‖, Morgan Kaufmann Publishers - Elsevier Science, India, Indian Reprint.

1	**Code of the subject**	IT303
2	**Title of the subject**	Computer Graphics
3	**Prerequisite**	
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To expose onto the primary tools by which the flood of information from Computational Science is analyzed.
6	**Brief Contents**	Introduction of computer graphics, Graphic Displays and the algorithms; Three Dimensional aspects of graphics; Transformations; Windowing and Clipping concepts; Hidden Lines and Surfaces etc.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**List of text books/references**	1.Computer Graphics, C Version Donald D Hearn, M. Pauline Baker 2. Computer Graphics: Principles and Practiceby James D. Foley, Andries van Dam , Steven K. Feiner

1	**Code of the subject**	IT304
2	**Title of the subject**	Trustworthy Artificial Intelligence
3	**Prerequisite**	Algorithms and Data Structures
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To understand the techniques and concepts related to machine based reasoning systems through various applications of AI

6	**Brief Contents**	Introduction to AI and intelligent agents. Problem solving methods in AI, Informed and uninformed search strategies, knowledge representation, Uncertain Knowledge and Reasoning, Probabilities, Bayesian Networks. Overview of different forms of learning, Learning Decision Trees, Artificial Neural Networks and Fuzzy Approaches; Logic in AI, Prolog, Modern AI language and tools etc.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text /references**	1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 2nd Ed, Prentice Hall, 2003 2. Elaine Rich and Kevin Knight. Artificial Intelligence, Tata McGraw Hill Reference Books: 1. Patrick Henary Winston, Artificial Intelligence, Pearson publication 2. Deepak Khemani. A First Course in Artificial Intelligence, McGraw Hill Education (India) 3. Eugene Charnaik and Drew McDermott, Introduction to Artificial Intelligence, Pearson publication 4. Nils John Nilsson, The Quest for Artificial Intelligence: A History of Ideas and Achievements, Morgan Kaufman 5. Dennis Rothman, Artificial Intelligence by Example

1	**Code of the subject**	IT305
2	**Title of the subject**	Optimization Techniques
3	**Any prerequisite**	Exposure to relevant concepts at the undergraduate level and instructor consent
4	**L-T-P**	3-1-0
5	**Learning Objectives**	The aim of this course is to have some basic understanding of provably convergent computational schemes for constrained optimization problems.
6	**Brief Contents**	Solving Linear constraint optimization problem, Non-linear programming: First and second order conditions. Iterative methods and associated issues. Line search methods: Stationarity of limit points of steepest decent, successive step-size reduction algorithms, etc. Hessian-based algorithms: Newton, Conjugate directions and Quasi-Newton methods. Constrained optimization problems: Lagrange variables, Karush-Kuhn-Tucker conditions, Regular points, Sensitivity analysis. Quadratic programming, Convex problems. Mixed integer models; Interior point methods; Iterative schemes for constrained problems; Sequential quadratic programming methods; Barrier methods; Trust-region methods, etc.
7	**Contents for lab**	Experiments will be based on the theory covered as above.

8	**List of textbooks/references**	1. Boyd, Stephen, Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004. 2. D. Bertsekas Nonlinear programming, 2nd Edition, Athena Scientific, 1999, Nashua. 3. V. Chvatal Linear programming, W. H. Freeman, 1983, New York. 4. E. K. P. Chong and S. Zak, An introduction to optimization, 2nd Edition, 2004, John Wiley and Sons (Asia) Pvt. Ltd., Singapore 5. R. Fletcher, Practical methods of optimization, 2nd Edition, Wiley, 2000, New York 6. D. Luenberger, Linear and nonlinear programming, 2nd Edition, 1984, Kluwer Academic Publisher, New York 7. O. L. Mangasarian, Nonlinear programming, SIAM, 1987, Philadelphia

1	**Code of the subject**	IT306
2	**Title of the subject**	Machine Learning
3	**Any prerequisite**	Introductory courses on probability theory and linear algebra. Knowledge of basic programming languages such as Python and MATLAB.
4	**L-T-P**	3-0-2
5	**Learning Objectives**	After successful completion of this course, students will able to relate/understand/solve several day-to-day real-time with machine learning algorithms. The objective of this course is to familiarize the students with different machine learning algorithms ranging basic linear classifier/regression modeling problems to non-linear classification problems using deep neural network.
6	**Brief Contents**	Introduction to the course of machine learning (ML), Classification, regression, sequence modeling. Linear classifier and classification problem, Gradient descent algorithm, Underfitting vs Over-fitting problem, Training, Testing, and Validation Process, Supervised vs unsupervised classification, Bayesian classifier: decision boundaries; nearest neighbour methods, and support vector machine (SVM); Unsupervised learning: k-means and hierarchical clustering, Feature extraction and feature selection; dimensionality reduction techniques: PCA, LDA and ICA, Introduction to Neural Networks: Modelling and applications to logic gates. Backpropagation learning algorithm: training and testing. Introduction to Convolution neural network (CNN): AlexNet, VGG architectures. Introduction to auto-encoder and generative adversarial networks (GAN).
7	**Contents for lab**	Experiments will be based on the theory covered as above.

8	**List of textbooks/references**	1. Christopher Bishop. Pattern Recognition and Machine Learning, 2nd Edition 2. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition. 3. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2nd Edition, 2008.

1	**Code of the subject**	IT307
2	**Title of the subject**	Wireless Communication Technologies
3	**Any prerequisite**	Student should have basic knowledge of communication/data communication.
4	**L-T-P**	3-0-2
5	**Learning Objectives**	This course introduces the concepts of wireless/mobile communication using cellular technologies. It helps students to know about the various modulation techniques, propagation methods, and multi-access techniques used in mobile communication. It provides detailed ideas about path loss and shadow fading and how to solve such problems as also various types of diversity and their outage probability.
6	**Brief Contents**	Fundamentals of Communication: Fundamentals of Wireless Communication, Advantages, Limitations, and Applications, Multiple access technique: TDMA, CDMA, FDMA, CSMA, OFDMA, Frequency spectrum. Wireless Technology: The cellular concepts: Frequency Reuse, Channel assignment strategies, Handoff strategies Interference and System Capacity, Evolution of cellular networks, Path Loss and Shadowing Concepts, Diversity Techniques, Wireless local area networks, etc.
7	**Contents for lab**	Experiments will be based on the theory covered as above.
8	**List of textbooks/references**	1. Andrea Goldsmith, Wireless communication, Cambridge University Press, 2005. 2. Roy Blake, Wireless communication technologies, Leo Chartland, Delmar Cengage Learning, 1st edition, 2000. 3. Modern Wireless Communications by Simon O. Haykin and Michael Moher, Pearson, 1st edition (March 4, 2004) 4. Rappaport, Theodore S. Wireless communications: Principles and practice, 2nd Edition. Pearson Education India, 2010.

1	**Code of the subject**	IT401
2	**Title of the subject**	Cloud Computing
3	**Any prerequisite**	Computer Networks, OS, Software engineering, Distributed Computing
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To equip with the enabling technology for an on-demand access to a shared pool of configurable computing resources. To introduce various aspects of cloud computing paradigm and future research trends.
6	**Brief Contents**	Introduction to Cloud Computing, Introduction to Parallel and Distributed Computing, Cloud Computing Architecture, Service Management, Data Management in Cloud Computing, Virtualization & Resource Management, Cloud Security, Open Source and Commercial Clouds, Cloud Simulator, Research trend in Cloud Computing, Fog Computing.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text /references**	1. Cloud Computing: Principles and Paradigms, Editors: RajkumarBuyya, James Broberg, Andrzej M. Goscinski, Wiley 2. Enterprise Cloud Computing - Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press 3. Cloud Computing Bible, Barrie Sosinsky, Wiley-India 4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley

1	**Code of the subject**	IT402
2	**Title of the subject**	Digital Image Processing
3	**Prerequisite**	Mathematics
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To introduce the basic concepts of Digital image processing with emphasis on applications in various field of recent research.
6	**Brief Contents**	Introduction and Fundamentals, Image Enhancement in Spatial Domain, Image Enhancement in Frequency Domain, Image Restoration, Segmentation, Representation and Description.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text /references**	1.Digital Image Processing 2nd Edition, Rafael C. Gonzalvez and Richard E. Woods. Published by: Pearson Education. 2.R.J. Schalkoff ,Digital Image Processing and Computer Vision John Wiley and Sons, NY. 3. William K. Prat, Digital Image Processing, John Wiley and Sons, NY

1	**Code of the subject**	IT403
2	**Title of the subject**	Cryptography
3	**Any prerequisite**	Linear Algebra, Number Theory, and Combinatorics.

4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject (in about 50 words)**	This course is largely about proving methods in the field of cryptography. This course is expected to build fundamental and deeper theoretical knowledge related to cryptography.
6	**Brief Contents**	Basics of Symmetric Key Cryptography, Asymmetric Key Cryptography, Hardness of Functions, Goldwasser-Micali Encryption, Goldreich-Levin Theorem, Attacks under Message Indistinguishability: Chosen Plaintext Attack (IND-CPA), Chosen Ciphertext Attacks (IND-CCA1 and IND-CCA2), Message Non-malleability Attacks like NMCPA and NM-CCA2, Inter-relations among the attack model, Pseudo-random Generators (PRG), Relation between One-way functions and PRG, Pseudo-random Functions (PRF), Left or Right Security (LOR), Formal Definition of Weak and Strong MACs, Using a PRF as a MAC, Variable length MAC, Public Key Signature Schemes, Assumptions for Public Key Signature Schemes, Shamir's Secret Sharing Scheme, Formally Analyzing Cryptographic Protocols, Zero Knowledge Proofs and Protocols.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, 2. Hans Delfs, Helmut Knebl, CRC Press, "Introduction to Cryptography, Principles and Applications", 3. Wenbo Mao, Springer Verlag., "Modern Cryptography, Theory and Practice", 4. Shaffi Goldwasser and Mihir Bellare, Pearson Education (Low Priced Edition), Lecture Notes on Cryptography

1	**Code of the subject**	IT399
2	**Title of the subject**	BTech Project/ Internship
3	**Any prerequisite**	No
4	**L-T-P**	0-0-12
5	**Learning Objectives**	To develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study.
6	**Brief Contents**	The purpose of this course is to enable the student to develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study. The student is expected to demonstrate the abilities of the major subject/field of study, including deeper insight into hardware/software application development work. Develop the capability to create, analyse and critically evaluate different technical/architectural solutions.

		Equip with the needed skills to clearly present and discuss theconclusions as well as the knowledge and arguments that form the basis for the learning outcome in written and spoken English. Importantly it is necessary to march on the ethical aspects of research and development work.
7	**Contents for lab**	There are no specific laboratory sessions for this. However, this being a completely practical oriented course, the student has to devote significant time to achieve the objectives.
8	**List of text books/references**	https://grad.wisc.edu/wp-content/uploads/sites/329/2018/02/2018-Project-Management-for-Graduate-Students-Course-Workbook.pdf

1	**Code of the subject**	IT404
2	**Title of the subject**	Software Engineering
3	**Any prerequisite**	N/A
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To help students to develop skills that will enable them to construct software of high quality – software that is reliable, and that is reasonably easy to understand, modify and maintain
6	**Brief Contents**	Introduction, software life-cycle models, software requirements specification, formal requirements specification and verification - axiomatic and algebraic specifications, function-oriented software design, object-oriented design, UML, design patterns, user interface design, coding and unit testing, integration and systems testing, debugging techniques, software quality - SEI CMM and ISO-9001. Software reliability and fault-tolerance, software project planning, monitoring, and control, software maintenance, computer-aided software engineering (CASE), software reuse, component-based software development, extreme programming.
7	**Contents for lab**	Experiments will be based on the theory covered as above.
8	**List of text books/references**	1. Ian Sommerville, Software Engineering, Addison-Wesley 2. Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India. 3. Pankaj Jalote, An integrated approach to Software Engineering, Springer/Narosa. 4. Roger S. Pressman, Software Engineering: A practitioner's approach, McGraw Hill.

1	**Code of the subject**	IT405
2	**Title of the subject**	Data Mining
3	**Any prerequisite**	N/A
4	**L-T-P**	3-0-2
5	**Learning Objectives**	Extract knowledge using data mining techniques. Explore recent trends in data mining such as web mining, spatial-temporal mining. Be acquainted with the tools and techniques used for Knowledge Discovery in Databases.
6	**Brief Contents**	Data Mining Concepts, Input, Instances, Types of Data, Data Mining Functionalities, Interestingness of Patterns, Classification of Data Mining Systems, Data Mining Task Primitive, Data Cleaning, Data Integration & Transformation, Data Reduction , Mining Frequent Patterns, Associations and Correlations, Mining Methods, Mining various Kinds of Association Rules, Decision Tree Induction, Bayesian Classification, Rule Based Classification, Classification by Back propagation, Support Vector Machines, Associative Classification, Lazy Learners, K-means Partitioning Methods, Multidimensional analysis & Descriptive mining of Complex data objects, Mining Spatial Databases, Mining Multimedia Databases, Mining Timeseries & Sequence data, Mining Text databases, Mining World -Wide Web Data Mining Applications and Trends in Data Mining, Massive Datasets/Text mining, Agent-Based Mining
7	**Contents for lab**	Experiments will be based on the theory covered as above.
8	**List of text books/references**	1. Jiawei Han and Micheline Kamber, ―Data Mining: Concepts and Techniques‖, Morgan Kaufmann Publishers, 2000 . 2. Ian H. Witten and Eibe Frank, ―Data Mining: Practical Machine Learning Tools and Techniques with Java implementations‖, Morgan Kaufmann Publishers, San Fransisco, CA (2000). 3. Dorian Pyle, ―Data Preparation for Data Mining‖, Morgan Kaufmann, (1999) 4. Korth, Silbertz, Sudarshan, ―Database Concepts‖, McGraw Hill 5. Elmasri, Navathe, ―Fundamentals of Database Systems‖, Addision Wesley

1	**Code of the subject**	IT406
2	**Title of the subject**	IoT and Applications
3	**Any prerequisite**	Basic programming knowledge
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To expose the learner about the IoT and Cyber physical system paradigm, applications, underlying protocols.
6	**Brief Contents**	Sensing, Actuation, communication Protocols, Interoperability in IoT, IoT Middleware, IoT Software Platforms, Prototyping IoT Applications, IoT in the Cloud, Edge Analytics, Cyber Security and Privacy in Internet of Things, IoT Use Cases.
7	**Contents for lab**	Experiments will be based on the theory covered as above.

8	**List of text books/references**	1. Pethuru Raj, Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press. 2. Arshdeep Bahga, Vijay Madisetti, Internet of Things: A Hands-on Approach", Universities Press.

1	**Code of the subject**	IT407
2	**Title of the subject**	Mobile Computing
3	**Any prerequisite**	Computer Networks
4	**L-T-P**	3-0-0
7	**Learning Objectives**	Understand the basic concepts of mobile computing and different mobile platforms and applications.
8	**Brief Contents**	Introduction, Mobility Management, Data Management, Software Models, Context Sensing, Overview of Mobility models, Cloud-based services, Peer-to-peer applications, Delay-tolerance, Distributed transactions in mobile environments.
9	**Contents for lab**	N/A
10	**List of text books/references**	1. Pitoura, Evaggelia, and George Samaras. Data management for mobile computing. Vol. 10. Springer Science & Business Media, 2012. 2. Hansmann, LotharMerk, Martin Niclous, Stober, Principles of Mobile Computing 3. Tomasz Imielinski, Mobile Computing, Springer.

1	**Code of the subject**	IT498
2	**Title of the subject**	Colloquium (Based on industrial training)/ MOOC
3	**Prerequisite**	
4	**L-T-P**	0-0-6
5	**Learning Objectives**	To instill the ability to identify skills and gain practical work experience To provide an opportunity to observe and contribute in the workplace To take ownership and responsibility of a project assignment, given by a designated manager/supervisor To provide networking opportunities with other members of the organization To offer performance feedback and mentorship throughout the internship
6	**Brief Contents**	An internship helps you train under experienced professionals and explore what your chosen career path would be like, and an internship with a company in your field can help you to develop the skills you require to thrive within a professional setting. At the end of the training period, the company may ask you to review your time with them and write a report based on your experience. In addition, hone the skills needed to develop internship report.

7	**Contents for lab**	There are no specific laboratory sessions for this. However, this being a completely practical oriented course, the student has to devote significant time to achieve the objectives.
8	**Text /references**	1. https://www.careereducation.columbia.edu/resources/10-tips-make-most-internship 2. https://in.indeed.com/career-advice/career-development/internship-report

1	**Code of the subject**	IT501
2	**Title of the subject**	Natural Language Processing
3	**Any prerequisite**	Linear algebra, Probability and Statistics, Python
4	**L-T-P**	3-0-2
7	**Learning Objectives**	To enable understand about the innovative real time applications using NLP components and implement rule-based systems.
8	**Brief Contents**	Human languages, models, ambiguity, processing paradigms; Phases in natural language processing, applications. Text representation in computers, encoding schemes. Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc. Morphology, acquisition models, Finite State Transducer. Ngrams, smoothing, entropy, HMM, ME, SVM, CRF. Part of Speech tagging, Context Free Grammar, spoken language syntax. Parsing- Unification, probabilistic parsing, TreeBank. Semantics, lexical semantics, WordNet Word Sense Disambiguation- Selectional restriction, machine learning approaches, and dictionary-based approaches. Discourse- Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure. Applications of NLP.
9	**Contents for lab**	Experiments will be based on the theory covered as above.
10	**List of text books/references**	1. Daniel Jurafsky and James H Martin, Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition‖, Prentice Hall, 2nd Edition, 2008. 2. Bird, Steven, Ewan Klein, and Edward Loper, Natural language processing with Python: analyzing text with the natural language toolkit. ", O'Reilly Media, Inc.", 2009. 3. Manning, Christopher, and Hinrich Schutze. Foundations of statistical natural language processing. MIT press, 1999.

1	**Code of the subject**	IT598
2	**Title of the subject**	M.Tech. Thesis Part-1
3	**Any prerequisite**	Art of Engineering Research and concerned research domain knowledge
4	**L-T-P**	0-0-24

5	**Learning Objectives**	To develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study.
6	**Brief Contents**	The purpose of this course is to enable the student to develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study. The student is expected to demonstrate the abilities of the major subject/field of study, including deeper insight into hardware/software application development work. Develop the capability to create, analyse and critically evaluate different technical/architectural solutions. Equip with the needed skills to clearly present and discuss theconclusions as well as the knowledge and arguments that form the basis for the learning outcome in written and spoken English. Importantly it is necessary to march on the ethical aspects of research and development work.
7	**Contents for lab**	There are no specific laboratory sessions for this. However, this being a completely practical oriented course, the student has to devote significant time to achieve the objectives.
8	**List of text books/references**	https://grad.wisc.edu/wp-content/uploads/sites/329/2018/02/2018-Project-Management-for-Graduate-Students-Course-Workbook.pdf

1	**Code of the subject**	IT599
2	**Title of the subject**	M.Tech. Thesis Part-2
3	**Any prerequisite**	Art of Engineering Research, concerned research domain knowledge and M.Tech. Thesis Part-1
4	**L-T-P**	0-0-24
5	**Learning Objectives**	To continue research from M.Tech. Theis Part-1, develop further deeper knowledge, understanding, capabilities and attitudes in the context of the thesis.
6	**Brief Contents**	The purpose of this course is to enable the student to develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study. The student is expected to demonstrate the abilities of the major subject/field of study, including deeper insight into hardware/software application development work. Develop the capability to create, analyse and critically evaluate different technical/architectural solutions. Equip with the needed skills to clearly present and discuss theconclusions as well as the knowledge and arguments that form the basis for the learning outcome in written and spoken English. Importantly it is necessary to march on the ethical aspects of research and development work.
7	**Contents for lab**	There are no specific laboratory sessions for this. However, this being a completely practical oriented course, the student has to devote significant time to achieve the objectives.

8	**List of text books/references**	https://grad.wisc.edu/wp-content/uploads/sites/329/2018/02/2018-Project-Management-for-Graduate-Students-Course-Workbook.pdf

1	**Code of the subject**	IT001
2	**Title of the subject**	Computer Vision
3	**Any prerequisite**	Machine learning
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	In this course, students will gain a broad understanding of the algorithms used for image segmentation, feature extraction and object detection. They will also understand the challenges involved in end-to-end machine vision system along with image acquisition, model deployment and actuation.
6	**Brief Contents**	Introduction to Image Processing system- Thresholding, Image Enhancement, Contrast Stretching, Image Histograms, Filters, Image Sharpening, Gradient based Edge Detection, finding corners, Using Scale and Orientation to Build neighborhood, SIFT, SURF, HOG feature detection, Computing local features, and Segmentation, Convolutional Neural Networks, Padding, Strided Convolution, Convolution over Volume, One layer Convolution, Pooling, object localization, object detection, Classic Networks, Transfer Learning, ImageNet Challenge, Feature extraction from videos and parallelization, Image Acquisition.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Forsyth and Ponce, Computer vision: A modern approach, Pearson, 2002. 2. Simon J.D. Prince, Computer vision: models, learning and inference, Cambridge University, 2012. 3. E. R. Davies, Computer Vision: Principles, Algorithms, Applications, Learning, Academic Press; 5th edition, 2017

1	**Code of the subject**	IT002
2	**Title of the subject**	Digital Signal Processing
3	**Any prerequisite**	N/A
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The objective of this course to familiarize students with types of filters. Also, they will be able to design task-specific filters at the end of this course.
6	**Brief Contents**	Review of Signals and Systems: Discrete time complex exponentials and other basic signals-scaling of the independent axis and differences from its continuous-time counterpart-system properties (linearity, time-invariance, memory, causality, BIBO stability)-LTI systems, convolution, correlation, continuous-time Fourier series and Fourier transform. Sampling, Frequency Domain Analysis of LTI Systems, Discrete Fourier Transform (DFT), FIR and IIR Filter design.
7	**Contents for lab**	N/A

8	**List of text books/references**	1. Alan V. Oppenheim and Ronald W. Schafer, Discrete-Time Signal Processing by, 3rd edition, 2010, Prentice Hall, Upper Saddle River, NJ. 2. Sanjit Mitra, Digital Signal Processing, 4th edition, 2011, McGrawHill, New York, NY 3. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications, Third Edition.

1	**Code of the subject**	IT003
2	**Title of the subject**	Pattern Recognition
3	**Any prerequisite**	Introductory courses on probability and linear algebra. Knowledge of basic programming languages.
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	After successful completion of this course, students should have a clear understanding of the basic steps of pattern recognition system, need of feature extraction and feature selection, and dimensionality reduction. Finally, students should have practical hands-on experience of implementing several pattern recognition techniques on real-time data.
6	**Brief Contents**	Introduction to pattern recognition (PR), data-sets, paradigms of PR. Representations of Patterns and Classes, Decision boundaries for binary-class/multiclass classification. problems. Supervised vs Unsupervised classification; Feature extraction and feature selection (dimensionality reduction). Bayesian Decision Theory, Linear Discriminant Function, Maximum Likelihood Estimation, and Bayesian Parameter Estimation and Support Vector Machines. Non-Parametric Techniques: Nearest Neighbor Methods and Parzen Window Method; Unsupervised Methods: PCA, LDA, LPP, K-means, and Mean-shift algorithm. State-space analysis: First-order Hidden Markov Models.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Christopher Bishop. Pattern Recognition and Machine Learning, Second Edition 2. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, Wiley, 2000. 3. Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad. 4. Lawrence R. Rabiner, Ronald W. Schafer, Digital Processing of Speech Signals

1	**Code of the subject**	IT004
2	**Title of the subject**	Information Retrieval and Extraction
3	**Any prerequisite**	N/A
4	**L-T-P**	3-0-0

5	**Learning Objectives of the subject**	To understand the theoretical basis behind the standard models of information retrieval, challenges. To understand the difficulty of representing and to be familiar with various IR algorithms and IR systems.
6	**Brief Contents**	Vector Space Model, Probabilistic Retrieval Strategies Language Models, Inference Networks, Extended Boolean Retrieval, Latent Semantic Indexing, Neural Networks Genetic Algorithms, Fuzzy Set retrieval, Fuzzy Information Retrieval System, Relevance feedback Clustering, Fuzzy Clustering, Passage based Retrieval N-grams, Cross-Language Information Retrieval Efficiency.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. David A. Grossman and Ophir Frieder, Information Retrieval- Algorithms and Heuristic, second edition. Publisher: Springer. 2. R. Baeza-Yates and B. Ribeiro-Neto, "Modern Information Retrieval". 3. S. Büttcher, C. Clarke, and G. Cormack, Information Retrieval: Implementing and Evaluating Search Engines

1	**Code of the subject**	IT005
2	**Title of the subject**	Human Computer Interaction
3	**Any prerequisite**	N/A
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The course is intended to introduce the student to the basic concepts of human-computer interaction. It will cover the basic theory and methods that helps student to design HCI.
6	**Brief Contents**	Foundations of Human–Computer Interaction: Human Capabilities, The Computer, The Interaction, Paradigms The Design Process: Interaction Design Basics, HCI in the Software Process, Design Rules, Universal Design Implementation Support: Implementation Tools, Evaluation and User Support Evaluation, User Support Users Models: Cognitive Models, Socio-organizational Issues and Stakeholder Requirements, Task Models and Dialogs Page: Analysing Tasks, Dialog Notations and Design, Groupware, Ubiquitous Computing, Virtual and Augmented Reality, Hypertext and Multimedia: Groupware and Computer-supported Collaborative Work, Ubiquitous Computing, Virtual Reality and Augmented Reality.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Alan Dix, Janet E. Finlay, Gregory D. Abowd, Russell Beale, Human-Computer Interaction. Harlow, England: Prentice Hall, 2004. 2. Yvonne Rogers, Helen Sharp, Jenny Preece, Interaction Design: Beyond Human Computer Interaction, 3rd Edition, Wiley, 2011 3. Preece, Jenny, et al. Human-computer interaction. Addison-Wesley Longman Ltd., 1994.

1	**Code of the subject**	IT006
2	**Title of the subject**	Digital Video Processing

3	**Any prerequisite**	N/A
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	At the end of this course, students will able to understand the knowledge within the area of intelligent video technology, with emphasis on motion tracking, enhancement and restoration, video segmentation and optimization.
6	**Brief Contents**	Video Sampling and Interpolation, Basic Linear Filtering with Applications to Image Enhancement, Computational Models of Early Human Vision, Motion Detection and Estimation, Video Enhancement and Restoration, Video Segmentation, Motion Segmentation, Tracking: Motion Tracking in Video, 2D and 3D Motion Tracking in Digital Video, Methods using Point Correspondences, Optical Flow and Direct Methods, Optimization: Pel-Recursive Methods, Bayesian Methods, Applications: Video Stabilization and Mosaicing, A Unified Framework for Video Indexing, Summarization, Browsing and Retrieval, Video Surveillance.
7	**Contents for lab (If applicable)**	N/A
8	**List of text books/references**	1. Alan Bovik, The Essential Guide to Video Processing 2. A Murat Tekalp, Digital Video Processing 3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.

1	**Code of the subject**	IT007
2	**Title of the subject**	Advanced Machine Learning
3	**Any prerequisite**	Machine Learning
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The course objectives are to expose students to learn several advanced machine learning topics including variants of deep-learning models. Also, students will be emphasized to solve several real-time projects based on the concepts learned in the course.
6	**Brief Contents**	Review of Machine Learning, Neural Network, Learning algorithms – Backpropagation algorithm, Optimization algorithms, Deep Neural Networks and their variants, Convolutional Neural Networks, Generative Adversarial Network, Recurrent Neural Network, Transformer, etc. Projects related to different domains like health care, agriculture, automobile, etc.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. Deep learning. MIT press, 2016. 2. David Dietrich, Barry Heller and Beibei Yang, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", EMC Education Services, Reprint 2015, Wiley. 3. Tephen Marsland, "Machine Learning – An Algorithmic Perspective", Taylor& Francis Group, Second Edition, 2015, Chapman & Hall / CRC Press.

1	**Code of the subject**	IT008
2	**Title of the subject**	Multimedia Processing
3	**Any prerequisite**	
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The course is intended to introduce the student to the concepts of multimedia systems, various coding, audio and video standards, resolution analysis and synchronization.
6	**Brief Contents**	Multimedia Systems and Processing, Lossless Image Compression Systems, Lossy Image Compression Systems: Theory of Quantization, Delta Modulation and DPC, Transform Coding & K-L Transforms, Discrete Cosine Transforms, Multi-Resolution Analysis: Theory of Wavelets, Multi-resolution Analysis: Theory of Sub-band Coding, Multi-resolution Analysis: Discrete Wavelet Transforms, Embedded Wavelet Coding, Image Compression Standards: JBIG and JPEG, JPEG-2000 Architecture and Features, JPEG-2000 Region of Interests Coding, JPEG-2000, Video Coding And Motion Estimation, Video Coding Standards: MPEG-1 standards, MPEG-2 Standard, MPEG-4 Standard, H.261 and H.263 Standards, H.264 standard, Audio Coding, Multimedia Synchronization, Video Indexing And Retrieval, state of the art video compression technique.
7	**Contents for lab**	N/A
8	**List of text books/references**	1 Alan Bovik, The Essential Guide to Video Processing. 2 Mark Nelson, *The Data Compression Book*, M&T Books, 1995. 3 Khalid Sayood, *Introduction to Data Compression*, Morgan Kaufmann, 1996. 4 J.F.K, Buford, Multimedia Systems, ACM Press, 1994

1	**Code of the subject**	IT009
2	**Title of the subject**	Digital Watermarking
3	**Any prerequisite**	Image Processing
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	This course enables students about different digital watermarking techniques, security aspects in it, deplorability and watermarking in real-world.
6	**Brief Contents**	Information Hiding, Steganography, and Watermarking, Importance of Digital Watermarking, Steganography, Applications and Properties, Models of Watermarking: Communication-Based Models of Watermarking, Geometric Models of Watermarking, Modelling Watermark Detection by Correlation; Basic Message Coding, Robust Watermarking, Watermark Security: Security Requirements, Watermark Security and Cryptography, Some Significant Known Attacks; Content Authentication.
7	**Contents for lab**	N/A

8	**List of text books/references**	1. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, Morgan Kauffman, Digital Watermarking and Steganography, 2007 2. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Morgan Kauffman, Digital Watermarking principles, 2007. 3. Introduction to Watermarking Techniques and Applications, AP Lambert Academic, 2020

1	**Code of the subject**	IT010
2	**Title of the subject**	Applied Image Processing
3	**Any prerequisite**	Image Processing
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	To introduce the basic concepts of Digital image processing with emphasis on applications in various field of recent research.
6	**Brief Contents**	Review of Image processing techniques, filtering in spatial and frequency domain, Image segmentations, object representations, Industrial applications of image processing, Biomedical applications of image processing, Image processing in healthcare and agriculture etc.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. G. J. Awcock, Ray Thomas, Applied Image Processing, McGraw-Hill, 1996 2. Rafael C. Gonzalvez and Richard E. Woods, Digital Image Processing 2nd Edition, Published by: Pearson Education. 3. R.J. Schalkoff, Digital Image Processing and Computer Vision John Wiley and Sons, NY. 4. William K. Prat, Digital Image Processing, John Wiley and Sons, NY.

1	**Code of the subject**	IT011
2	**Title of the subject**	Cognitive Radio
3	**Any prerequisite**	Digital Communication
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The Students will be enabled to understand and acquire knowledge in cognitive networks. To emphasis on knowledge-building to understand architectures for various networks. To provide a complete understanding of concepts, and to identify the pros and cons of designing a cognitive network and SDR.
6	**Brief Contents**	Introduction of various generations of wireless communication, Spectrum scarcity, cognitive radio (CR) architecture, functions of cognitive radio, Fundamental challenges, and issues in designing cognitive radio. Spectrum access models, dynamic spectrum access (DSA), underlay, overlay, and hybrid cognitive radio, Potential applications of cognitive radio. Interference temperature/channel estimation, Detection of spectrum holes, Practical spectrum sensing approaches, Collaborative sensing, External Sensing. Framework of Trust in CRN; Trusted Association and Routing; Trust with Learning; Security in CRN. Introduction

		to SDR. Evolution of SDR Baseband Requirements. SDR Architectures -Ideal SDR Architectures, Realistic SDR Architecture. SDR and Cognitive Radio Relationship.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Hoseyin Arslan (Ed.), "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems," Ser. Signals and Communication Technology, xviii, I. edition, Springer, Aug. 2007 2. Joseph Mitola, III, "Cognitive Radio Architecture: The Engineering Foundations of Radio XML," John Wiley and Sons Ltd., 2006. 3. Kwang-Cheng Chen and Ramjee Prasad, Cognitive Radio Networks, John Wiley & sons, 2009. 4. Ahmed Khattab, Dmitri Perkins, Magdy Bayoumi, Cognitive Radio Networks: From Theory to Practice, Springer, 2013.

1	**Code of the subject**	IT012
2	**Title of the subject**	Next Generation Networks
3	**Any prerequisite**	It is desirable to have the knowledge of Data networking and Telecommunications principles.
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	After successful completion of this course, students will able to learn emerging network technologies, their features, challenges, advantages, and disadvantages. To learn how broadband data and multimedia services are carried out to users over a common Multi-Service Infrastructure.
6	**Brief Contents**	Introduction To Next Generation Networks (NGN): Communication and Networking in coming Era, Technologies influencing change, NGN Services, Network Infrastructure convergence, services convergence etc., Overview of Wireless network and Technologies GSM, 1G, 2G, 3G and 4G, Bluetooth, Radio frequency, Overview Of TCP/IP, LANs, WANs. Optical Networks, Wire-line and Wireless Networks, General packet radio service (GPRS): GPRS and packet data network, network architecture, operation, and data services in GPRS. Applications of GPRS, Billing, and charging in GPRS, Ad-hoc network: Architecture and Protocols, Wireless LAN, IEEE802.11a, 802.11b standards, Wireless LAN architecture, Mobile ad hoc networks, and sensor network.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Neill Wilkinson, “Next Generation Networks Services, Technologies, and Strategies”, Wiley, 2002. 2. Robet Wood, “Next Generation Network Services”, Pearson, 2005. 3. YB. Lin and I Chlamtac, “Wireless and Mobile Network Architectures”, Wiley, 2001 4. A.S. Tanenbaum, “Computer Networks”, Pearson Education, 2003.

1	**Code of the subject**	IT013
2	**Title of the subject**	Queuing Theory
3	**Any prerequisite**	Basic knowledge of Engineering Mathematics and
4	**L-T-P**	3-0-0
5	**Learning Objectives of the**	To teach the applications of queuing theory related to
6	**Brief Contents**	Basics of Probability and Statistics, Random processes- Introduction, classification, Stationary process – Wide Sense Stationary, Strict Sense Stationary, Markov Process, Markov Chain, Problems based on Markov Process. Transition probabilities, Limiting distributions, Poisson Process - Properties, Poisson Process - Problems Queuing system – introduction, Markovian Models, Birth and Death Process, Little's Formula, M/M/1, Infinite Capacity, M/M/1, Finite Capacity, M/M/c, Infinite Capacity, M//M/c, Finite Capacity and finite population, M/M/ queue. Non Markovian queues- M/G/1 queue, GI/M/1 queue, GI/M/m queue, GI/G/1 queue, M/G/m queue, GI/G/m queue, Pollaczek- Khinchine formula. Priority queues-Queues with preemption, queues with time dependent priorities. Series queues, Open Networks, Closed Networks, batch service, batch arrival.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. K. S. Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, John Wiley and Sons, 2nd edition, 2002. 2. A.O. Allen, Probability, Statistics and Queuing Theory with Computer Applications, Elsevier, 2nd edition, 2005. 3. Srivastava, H. M., & Kashyap, B. R. K. (1982). Special functions in queuing theory and related stochastic processes. ACADEMIC PRESS. 4. Dimitri P. Bertsekas and Robert G. Gallager, "Data Networks," (2nd edition) Prentice Hall, 1992 5. Leonard Kleinrock, Wiley-Interscience, Queueing Systems, Volume I; 1st edition (1 January 1975).

1	**Code of the subject**	IT014
2	**Title of the subject**	Network design and optimization
3	**Any prerequisite**	Basics of wireless communications
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	Students will acquire knowledge of the planning and optimization of wireless networks and their specifications. The course will discuss the working principles of different types of networks and their performance optimization.

6	**Brief Contents**	Review of all Network Technologies, Study of Various Quality of service aspects in wired and wireless Networks based on applicative scenarios and their optimization.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. D. Medhi and K. Ramasamy, Network Routing: Algorithms, Protocols, and Architectures - 2nd Edition, Morgan Kaufmann Publishers (an imprint of Elsevier), publication date: September 11, 2017. 2. D. Medhi and K. Ramasamy, Network Routing: Algorithms, Protocols, and Architectures, Morgan Kaufmann Publishers (an imprint of Elsevier), publication date: March 29, 2007. 3. M. Pióro and D. Medhi, Routing, Flow, and Capacity Design in Communication and Computer Networks, Morgan Kaufmann Publishers (an imprint of Elsevier), publication date: July 1, 2004.

1	**Code of the subject**	IT015
2	**Title of the subject**	Advanced Wireless Communications
3	**Any prerequisite**	Introduction to Probability and Statistics, Introduction to
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The course provides advanced knowledge in a number of transmission techniques and technologies in wireless communications. It covers the fundamentals of MIMO communications. Other advanced topics are also viewed to update students with emerging techniques and developments in 5G.
6	**Brief Contents**	Basics of single-user Multiple-Input-Multiple-Output (MIMO) communications – Channel models, outage capacity, ergodic capacity – Diversity techniques: time, frequency, space and diversity combiners – Precoding for spatial multiplexing, optimum, linear and nonlinear receivers – Space-time coding and MIMO decoding. Emerging techniques and applications in 5G–Cooperative communications, Device-to-device (D2D) communications, Green and energy-efficient communications, –Internet of Things (IoT) networks and Low Power Wide Area Network (LPWAN) technologies.
7	**Contents for lab (If applicable)**	N/A
8	**List of text books/references**	1) D. Tse and P. Viswanath, “Fundamentals of wireless communication”, 2005. 2) R. W. Heath Jr. and A. Lozano, “Foundations of MIMO Communication”, 2018. 3) Liu, KJ Ray, et al. Cooperative communications and networking. Cambridge university press, 2009. 4) E. Bjornsson, J. Hoydis, L. Sanguinetti, “Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency”, 2017.

1	**Code of the subject**	IT016
2	**Title of the subject**	Multimedia Networks
3	**Any prerequisite**	N/A
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The course is aimed at developing students' ability to understand and apply the fundamental ideas that govern the design of the architecture of modern multimedia communication networks to real problems.
6	**Brief Contents**	Multimedia networks principles, Audio video streaming, Jitter problems, Multicast, principles, and protocols, Multimedia Protocols – SIP, RTSP, etc., Traffic engineering and Quality of services, Queuing architectures, Content in Distributed network, CDN architecture.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Multimedia Communications: Protocols and Applications, Prentice Hall, 1998 2. Multimedia Communications: Protocols and Applications, F. Kuo, W. Effelsberg, andJ.Garcia-Luna-Aceves, Prentice Hall PTR, 2000 3. Multimedia over IP and Wireless Networks: Compression, Networking, and Systems, by M. Van der Schaar, P. Chou, Academic Press, 2007. 4. Multimedia Communications Applications, Networks, Protocols and Standards Fred Halsall, Addison Wesley, 2001

1	**Code of the subject**	IT017
2	**Title of the subject**	Industrial IoT Communication
3	**Any prerequisite**	Basic understanding of industrial plants, physics of the real world, Computer communications, Machine Learning.
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The candidates will learn about the emerging digitization issues associated with factory floor, various approaches to data collection and processing using machine learning techniques.
6	**Brief Contents**	Industry 4.0: The PDP loop concept, IIoT reference architecture; Connecting Brownfield environments: Overview of existing and the state-of-the-art manufacturing plants, Smart factories, digitization and cloud centric IoT systems, Advancements in industrial IoT, applications and solutions – case studies, issues and challenges in brownfield connectivity. Connectivity layers: Issues with placing together different data logging sensors. Hardware and software approaches to data collection and condition monitoring of industrial processes: Gateways, connectivity agents; Enterprise systems: Edge analytics, Integration of multiple data systems, Data value mapping, low-code application development; Open IoT.
7	**Contents for lab**	N/A

8	**List of text books/references**	1. Alasdair Gilchrist (Apress), "Industry 4.0: The Industrial Internet of Things" 2. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), "Industrial Internet of Things: Cyber manufacturing Systems". 3. White papers and research articles.

1	**Code of the subject**	IT018
2	**Title of the subject**	Detection and Estimation Theory
3	**Any prerequisite**	Student must have basic knowledge about linear algebra,
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject (in about 50 words)**	The students will learn to mathematically formulate appropriate detection and estimation problems, solve these problems to get good/best detectors and estimators and analyze their performance. This is a math-oriented course and will use concepts from probability and linear algebra.
6	**Brief Contents**	Review of Gaussian variables and processes, Statistical Decision Theory: Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio, composite hypothesis testing, Detection of Deterministic Signals: Matched filter detector and its performance. Detection of Random Signals: Estimator- correlator, linear model, general Gaussian detection. Nonparametric Detection: Detection in the absence of complete statistical description of observations. Estimation of Signal Parameters: Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics. Signal Estimation in Discrete-Time: Linear Bayesian estimation, Weiner filtering, dynamical signal model, discrete Kalman filtering.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. H. L. Van Trees, Detection, Estimation and Modulation Theory, John Wiley and sons 2004. 2. Signal detection and estimation by Mourad Barkat, Artech House 1991. 3. An Introduction to Signal Detection and Estimation by Poor, H. Vincent, Springer 1998.

1	**Code of the subject**	IT019
2	**Title of the subject**	Distributed System
3	**Any prerequisite**	Fundamentals of distributed systems, Basic knowledge of software systems. Basic programming skills in a mainstream programming language.
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The candidates will learn about the principles of distributed systems and contrast with other forms of computation, identify applications of distributed systems in particular the use of cloud and serverless applications, big data and graph processing applications, interactive and online gaming,

		etc.; analyze and design core architectures, components, and techniques in distributed systems.
6	**Brief Contents**	Introduction to Distributed Systems: Parallel versus distributed systems, challenges, CAP theorem; Functional requirements: Naming, replication, consistency, consensus; Non-functional requirements: Measuring NFRs, scalability and elasticity etc.; Resource management and scheduling: scheduling issues for small and large systems, centralized and decentralized schedulers, portfolio scheduling; System architecture and programming models: Communication, big data, machine learning, layering; Distributed ecosystems: massive processing, the super-distribution principle, cloud, edge, big data, Distributed ecosystems in online gaming etc.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Von Bochmann, Gregor, "Concepts for distributed systems design", Springer Science & Business Media, 2012. 2. Van Steen, Maarten, and Andrew S. Tanenbaum, "Distributed systems". 3. Sukumar Ghosh, "Distributed systems", CRC Press 4. Ajay D. Kshemkalyani and Mukesh Singhal, "Distributed computing: Principles, algorithms and systems", Cambridge press.

1	**Code of the subject**	IT020
2	**Title of the subject**	Information Theory and Coding
3	**Any prerequisite**	Linear algebra
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	This course gives brief knowledge about the basic algebraic relationships of entropy, relative entropy, and mutual information. In this course students learn how to compress the data using source coding and how to make data transmission reliable using channel coding. It introduces the basic principles of encoding, decoding, error detecting and error correcting techniques.
6	**Brief Contents**	Information Theory: Introduction, Discrete memory less source, Binary source. Entropy, Relative Entropy, and Mutual Information, Channel capacity, Data Compression Examples of Codes, Kraft Inequality, Optimal Codes, Bounds on the Optimal Code Length, Kraft Inequality for Uniquely Decodable Codes, Huffman Codes, Shannon–Fano Coding, etc. Error detecting and Error correcting code, Block Codes, Cyclic Codes, Convolution Codes
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Joy A. Thomas and Thomas M. Cover, Elements of Information Theory, John Wiley and Sons. 2. John G. Proakis, McGraw Hill, Digital Communication Singapore, 4th Edition, 2001. 3. Bernard Sklar, Digital Communications: Fundamentals and Applications, 2nd Ed., Pearson Prentice Hall, 2001.

1	**Code of the subject**	IT021
2	**Title of the subject**	Convex Optimization
3	**Any prerequisite**	Basic knowledge of Engineering Mathematics and Statistics
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	To learn the concepts and applications of optimization for solving real world problems.
6	**Brief Contents**	**Linear Programming:** Convex sets, Mathematical Model, Assumptions of linear programming, Graphical method Simplex method, Big M Method, Two-Phase Method, Exceptional cases in LPP. **Duality in Linear Programming:** Dual simplex method, revised simplex method, sensitivity or Post-optimal analysis, Transportation problem, Assignment Problem. **Integer Programming Problem:** Cutting plane method, Gomory's cut method, Branch and bound technique, Travelling salesman problem, Cargo loading problem. **Non-linear Programming:** Quadratic forms and classical methods, Convex functions and Kuhn-Tucker theory, Beale's method, Separable programming. **Dynamic Programming and Game Theory:** Bellmen's principle, Recursive relations, Solution of LPP by dynamic programming, Game theory, games with mixed strategy, Stochastic linear programming.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Taha, H.A., 1992. Operations Research (5th edn), Prentice Hall Publication. 2. Hillier, F.S. and Lieberman, G.J., 1967. Introduction to operations research. San Francisco: Holden-Day. 3. Ravindran, A, Phillips, DT, Solberg, JJ. 1987. Operations Research: Principles and Practice, John Wiley 4. Boyd, Stephen, Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.

1	**Code of the subject**	IT022
2	**Title of the subject**	Digital Watermarking and Steganalysis
3	**Any prerequisite**	N/A
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The objective of the course makes students familiar about Digital watermarking and steganography.

6	**Brief Content**	Information Hiding, Steganography, and Watermarking, Importance of Digital Watermarking, Applications and Properties. Models of Watermarking: Communication-Based Models of Watermarking, Geometric Models of Watermarking, Modelling Watermark Detection by Correlation; Basic Message Coding: Mapping Messages into Message Vectors, Error Correction Coding, Detecting Multi-symbol Watermarks; Watermarking with Side Information: Informed Embedding, Watermarking Using Side Information, Dirty-Paper Codes; Robust Watermarking: Approaches, Robustness to Volumetric Distortions, Robustness to Temporal and Geometric Distortions; Watermark Security: Security Requirements, Watermark Security and Cryptography, Some Significant Known Attacks; Content Authentication: Exact Authentication, Selective Authentication, Localization, Restoration; Notation and Terminology, Information-Theoretic Foundations of Steganography, Practical Steganographic Methods, Minimizing the Embedding Impact; Steganalysis: Steganalysis Scenarios, Some Significant Steganalysis Algorithms.
7	**Contents for lab (If applicable)**	N/A
8	**List of text books/references**	1. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, Morgan Kauffman, Digital Watermarking and Steganography. 2. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Morgan Kauffman, Digital Watermarking principles 3. Frank Y. Shih, Digital Watermarking and Steganography: Fundamentals and Techniques, Second Edition CRC Press.

1	**Code of the subject**	IT023
2	**Title of the subject**	Cryptography and Network Security
3	**Any prerequisite**	Linear Algebra
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	To enhance the ability to analyse, identify and define the computing requirements for data security.
6	**Brief Contents**	Classical Encryption Techniques, Finite Field and Number Theory, Polynomial Arithmetic, Prime Numbers, Fermat‘s And Euler‘s Theorem, Testing For Primality, Key Management, Elliptic Curve Arithmetic, Elliptic Curve Cryptography. Cryptographic Protocols, Digital Signatures. Authentication applications, IP security, Encapsulating Security Payload (ESP)-Internet Key Exchange (Phases of IKE, ISAKMP/IKE Encoding). Web Security: Web Security Considerations, Secure Socket Layer and Transport layer Security. System Security: Intrusion Detection, Virus and related threats, Firewalls, Trusted Systems.
7	**Contents for lab**	N/A

8	**List of text books/references**	1. William Stallings, Cryptography and Network security, 4e, Prentice Hall of India, New Jersey, 2008. 2. Christof Paar, Jan Pelzl, Understanding Cryptography, Springer-Verlang, Berlin, 2010 3. Behrouz A Forouzan, Cryptography and Network security, Tata Mc-Graw Hill, New York, 2007.

1	**Code of the subject**	IT024
2	**Title of the subject**	Distributed System Security
3	**Any prerequisite**	Basics of Distributed System
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	This is a course that will cover advanced security concepts beyond traditional offerings. Emphasis will be made on all aspects of cyber security including vulnerabilities, threats, attacks and defences in distributed systems.
6	**Brief Contents**	Security Requirements of Distributed Systems; Security Violations, Security Goals, Security Services, Security Protocols, and Security Mechanisms; Attack on Security Protocols and Security Mechanisms; Secret Sharing Techniques and One-Way Functions; Discrete Logs, Block Encryption/Decryption Functions, Hash Functions, and MAC Functions; Algorithmic Implementation and Security Requirements of One-Way Functions; OS Security Violations and Techniques to Prevent Them; Access Control Models; Authenticated Diffie-Hellman Key Establishment Protocols; Group Key Establishment Protocols; Block Ciphers and Stream Ciphers; Block Cipher Modes of Encryption; Nonce, Timestamps and Authentication Protocols; Digital Page 1/6Signatures and Source Non-Repudiation Protocols; PKI and X.509 Authentication Service; Security Protocol Verification: Strand Space Theory; Kerberos; E-mail Security; Security Issues in Layered Communication Models: IP Security, Secure Socket Layer and Transport Layer Security; Secure Electronic Transactions; Intrusion Detection; Malicious Software Detection; Firewalls.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Anirban Chakrabarti, Distributed Systems Security: Issues, Processes and Solutions 1st Edition by Abhijit Belapurkar (Author), Wiley, 2009. 2. Ajay D. Kshemkalyani and MukeshSinghal, “Distributed Computing: Principles, Algorithms, and Systems”, Cambridge University Press, 2011. 3. Andrew S. Tanenbaum and Maarten van Steen, “Distributed Systems: Principles and Paradigms”, Second Edition, Pearson Prentice-Hall, 2007.

1	**Code of the subject**	IT025
2	**Title of the subject**	Cyber Security and Laws
3	**Any prerequisite**	N/A

4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	To realize the activities carried using forensic technologies in detection of cybercrime. To introduce a novel methodology of performing cyber forensics or system forensics. To relate the laws enforced by the judiciary to handle cybercrimes and cyber
6	**Brief Contents**	Mobile Forensics, Computer Ethics and Application Programs, Cyber Forensic, Data Recovery, Introduction to Deleted File Recovery, Formatted Partition Recovery, Data Recovery Tools, Data Recovery Procedures and Ethics, file modification and file access, Recover Internet Usage Data, Recover Swap Files/ Temporary Files/Cache Files, Introduction to Encase Forensic Edition, Forensic Tool Kit (FTK), Introduction to IT laws & Cyber Crimes, Introduction to Cyber Forensic Investigation, Investigation Tools, eDiscovery, Digital Evidence Collection, Evidence Preservation, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Encryption and Decryption methods, Search and Seizure of Computers, Recovering deleted evidences, Password Cracking, Introduction to Cyber Security, Implementing Hardware Based Security, Software Based Firewalls, Security Standards, Assessing Threat Levels, Forming an Incident Response Team, Reporting Cyber crime, Operating System Attacks, Application Attacks, Reverse Engineering & Cracking Techniques and Financial Frauds, Security Audit and Standards.
7	**Contents for lab**	N/A
8	**List of text books/references**	1.Raghu Santanam, Sethumadhavan, MohitVirendra, Cyber Security, Cyber Crime and Cyber Forensics: Applications and Perspectives, IGI Global 2. Chris Davis, IT Auditing Using controls to protect Information Assets, TMH 3. Hamid Jahankhani, Cyber Criminology, Springer.

1	**Code of the subject**	IT026
2	**Title of the subject**	Advanced Cryptography
3	**Any prerequisite**	Basics of Cryptography
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	This course investigates advanced topics in cryptography. It begins with an overview of necessary background in algebra and number theory, private- and public-key cryptosystems, and basic signature schemes. The course will cover number theory and basic theory of Galois fields used in cryptography, discrete logarithm-based cryptosystems including those based on elliptic curves; interactive protocols including the role of zero-knowledge proofs in authentication.

6	**Brief Contents**	Review of the prerequisite Cryptography: Private-key cryptosystems; Advanced Encryption Standard (AES), Overview of modular arithmetic, discrete logarithms, and primality/factoring, Public-key cryptosystems; ElGamal cryptosystem, Basic signature schemes. Algebra and number theory: Rings of polynomials, Existence and finding primitive roots, Blum integers, Primes; Agrawal, Kayal, Saxena P-time algorithm for recognizing primes, Elliptic curves. Discrete logarithm-based cryptosystems and signatures: Elliptic Curve Cryptosystem (ECC), Digital Signature Standard (DSS), Selection of other signature schemes, Overview of discrete logarithm algorithms, Ethical aspects of public-key cryptosystems and signatures, Hashing, emerging SHA-3 standard. Interactive protocols: Touch of complexity theory, Interactive proof systems, 0-knowledge proof systems, 0-knowledge authentication, Electronic cash; Chaum and Brands schemes. Private information retrieval: AES news, SHA-3 news, Private/public/group/share key generation and management, Digital watermarking, digital fingerprinting, Steganography. Selected topics in quantum computing, Quantum computers, Shor's algorithm, future demise of RSA, Quantum cryptography, Quantum key distribution and reconciliation
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Douglas R. Stinson, Cryptography: Theory and Practice, CRC Press, fourth edition 2019. 2. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, CRC Handbook of Applied Cryptography, CRC Press. 3. Lawrence C. Washington, Elliptic Curves. Number Theory and Cryptography, Chapman and Hall, CRC Press 2003.

1	**Code of the subject**	IT027
2	**Title of the subject**	Information Security and Secure Coding
3	**Any prerequisite**	Basics of Cyber Security
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	To learn how secure coding is important when it comes to lowering risk and vulnerabilities. Identify the insecure coding practices that lead to common software programming errors. Learn about XSS, Direct Object Reference, Data Exposure, Buffer Overflows, Resource Management, Active Defences, and Threat Modelling.

6	**Brief Contents**	Introduction to Information security and Secure coding, Injections (SQL, command, JSON), defenses, Broken authentication and Session management. Cross-site Scripting (reflected XSS HTML, reflected XSS JS), Insecure direct object reference, Security misconfiguration. Sensitive data exposure, Missing function level access control, Cross-site request forgery. Using components with known vulnerabilities, Invalidated redirects and forwards. Buffer overflows, Insecure interaction between components. Risky resource management, Porous defences, Active defences, Threat modeling.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. "Fundamentals of Cyber Security", Mayank Bhushan, Rajkumar Singh Rathore, Aatif Jamshed, *BPB Publications*. 2. "Building Secure Software: How to Avoid Security Problems the Right Way", Viega, John, Gary McGraw, *MAddison-Wesley Professional*. 3. "Foundations of Information Security: A Straightforward Introduction", Jason Andress, No Starch Press, US.

1	**Code of the subject**	IT028
2	**Title of the subject**	Malware Analysis
3	**Any prerequisite**	Networks and Operating Systems, Computer security.
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	This course will introduce students to modern malware analysis techniques through readings and hands-on interactive analysis of real-world samples. After successful completion of this course students will be equipped with the skills to analyze advanced contemporary malware using both static and dynamic analysis.
6	**Brief Contents**	Introduction to malware, Basic Static and Dynamic Analysis, Overview of Windows file format, PEView.exe, Patching Binaries , Disassembly (objdump, IDA Pro), Introduction to IDA, Introduction to Reverse Engineering, Extended Reverse Engineering using GDB and IDA, Advanced Dynamic Analysis - debugging tools and concepts, Malware Behavior - malicious activities and techniques, Knowledge of relevant system internals, and experience in using various malware analysis tools Analyzing Windows programs–WinAPI, Handles ,Networking , COM, Data Encoding, Malware Counter measures, Covert Launching and Execution, Anti Analysis - Anti Disassembly, VM, Debugging -, Packers – packing and upacking, Intro to Kernel – Kernel basics, Windows Kernel API, Windows Drivers, Kernel Debugging, Rootkit Techniques- Hooking, Patching, Kernel Object Manipulation , Rootkit Anti-forensics, Covert analysis.

7	**Contents for lab**	N/A
8	**List of text books/references**	1. Michael Sikorski and Andrew Honig, Practical Malware Analysis, No Starch Press,2012 2. Reverend Bill Blunden, The Rootkit Arsenal: Escape and Evasion in the Dark Corners of the System, Second Edition 3. Jamie Butler and Greg Hoglund, Rootkits: Subverting the Windows Kernel. 4. Dang, Gazet, Bachaalany, Practical Reverse Engineering, Wiley,2014

1	**Code of the subject**	IT029
2	**Title of the subject**	Formal methods for Security Verifications
3	**Any prerequisite**	Operating Systems Concepts, Information System Security
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	To make use of mathematical background to understand and use formal methods like set theory, propositional logic and operational semantics
6	**Brief Contents**	Introduction to Formal Methods, Mathematical Background, Formal Specifications, Case Study Formal Specifications and Models, Model Checking and Formal Verification, Advanced models: Real-time models , Case Study Formal Verification , Static and Dynamic Analysis of programs, temporal logic: CTL and LTL, Buchi automata, Explicit model checking, BDDs and model-checking with BDDs, symbolic model checking, SAT and model-checking with SAT, Security verification, hybrid automata, hybrid system verification, applications of model checking to hardware, software, and protocols verification.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Edward Griffor, Handbook of System Safety and Security. 2. Ulrich Kühne, Rolf Drechsler, Formal Modeling and Verification of Cyber-Physical Systems. 3. Michael Huth and Mark Ryan, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge Univ. Press, 2nd edition

1	**Code of the subject**	IT030
2	**Title of the subject**	IoT and its security
3	**Any prerequisite**	
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The objective of this course is to acquaint participants with some of the fundamental concepts and state-of-the-art research in the areas of IoT and its Security.
6	**Brief Contents**	Introduction to IoT, potential security challenges in IoT paradigm, Architecture, Protocols, Performance Modeling & Analysis, Industrial IoT (IIoT) and the Industrial Internet Consortium (IIC), IoT Security solutions, Emerging IoT Standards, Open Problems & Research challenges.
7	**Contents for lab**	N/A

8	**List of text books/references**	1. Chintan Patel Nishant Doshi, Internet of Things Security: Challenges Advances and Analytics, T&F/CRC Press. 2. Cheruvu, Apress, Demystifying Internet of Things Security. 3. Al-Turjman, Security In Iot-Enabled Spaces, CRC Press. 4. Russell, Brian and Drew Van Duren, Practical Internet of Things Security, Packt Publishing, 2016.

1	**Code of the subject**	IT031
2	**Title of the subject**	Blockchain Technologies
3	**Any prerequisite**	Distributed systems, networking, cryptography, and data structures
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	Be able to state core blockchain concepts, the benefits, and the limitations of blockchain technologies. Apply various blockchain concepts to analyze examples, proposals, case studies, and preliminary blockchain system design discussions.
6	**Brief Contents**	Intro to cryptography & cryptocurrencies, Bitcoin mechanics, Consensus protocols, Ethereum and decentralized applications, Decentralized finance and economics, Privacy on a public blockchain, Scaling the blockchain, Emerging Applications of Blockchain in industry
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Narayanan, Arvind, et al. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016. 2. Lewis, Antony. The basics of bitcoins and blockchains: an introduction to cryptocurrencies and the technology that powers them. Mango Media Inc., 2018. 3. Antonopoulos, Andreas M. Mastering Bitcoin: unlocking digital cryptocurrencies. " O'Reilly Media, Inc.", 2014.

1	**Code of the subject**	IT033
2	**Title of the subject**	Parallel and Concurrent Programming
3	**Any prerequisite**	Advanced Computer Architecture, C/C++ Programming
4	**L-T-P**	3-0-0
5	**Learning Objectives of the**	The Course exposes the learner to know the various parallel

6	**Brief Contents**	Introduction to Parallel and Distributed Systems: Parallel Programming Paradigms, Parallel Architecture, Principals of Parallel Programming, Models of Parallel Computation, Complexity, PRAM, Memory Consistency & Performance Issues, Memory Consistency & Performance Issues, Shared Memory & Message Passing. OpenMP: Introduction to OpenMP, Work Sharing, Scheduling, Synchronization, Tasks, Environment Variables, and Run-Time Library Routines, Other Clauses and Directives. MPI: Basics of MPI, Cost Model, One-sided/two-side communication, Hybrid programming (MPI + OpenMP). Introduction to CUDA: GPU architecture, high-performance computing on GPUs, parallel algorithms, CUDA libraries, and applications of GPU computing. Introduction to the design of parallel algorithms and hands-on.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Chandra et al, ―Parallel Programming in OpenMP, Morgan Kaufmann. 2. Chapman, Jost, and van der Pas, ―Using OpenMP: Portable Shared Memory Parallel Programming, MIT Press. 3. Tanenbaum, Andrew S. Distributed operating systems. Pearson Education India, 1995. 4. Programming Massively Parallel Processors (3rd Edtion)

1	**Code of the subject**	IT034
2	**Title of the subject**	Scientific Computing and Numerical Methods
3	**Any prerequisite**	Engineering Mathematics
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject (in about 50 words)**	To demonstrate an understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems. To apply numerical methods to obtain approximate solutions to mathematical problems.
6	**Brief Contents**	Introduction, types of errors, Bisection Method, False Position Method, Newton-Raphson Method, Gauss Jordan Methods, etc and their Convergence. Finite Difference Operators and Their Relationships, Difference Tables, Differentiation Continuous Functions, Differentiation of Tabulated Functions, Higher Order Derivatives Newton-Cotes Integral Formula, Trapezoidal Rule, Simpson‘s Rules, Boole‘s Rule and Weddle‘s Rule, Romberg Integration, Taylor Series Method, Picard‘s Method, Runga-Kutta methods, etc.

7	**Contents for lab**	N/A
8	**List of text books/references**	1. Balagurusamy, E., Numerical Methods, Tata McGraw Hill Education Pvt. Ltd., 1999. 2. Sastry, S. S., Introductory Methods of Numerical Analysis, PHI Learning Pvt Ltd., 2012. 3. Jain, M. K., Iyengar, S.R.K and Jain, R.K, Numerical Methods for Scientific and Engineering computation, Wiley Eastern Ltd., 1985.

1	**Code of the subject**	IT035
2	**Title of the subject**	Game Theory
3	**Any prerequisite**	Basic knowledge of Engineering Mathematics and
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	To learn the applications of game theory, auction and equilibrium.
6	**Brief Contents**	Introduction to Game Theory, Dominant Strategies and Nash Equilibrium, Alternate Strategies: Maximin, Maximax, and Minimax Regret Solvability, N-Player Games, Mixed Strategy, Subgame Perfection in Discrete Choice Games, Continuous Games and Imperfect Competition, Infinitely Repeated Games, Tacit Collusion, Simultaneous-play, Bayesian Games, Applications of Bayesian Games: Auctions and Voting, Cournot‘s Duopoly with Imperfect Information, Radio Spectrum, With Arbitrary Distribution of Valuations, Extensive Form Game with Perfect Information, Stackelberg Model of Duopoly, Buying Votes, Committee Decision-Making, Repeated games, The Prisoner‘s Dilemma, General Result, Supermodular Game and Potential Game, Wireless Networks: Resource Allocations, Admission Control, Routing in Sensor and Ad-Hoc Networks, Modeling Network Traffic and Strategic Network Formation, Rubinstein Bargaining Model with Alternating Offers, Nash Bargaining Solution, Multi armed bandit problem.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Martin Osborne, An Introduction to Game Theory, Oxford University Press, 2003 2. Prajit Dutta, Strategies and Games, MIT Press. 3. K H Ericson, Game Theory, Createspace Independent Publishing Platform.

1	**Code of the subject**	IT036
2	**Title of the subject**	Big Data Analytics
3	**Any prerequisite**	N/A
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The course focuses on big data computer system, storage, processing, analysis, visualization, and applications. State-of-the-art computational frameworks for big data.

6	**Brief Contents**	Overview of Big Data, State-of-the-art computing paradigms/platforms, Big data programming tools (e.g., Hadoop, MongoDB, Spark, etc.), Big data extraction and integration, Big data storage, Scalable big data indexing, Large-scale graph processing techniques, Big data stream techniques and algorithms, Large-scale probabilistic data analysis, Big data privacy, Big data visualizations, problems in real applications.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Kuan-Ching Li, Hai Jiang, Laurence T. Yang, and Alfredo Cuzzocrea. Big Data: Algorithms, Analytics, and Applications. Chapman & Hall/CRC Big Data Series, 2015. 2. Thomas Erl, Wajid Khattak, and Dr. Paul Buhler. Big Data Fundamentals: Concepts, Drivers & Techniques. The Prentice Hall Service Technology Series, 2016. 3. Wajid Khattak, Paul Buhler, Thomas Erl, Big Data Fundamentals: Concepts, Drivers & Techniques, John Wiley & Sons, Inc

1	**Code of the subject**	IT037
2	**Title of the subject**	Nature Inspired Computing
3	**Any prerequisite**	Basic Mathematics, Data Structures, and Algorithms
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	It introduces a new paradigm of computing and solving problems. It has great applications in Artificial Intelligence, Data Mining, Machine Learning, and real-world design and optimization problems.
6	**Brief Contents**	Introduction to Evolutionary Computation: Representation, Initial Population, Fitness Function, Selection, Reproduction Operators, Stopping Conditions, Evolutionary versus Classical Computation; Genetic Algorithm: Canonical Genetic Algorithm, Crossover, Mutation, Control Parameters, Genetic Algorithm Variants, Applications; Differential Evolution, Particle Swarm Optimization, Artificial Bee Colony Algorithm. ANN Introduction, Evolution, McCulloh-Pitts Neuron, Linear Separability, Hebb Network; Perceptron Networks, Adaptive Linear Neuron, Multiple Adaptive Linear Neuron, Back-Propagation Network, Radial Basis Function Network; Associative Memory Network, Heteroassociative Memory Network, Bidirectional Associative Memory, Hopfield Network, Iterative Autoassociative Memory Network, Temporal Associative, Self-organizing maps, Linear Vector Quantization, Counter Propagation Network.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. S N Sivanandam and S N Deepa, Principles of Soft Computing, Wiley India 2. Andries P. Engelbrecht, Computational Intelligence: An Introduction, Jhon Wiley & Sons. 3. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, PHI.

1	**Code of the subject**	IT038
2	**Title of the subject**	Deep learning
3	**Any prerequisite**	Machine learning
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	This course will enable the learner to acquire the knowledge of applying Deep Learning techniques to solve various real life problems.
6	**Brief Contents**	Introduction to Deep Learning, Bayesian Learning, Decision Surfaces, Linear Classifiers, Linear Machines with Hinge Loss, Optimization Techniques, Gradient Descent, Batch Optimization, Neural Network, Multilayer Perceptron, Back Propagation, Unsupervised Learning with Deep Network, Autoencoders, Convolutional Neural Network, Transfer Learning, Revisiting Gradient Descent, Momentum Optimizer, RMSProp, Adam, early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization, Residual Network, Skip Connection Network, Fully Connected CNN etc. Image Denoising, Semantic, Segmentation, Object Detection etc., LSTM Networks, Generative Modeling with DL, Variational Autoencoder, Generative Adversarial Network Revisiting Gradient Descent, Momentum Optimizer, RMSProp.
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Ian Goodfelllow, Yoshua Benjio, Aaron Courville, Deep Learning-, The MIT Press. 2. Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, John Wiley & Sons Inc. 3. Wani, M. Arif, et al. *Advances in deep learning*. Springer, 2020.

1	**Code of the subject**	IT039
2	**Title of the subject**	Program Analysis Verification and Testing
3	**Any prerequisite**	Discrete Mathematics, Data Structures, Theory of Computation
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	To provide overview of the theoretical fundamentals of the subject also to provide information of some of the modern verification and testing tools.
6	**Brief Contents**	Dataflow Analysis, Interprocedural Analysis: functional, call-string and graph reachability based approaches; Abstract Interpretation, Weakest Precondition, Floyd-Hoare Logic, Separation Logic; Software Model Checking: symbolic execution, state-space reduction, state-less model checking, counter-example guided abstraction refinement, model checking of concurrent programs; Program Testing: program testing basics, automatic test-case generation, directed testing
7	**Contents for lab**	N/A

8	**List of text books/references**	1. Edsger Wybe Dijkstra. A Discipline of Programming. Prentice Hall PTR, Upper Saddle River, NJ, USA. 2. Michael Huth and Mark Ryan. Logic in Computer Science: Modelling and Reasoning about Systems. Cambridge University Press, New York, NY, USA 3. Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman. Compilers: Principles, Techniques, and Tools (2nd Edition). Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA, 2006.

1	**Code of the subject**	IT040
2	**Title of the subject**	Competitive programming
3	**Any prerequisite**	Data structures and algorithms
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	The focus of the course is the development and implementation of advanced algorithms, as well as the skills required for programming competitions.
6	**Brief Contents**	Introduction; Problem formats; Online judging systems; Parsing Input; Formatting Output, Review of Fundamental Data Structures), Divide and Conquer, Greedy, and Dynamic Programming Approaches; Graph Algorithms- search, shortest path, minimum spanning tree, network flow, bipartite graph matching, String Processing- edit distance, subsequences, suffixes) Numerical algorithms and Combinatorics, Chinese Remainder Theorem and modular math, Large number computations, generating and counting permutations and combinations, Applications of Geometric Algorithms 2D line segment and polygon queries –intersection, area; calculations on a sphere; 3D volume calculations; ray-surface intersection; convex hull; spatial subdivisions, Basic heuristic search, Advanced search and Simulation problems
7	**Contents for lab**	N/A
8	**List of text books/references**	1. Halim, Steven, Felix Halim, and Suhendry Effendy. Competitive programming 4: The new lower bound of programming contests in the 2020s, 2018. 2. Laaksonen, Antti. Guide to competitive programming. Cham: Springer, 2020. 3. Skiena, Steven S., and Miguel A. Revilla. "Programming challenges: The programming contest training manual." Acm SIGACT News 34.3 (2003): 68-74.