# **Course Structure**

# Integrated M.Tech. (Early exit) leading to 4 Year B.Tech. in Information Technology

For batch 2023 onward

ABV-Indian Institute of Information Technology & Management, Gwalior

## 4 year (8 semester) B.Tech. in Information Technology (Total credits: 170)

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

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

## EXIT AFTER YEAR - 1

# Certificate in Engineering Sciences (46 credits)

	C1				
	SI no	Course Code	Subjects	Credits	L-T-P
SEMESTER -3	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 cre	dite

	Sl no	Course Code	Subjects	Credits	L-T-P
	1	HS202	Entrepreneurship and Innovation	2	2-0-0
4	2	IT206	Theory of Computation	3	3-0-0
MESTER	3	IT207	Operating Systems	4	3-0-2
	4	IT208	Computer Networks	4	3-0-2
	5	EE207	Signals and Systems	4	3-1-0
SE	6	IT209	Graph Theory	4	3-0-2
•1			Total	21 cre	edits
		MO201	MOOC-2 (Optional in summer)	2/3-0	0-0

EXIT AFTER YEAR - 2

Diploma in Information Technology (89 credits)

ESTER -5	Sl no	Course Code	Subjects	Credits	L-T-P
	1	MS301	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
EM	5	IT303	Computer Graphics	4	3-0-2
$\mathbf{S}$	6	IT304	Trustworthy Artificial Intelligence	4	3-0-2
			Total	22 cr	edits

	Sl no	Course Code	Subjects	Credits	L-T-P
٩	1	ENXXX	Art of Engineering Research	2	2-0-0
R	2		Multidisciplinary/Open Elective- 2/MOOC 1 <sup>\$</sup>	3	3-0-0
ESTE	3	IT0XX	Department Elective-1	3	3-0-0
	4	IT305	Optimization Techniques	4	3-1-0
EM	5	IT306	Machine Learning	4	3-0-2
$\mathbf{S}$	6	IT307	Wireless Communication Technologies	4	3-0-2
			Total	20 cr	edits

Colloquium of 3 credits in summer semester (MOOC, NPTEL etc. in leu of colloquium) <sup>§</sup> MOOC 1 can also be taken in summer after 2<sup>nd</sup> semester if the student wishes to finish it earlier.

### EXIT AFTER YEAR - 3

# B.Sc. in Information Technology (131 credits)

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

<sup>\$</sup> MOOC 2 can also be taken in summer after 4th semester if the student wishes to finish it earlier

E	Sl no	Course Code	Subjects	Credits	L-T-P
EMES ER -8	1	IT499	BTech Project/Internship	12	0-0-24
	2	IT0XX	Department Elective – 3/MOOC 4	3	3-0-0
Š			Total	15 cr	edits



B.Tech. in Information Technology (170 credits)

# Electives courses 1. Visual Information Processing

Sl.No	Course Name	Course Code	L-T-P	Credits
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	Course 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 Communications	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	3-0-0	3

## 3. Information Security

Sl.No	Course Name	Course 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 Verifications	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	Course 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 Methods	IT034	3-0-0	3
4	Game Theory	IT035	3-0-0	3
5	Big Data Analytics	IT036	3-0-0	3
6	Nature Inspired computing	IT036	3-0-0	3
7	Deep Learning	IT037	3-0-0	3
8	Program Analysis Verification and Testing	IT038	3-0-0	3
9	Competitive Programming	IT039	3-0-0	3

#### NOTE-1:

<sup>§</sup> <u>BTech. in Information Technology</u>: If a candidate opts for an early exit after  $4^{th}$  year in the beginning of  $3^{rd}$  year or termed as Planned Exit.

<sup>#</sup> <u>BSc (Honours) in Information Technology</u>: If a candidate opts for an abrupt exit after 4<sup>th</sup> year without exercising an option for exit in the beginning of 3<sup>rd</sup> 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.

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		edits	

#### **Minor in Information Technology**

**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 4<sup>th</sup> semester. A student can opt for these courses along with his regular courses in 4<sup>th</sup> semester OR he can take one of the two courses in 4<sup>th</sup> semester and the other in his 6<sup>th</sup> 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.

### <u>SYLLABUS</u> SEMESTER - I

1	Code of the subject	EE101
2	Title of the subject	Fundamentals of Electrical and Electronics
3	Prerequisite	NA
4	L-T-P	3-0-2
5	Learning Objectives of the subject	<ul> <li>After the completion of the course, the students will be able to:</li> <li>Demonstrate the use of semiconductor diodes in various applications.</li> <li>Discuss and explain the working of transistors, their configurations and applications.</li> </ul>
		<ul> <li>Apply networks laws and theorems to solve electric circuits.</li> <li>Analyze transient and steady state response of DC circuits.</li> <li>Explain and analyse the behaviour of transformer.</li> <li>Elucidate the principle and characteristics of DC motor and DC generator.</li> </ul>
6	Brief Contents	Fundamental laws of electrical engineering circuit parameters, Classification of devices of an electrical circuit; Basic devices: resistors, controlled sources, diodes, capacitors and inductors, ideal transformers, Methods of Analysis, DC Network Theorems, Basic circuit analysis methods: nodal, mesh and modified nodal- analysis; Transient analysis of RL, RC, and RLC circuits, Three Phase Circuits and Power Measurements, Single Phase Transformers, Three Phase Induction Machines, DC Machines Semiconductor Materials: Ge, Si, and GaAs; n-Type and p-Type Materials; Semiconductor Diode and types; Construction and application of Bipolar Junction Transistors; Common-Base Configuration, Common- Emitter Configuration, Common-Collector Configuration; Clipper and Clamper, Rectifiers, Basics of MOSFET.
7	Contents for lab	Familiarization with CRO, DSO and Electronic Components, Diodes characteristics - Input-Output and Switching, BJT and MOSFET Characteristics, Zener diode as voltage regulator, Rectifiers, Clippers and Clampers, Network laws and theorems, Measurement of R,L,C parameters, A.C. series and parallel circuits, Measurement of power in 3 phase circuits, Reactance calculation of variable reactance choke coil, open circuit and short circuit tests on single phase transformer, Starting of rotating machines.
8	Text /references	<ul> <li>Electronic Devices and Circuit Theory by R.L. Boylestad and L. Nasheisky, Pearson.</li> <li>Basic Electrical Engineering by J. Nagrath and D. P. Kothari, TATA Mc Graw Hill.</li> <li>Electric Circuits by D. A. Bell, Oxford Higher Education.</li> <li>Modern Semiconductor Device Physics by S.M. Sze, Wiley.</li> </ul>

•	Electrical Technology by E. Hughes, Pearson Education.
•	Electrical Engg Fundamentals by V. Del Toro, PHI Learning.
•	Electronic Devices and Circuits by Milliman, J. and Halkias, C.C., Tata McGraw Hill.
•	Introduction to Electrical Engineering by Naidu, M.S. and Kamashaiah, S., Tata McGraw Hill.

1	Code of the subject	ES101
2	Title of the subject	Engineering Physics
3	Prerequisite	Basic knowledge of fundamentals of physics
4	L-T-P	3-0-2
5	Learning Objectives	Engineering Physics offers a multidisciplinary undergraduate program spanning engineering and physics in which fundamental physical principles are used to address research problems of technological importance at the frontiers of engineering and science. It promotes the understanding of the physical environment while discovering how physics is applied to problem-solving in our changing high-tech world. The engineering physics curriculum is designed to fulfill the educational requirements for professional work in various fields of applied science which are based upon a thorough knowledge of physics and foundation of basic scientific principles as well as the theoretical knowledge and skills required for specific engineering applications. Engineering physicists perform research and development in various industries pertaining to fields of telecommunications, microelectronics, lasers, fiber optics, nanotechnology and quantum computers.
6	Brief Contents	Quantum Physics: Black body radiation, Planck's hypothesis, wave particle duality, de-Broglie Hypothesis, Heisenberg uncertainty principle, photoelectric effect, Compton effect, phase and group velocity, wave function & its physical significance, Schrodinger's wave equation, Applications of Schrodinger equation. Electrodynamics: Maxwell's equations: differential and integral forms, significance of Maxwell's equations, displacement current and correction in Ampere's law, electromagnetic wave propagation, transverse nature of EM waves, applications, pointing vector & Poynting theorem. Physics of Materials: Types of Solids, Miller indices, Crystal structure, crystal systems, energy bands in solids, classification of solids, conductivity in metals and concepts of Fermi level, effective mass and holes, phonons, bulk and nanomaterials. Synthesis and characterization techniques, Graphene and 2D materials and its applications. Laser and Fiber Optics: Principles of lasers, Einstein Coefficients and their relations, Types of Dasers and their applications. Concept of optical fibers and types of optical fibers, modes of propagation, fiber optic communication, optical fiber sensors, connector and couplers.
8	Contents for lab	Practical experiments based on theory contents.
9	Text /references	<ul> <li>Engg. Physics- Kakani &amp; Kakani, CBS Publications.</li> <li>David J Griffith, Introduction to Quantum Mechanics, 2<sup>nd</sup> ed., PHI, 2013. (Text Book).</li> <li>Avadhanulu, M. N, &amp; Kshirsagar, S. G., A Textbook of Engineering Physics, S. Chand, 2014. (Text Book)</li> <li>Neeraj Mehta, Applied Physics for Engineers, PHI Learning Pvt. Ltd., 2011. (Text Book)</li> <li>Fiber optic communication- J Keiser (McGraw Hill) (Text Book)</li> <li>David J Griffith, Introduction to Electrodynamics, 4<sup>th</sup> ed. PHI 2014. (Ref.)</li> </ul>

• Paul Dirac, <i>Principles of Quantum Mechanics</i> , 4 <sup>th</sup> ed., Oxford Uni. Press, 2004. (Ref.)
• Kittel, C., <i>Introduction to Solid State Physics</i> , 8 <sup>th</sup> ed., Wiley, 2014. (Ref.)
• Malik and Singh, Engg Physics, TMH

1	Code of the subject	ES102
2	Title of the subject	Engineering Mathematics
3	Any prerequisite	None
4	L-T-P	3-1-0
5	Learning Objectives	To explore the connections of mathematical     foundation courses (Algebra, Calculus and Differential
		Equations) to the mathematics in the later engineering subjects.
		• To provide platform for the exchange of ideas,
		practices and pedagogy in the mathematics education
		in engineering and technical institutions.
6	Brief Contents	Vector spaces over arbitrary field, subspaces, linear combination, spanning set, linear dependence and independence of vectors, basis and dimension of vector spaces. Linear Transformation, The Null Space and the Range Space of a <b>Linear Transformation</b> , Rank, Nullity, Rank-Nullity Theorem, Algebra of linear transformations, Isomorphism, Matrix representation, Linear functionals, Annihilator, Transpose of a linear transformation. Matrix representation, matrix representation of a linear transformation, Rank of a matrix - echelon form, normal form, types of matrices-symmetric, skew-symmetric, Hermitian, skew-Hermitian, orthogonal, unitary matrices, consistency of system of linear equations (Homogeneous and Non-Homogeneous). Eigen values and Eigen vectors and their properties (Hermitian, Skew-Hermitian, Unitary matrices), Characteristic equations, Cayley-Hamilton theorem (without proof), Diagonalisation, Inner product, Norms of vectors, orthogonal vectors, Cauchy Schwarz Inequality, Triangle inequality. Introduction of function of two variables, Limit, Continuity, Partial differentiation, Differentiations, Maxima and minima for a function of several variables, Method of Lagrange multipliers with one subsidiary condition, Applications of maxima and minima with illustrative examples, Jacobians- Simple problems.
7	Contents for lab	Not applicable
8	Text /references	<ol> <li>Linear Algebra and its Applications, <u>Gilbert Strang</u>.</li> <li>Fundamentals of Linear Algebra, James B. Carrell</li> <li>Functions of Several Variables, Wendell Fleming</li> </ol>

1	Code of the subject	EE102	
2	Title of the subject	Engineering Design Principles	
3	Any prerequisite	None	
4	L-T-P	2-0-2	
5	Learning Objectives	The course should enable the students to:	
		• Widen students' knowledge on design process.	
		• Enable Students to attain knowledge on tools used in Design Methods.	
		• Create an understanding on the process of material selection and design.	
		• Develop in depth knowledge on Engineering statistics and reliability	
		<ul> <li>Create awareness on legal and ethical issues in Design an Quality Engineering</li> </ul>	
6	Brief Contents	an Quanty Engineering.	
0	bitei contents	Computer Aided Engineering, Designing of, Product life cycle, Human Factors in Design, Industrial Design. Design Methods, Creativity and Problem Solving, Product	
		Design Specifications, Conceptual design, Embodiment	
		Methods Material Selection Processing and Design	
		Engineering Statistics and Reliability Legal and Ethical	
		Issues in Design and Quality Engineering	
7	Contents for lab	Create geometric constructions; drawing parallel and perpendicular lines, and to construct circles, arcs, tangencies, and irregular curves, Apply orthographic projection method to obtain: Multiview, auxiliary view and	
		Create 3-D computer drawing : using Computer Aided Design (CAD) software	
8	Text /references	• Fundamentals of Engineering Drawing by W.J. Luzadder and L.M. Duff, PHL	
		• Engineering Design - "A Materials and Processing Approach" by Dieter, George F. McGraw Hill	
		Approach by Dieter, George E., McGraw IIII.	
		• Product Design and Development by Karl T. Ulrich and	
		<ul> <li>Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw Hill.</li> <li>Environment Device Network Construction of the Second Device Weight Second Device Weig</li></ul>	
		<ul> <li>Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw Hill.</li> <li>Engineering Design by Pahl, G, and Beitz, W., Springer – Verlag, NY.</li> </ul>	
		<ul> <li>Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw Hill.</li> <li>Engineering Design by Pahl, G, and Beitz, W., Springer – Verlag, NY.</li> <li>Elements of Engg. Design by Ray, M.S., Prentice Hall Inc.</li> </ul>	
		<ul> <li>Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw Hill.</li> <li>Engineering Design by Pahl, G, and Beitz, W., Springer – Verlag, NY.</li> <li>Elements of Engg. Design by Ray, M.S., Prentice Hall Inc.</li> <li>The principles of Design by Suh, N. P., Oxford University Press, NY.</li> </ul>	
		<ul> <li>Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw Hill.</li> <li>Engineering Design by Pahl, G, and Beitz, W., Springer – Verlag, NY.</li> <li>Elements of Engg. Design by Ray, M.S., Prentice Hall Inc.</li> <li>The principles of Design by Suh, N. P., Oxford University Press, NY.</li> <li>Visualization, Modeling, and Graphics for Engineering Design by D.K. Lieu and S.A. Sor, Cengage Learning.</li> </ul>	
		<ul> <li>Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw Hill.</li> <li>Engineering Design by Pahl, G, and Beitz, W., Springer – Verlag, NY.</li> <li>Elements of Engg. Design by Ray, M.S., Prentice Hall Inc.</li> <li>The principles of Design by Suh, N. P., Oxford University Press, NY.</li> <li>Visualization, Modeling, and Graphics for Engineering Design by D.K. Lieu and S.A. Sor, Cengage Learning.</li> <li>Fundamentals of Computer Graphics by Shirley, Peter,</li> </ul>	

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	<ul> <li>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.</li> <li>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.</li> </ul>
7	Contents for lab	Experiments are based on the theoretical contents and their applications
8	Text/references	<ol> <li>Kernighan, B.W. and D. M. Ritchie (1998): The C programming language, 2nd ed. Prentice Hall of India.</li> <li>Kanetkar, Y (2016): Let us C, 15thed .BPB Publications.</li> <li>King K.N (2008): C Programming: A Modern Approach, 2nd ed. W. W. Norton &amp; Company.</li> </ol>

-		
1	Code of the subject	HS 101
2	Title of the subject	Freshman Skills
3	Any prerequisite	No
4	L-T-P	2-0-0
5	Learning Objectives	To improve their Personal Skills and Attributes, Study Skills and academic preparation, and learn Community Service.
6	Brief Contents	Personal Skills and Attributes Focus: Self-Awareness, Self- Management, and Character Development, Institute personnel and available services, the rotating schedule, acceptable use of social media, opportunities for involvement in extracurricular clubs and sports, effective time-management skills, positive character traits, building self-awareness. Study Skills and Academic Preparation Focus: The Principles of Learning, Establishing Strong Study Skills, Developing an Academic , Pathways, Personal Goals, identify personal post-secondary goals, inherent aptitudes,

7	Text /references	
		Possible linguistic needs, transferable skills, resume
		local and global economics, societal trends, cultural trends,
		for future goals, financial requirements for future goals,
		exploring post-secondary options, academic requirements

1	Code of the subject	• HS102
2	Title of the subject	Sports and Physical Education
3	Prerequisite	• No
4	L-T-P	• 0-1-2
5	Learning Objectives	<ul> <li>Students will get knowledge and understanding of the facts, concepts and practice relating to a range of sports-both indoor and outdoor.</li> <li>To teach the students how to keep them fit, to increase his/her concentration, team coordination ability, which will help them as a professional.</li> </ul>
6	Brief Contents	<ul> <li>he course will be taught in two components</li> <li>Theory, Sport History, Human Anatomy, Stress Management/ Meditation/Yoga, Important tournaments and its players, Rules and Field Requirements, Sport Equipment, Sports Psychology, Role of IT in sports</li> </ul>
7	Contents for Field Sessions	<ul> <li>Indoor/ Outdoor: Cricket/ Football/ Volleyball/ Basketball/Badminton/ Table-Tennis/ Lawn-Tennis/ Athletics/ Yoga</li> </ul>
8	Text/references	<ul> <li>Nation at Play: Ronojoy Sen</li> <li>The Art of Captaincy: What Sports teaches us about Leadership by Mike Brearley</li> <li>The Anatomy of Exercise and Movement for the Study of Dance, Pilates, Sports, and Yoga by Jo Ann Staugaard-Jones</li> <li>Stress and Its Management by Yoga, by K.N. Udupa, R.C. Prasad</li> <li>THE WINNING WAY: Learning from Sport for Managers by Anita Bhogle, Harsha Bhogle</li> <li>Think Like a Champion by Webster, Rudi V.</li> <li>Attitude is Everything, by Jeff Keller</li> </ul>

1	Code of the subject	EE103	
2	Title of the subject	Digital Electronics	
3	Any prerequisite	NA	
4	L-T-P	3-0-2	
5	Learning Objectives of the subject	<ul><li>After the completion of the course, the students will be able to:</li><li>Recognize and apply the number systems and Boolean</li></ul>	
	J	algebra.	
		• Reduce Boolean expressions and implement them with Logic	
		Gates.	
		• Analyze, design and implement combinational and sequential circuits	
6	Brief Contents	Boolean algebra, K-maps, logic gates, Number Systems, Design	
		Introduction to digital logic families Data processing and	
		conversion: Sample and hold circuits, ADCs and DACs: Basic	
		memory circuits ROM, RAM and PLA.	
7	Contents for lab	Implementation of digital logic using switching circuits, Study of	
		universal gates, Design of a 1-bit Full Adder/Subtractor using	
		logic gates, Design and implementation of a 4-bit binary ripple,	
		adder using logic gates, 4 X 3 bit binary multiplier using logic	
		and gray to binary). Study of combinational MSI circuits – 1-bit	
		half/full adder 1-bit half/full subtractor and 1-bit magnitude	
		comparator. Study of sequential circuits – Implementation of	
		Flip-Flops, Design of a synchronous decade counter, Design of	
		4-bit parallel input serial output (PISO), shift-register.	
8	List of text	Text/ Reference Books:	
	books/references	• Digital Circuits and Logic Design by S. Lee, Prentice Hall	
		India.	
		• Digital Principles and Applications by D. P. Leach, A. P.	
		Malvino and G. Saha, McGraw Hill Education.	
		<ul> <li>Digital Design by M. M. Mano and M.D. Ciletti, Pearson, Prentice Hall</li> </ul>	
		<ul> <li>Digital Principles and Design by Donald D Givone.</li> </ul>	
		McGraw-Hill.	
		• Digital Design: Principles and Practices by John F Wakerly,	
		Pearson.	
		• Digital Electronics: Principles Design and Applications by	
		AK Maini.	
		• Digital Integrated Electronics by H. Taub and D. Schilling, McGraw Hill.	

1	Code of the subject	ES103		
2	Title of the subject	Probability and Statistics		
3	Any prerequisite	No		
4	L-T-P	3-1-0		
6	Learning Objectives of the subject (in about 50 words)	To introduce students about basics of probability theory and statistics.		
7	Brief Contents (module wise )	Introduction: Measures of Central Tendency, Measures of Dispersion, Measures of Skewness, and Measures of Kurtosis, Moments about mean and about any point. Probability: Basic terminology, Types of Probability, Probability rules, Bayes Theorem, Probability distribution, Binomial, Poisson, Negative-Binomial, Geometric, Hyper-geometric, Uniform, Exponential, Normal distribution, log-normal, beta and gamma distributions. Sampling: Types and Sampling Distribution, Random sampling, Relationship between sample size and standard error, Central limit theorem, Weak law of large numbers, estimation theory (MLE). Testing Hypotheses-1: One Sample Tests, Basics to hypotheses, Inference of single mean/proportion, Measuring the power of hypotheses test (z-test and t-test), P-values, interval estimation. Testing Hypotheses-2: Two Sample Tests, Testing for differences between means/proportions. Testing Hypotheses-3: Chi–Square distribution, Chi–Square as a test of independence, Testing the appropriateness of a distribution, Analysis of variance (ANOVA), Inference about a population variance (Chi-square test, F-test). Nonparametric tests (Self Study): The sign-test, Rank-sum, test of randomness, Kolmogorov-Smirnov, Anderson-Darling test. Simple Regression and Correlation: Estimation using the regression line, Correlation analysis, making inferences about population parameters. Multiple Regression: Multiple regression and correlation analysis, Finding multiple regression equation, Inferences about population parameters.		
8	Contents for lab	NA		
10	List of text books/references	<ol> <li>Johnson, R. A., Miller &amp; Freund's Probability and statistics for engineers, Pearson Education, 2000.</li> <li>Ross S. M., Introduction to Probability and Statistics for Engineers and Scientists 5th Edition, Elsevier.</li> <li>Hogg R. V., Craig A., Probability and Statistical Inference, 6th edition, Pearson Education.</li> </ol>		

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 of	To enable students to learn how to store data while maintaining
	the subject (in about 50 words)	the data's 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 (If applicable)	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. <i>Data Structures and Algorithms in Java</i> , 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	EE104
2	Title of the subject	Hardware Workshop
3	Any prerequisite	NA
4	L-T-P	1-0-4
5	Learning Objectives of the subject	<ul> <li>To familiarize students with various electronic devices and their specifications.</li> <li>Develop skill for Design and testing of different types of electronic subsystems using Analog and Digital IC's</li> <li>Familiarize students with PCB layout tool to prepare PCB print for assigned projects.</li> <li>Develop skills of writing a structured technical document for project and its presentation.</li> </ul>
		• Develop the ability to diagnose faults and their rectification.

(	6 Brief Contents	Familiarization /Identification of electronic components with
		specification and Functionality, type, size, colour coding,
		package, symbol, cost etc. Active, Passive, Electrical, Electronic,
		Electro-mechanical, Wires, Cables, Connectors, Fuses,
		Switches, Relays, Crystals, Displays, Fasteners, Heat sink,
		Arduino Uno, Rasberry Pi, ESP8266 Module, HC 05 Bluetooth
		Module.
		Drawing of electronic circuit diagrams using EDA tools,
		Interpret data sheets of discrete components and IC's, Estimation
		and costing, Familiarization/Application of testing instruments
		and commonly used tools like Multimeter, Function generator,
		Power supply, CRO etc. Soldering iron, De-soldering pump,
		Cutters, Wire strippers, Screw drivers, Hot air soldering and
		desoldering station etc., Testing of electronic components
		Resistor, Capacitor, Diode, Transistor etc. using multimeter and
		different IC's using IC tester, Design and fabrication of a single
		sided PCB for a simple circuit with manual etching, Assembling
		electronic circuit/system on general purpose PCB, testing and
-	7 Contonts for lab	show the functioning
	/ Contents for lab	Hardware Based Projects for smart city applications, industries,
		nealincare,
		development sector etc.
	Q List of toxt	Tayt/ Deference Books:
0	books/references	https://electronicsforu.com/
	books/references	<ul> <li>https://electronicsforu.com/tag/mini-projects.</li> </ul>
		• Electronics Lab Manual by K. A. Navas, PHI.
		• Electronic Projects in Workshop by R.A Penfold, Newnes Technical
		Books.
		• Electronic Designer's Handbook by T.K. Hamingway, Business Books Limited
		<ul> <li>Digital Circuits and Logic Design by S. Lee, Prentice Hall India.</li> </ul>
		• Digital Principles and Applications by D. P. Leach, A. P. Malvino and
		G. Saha, McGraw Hill Education.
		• Digital Design by M. M. Mano and M.D. Ciletti, Pearson, Prentice Hall.

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	1. HM Deitel and PJ Deitel —C++ How to Program, Seventh
	books/references	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	HS103	
2	Title of the subject	Ecology and Environment Sciences	
3	Prerequisite	No	
4	L-T-P	2-0-0	
5	Learning Objectives	<ul> <li>Upon course completion, students will be able to:</li> <li>1. Understand the basic principles of ecology and ecosystem function.</li> <li>2. Describe the interrelationships between land, sea, the atmosphere, and the living things that occupy these environments.</li> <li>3. Determine the role that humans play in affecting the characteristics of the environment.</li> <li>4. Evaluate current environmental issues and problems including the solutions and management practices that have been used</li> </ul>	
6	Brief Contents	<ul> <li>Environment and Human Intervention</li> <li>Environment: Definition, environment and ecology, importance of environment, need of public awareness, sustainable ecosystem, human activities, and environment- agriculture, transport, mining, Environmental Impact Assessment (EIA)</li> <li>Environmental Pollution</li> <li>Water pollution, waste-water treatment- case studies, land pollution, air pollution, noise pollution, Pollution and public health issues, pollution and environment, greenhouse effect</li> <li>Environment Protection Policies</li> <li>Environment policies, forests, biosphere reserves, flora and wildlife, environment laws/acts, environment and non-</li> </ul>	

r		
		government organizations, introduction to GST-CGST and
		SGS1, Swachn Bharat Abniyan- initiatives, responsibilities
		and future aspects, Cash-less economy-modes of payment-
		money transfer (advantages and disadvantages), Making in India
		concept.
		Applied issues in Ecology
		Sustainability, habitant degradation, degradation of urban and
		industrial landscape conservation threats to biodiversity
		avalutional acalegy
		evolutional ecology
7	Contents for lab	NA
8	Text /references	1. Townsend, C.R., Begon, M. and Harper, J.L., 2003.
		Essentials of ecology (Ed. 2). Blackwell Science.
		2. R. Rajagopalan, 2011. Environmental Studies, Oxford IBH
		Puh
		3. Martell, L., 2013. <i>Ecology and Society: An introduction</i> . John
		Wiley & Sons.

1	Code of the subject	CS104
2	Title of the subject	Mobile Application Technologies
3	Any prerequisite	
4	L-T-P	0-1-2
5	Learning Objectives	To develop the basic skills of using Android IDE and Android SDK for implementing Android applications
6	Brief Contents	Introduction, UX development, Testing and debugging of front end and back end application components and their interaction.
7	Contents for lab	Experiments are based on the theoretical contents and their applications
8	List of text books/references	<ol> <li>Android Programming: The Big Nerd Ranch Guide 4th Edition, Bill Phillips, Brian Hardy</li> <li>The Busy Coder's Guide to Android Development, Mark Murphy.</li> </ol>

1	Code of the subject	HS201
2	Title of the subject	Indian culture, Ethics and Morale
3	Prerequisite	No
4	L-T-P	2-0-0
5	Learning Objectives	<ul> <li>Upon course completion, students will be able to:</li> <li>1. Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field.</li> <li>2. Articulate what makes a particular course of action ethically defensible.</li> <li>3. Assess their own ethical values and the social context of problems.</li> <li>4. Evaluate the concept of karma that helps to maintain work life balance.</li> <li>5. Demonstrate contemporary approaches to leadership who incrines human heirs to reach their goals.</li> </ul>
6	Priof Contonts	Human Values and Ethics
		Morals, values and ethics-integrity, work ethics, service learning, civic virtue, respect for others, living peacefully, caring, sharing, honesty, courage, cooperation, commitment, empathy, self-confidence, character, spirituality. <b>Work Ethos and Values</b> Meaning of work ethos, levels, dimensions, steps, factors responsible for poor work ethos. Meaning of values, features, values for Indian managers, relevance of value- based management in global change, impact of values on stakeholders: employees, customers, government, competitors and society, values for managers, trans- cultural human values in management and management education, secular v/s spiritual values in management, importance of value system in work culture <b>Indian Ethos-An Overview</b> Meaning, features, need, history, relevance, principles practised by Indian companies, requisites, elements, role of Indian ethos in managerial practices, management lessons from Vedas, Mahabharata, Bible and Quran. <b>Contemporary Approaches to Indian Ethos</b> Contemporary approaches to leadership, joint Hindu family business, leadership qualities of karta, Indian systems of learning - gurukul system of learning, advantages- disadvantages of karma, importance of karma to managers, nish kama karma, laws of karma, law of creation, law of humility, law of growth, law of responsibility law of connection corporate karma
		leadership.
7	Contents for lab	NA

8	Text /references	1.	Khandelwal, N. M., 2011. Indian Ethos and Value for Management Himalaya Publishing House 1st Edition
		2.	Govindarajan, M., Natarajananad, S., SenthilKumar V.S., 2009.
			Engineering Ethics includes Human Values. PHI Learning Pvt.
			Ltd.
		3.	Nandagopal R., Ajith Rn., 2010. Indian Ethos and Values in
			Management. Tata McGraw Hill Education, 1st Edition.
		4.	Murthy, P.S.R., 2013. Indian Culture, Values and Professional
			Ethics. BS Publication

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	<ul> <li>1.Bernanrd Kolman, Robert C Busby, S.Ross, Discrete Mathematical Structures, PHI Learning</li> <li>2. Kenneth H. Rosen, Discrete Mathematics and Its Appications, Tata McGraw-Hill Edition</li> <li>3. I.N. Herstein, Topics in Algebra, John Wiley Publications</li> <li>4. Ralph P. Grimaldi, B.V. Ramana, Discrete and Combinatorial Mathematics, Pearson Education</li> </ul>

		-
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	
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	<ol> <li>Introduction to Algorithms (Eastern Economy Edition) by Thomas H Cormen and Charles E Leiserson.</li> <li>Design and Analysis of Algorithms by S Sridhar.</li> <li>Design and Analysis of Computer Algorithms by AHO.</li> </ol>

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	<ol> <li>Abraham Silberschatz, Henry Korth, and S. Sudarshan. Database Systems Concepts (5ed.). McGraw-Hill, New York, USA.</li> <li>Ramez A. Elmasri, Shankrant B. Navathe. Fundamentals of Database Systems Addison-Wesley Longman Publishing Co.</li> <li>Paul DuBois. Mysql. New Riders Publishing</li> <li>C. J. Date. Database in Depth: Relational Theory for Practitioners. O'Reilly Media, Inc.</li> <li>Bipin C. Desai. An Introduction to Database Systems. West Publishing Co.</li> </ol>

# **SEMESTER - IV**

1	Code of the subject	MS619
2	Title of the subject	Entrepreneurship and Innovation
3	Prerequisite	No
4	L-T-P	2-0-0
5	Learning Objectives	Course is designed for preparing students to take of
		Entrepreneurial journey on the basis of innovative ideas.
		The content is highly focused to start venture to making
		business mature up-to international level.
6	Brief Contents	Entrepreneurship, Creativity and innovation, Business
		planning process, Institutions supporting entrepreneurs,
		Family businesses, International entrepreneurship

		opportunities, Informal risk capital and venture capital,
		Managing growth.
7	Contents for lab	No

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	<ol> <li>Hopcroft J.E., Motwani R. and Ullman J.D, —Introduction to Automata Theory, Languages and Computations, Pearson Education.</li> <li>John C Martin, —Introduction to Languages and the Theory of Computation, TMH, New Delhi. REFERENCES</li> <li>Mishra K L P and Chandrasekaran N, —Theory of Computer Science – Automata, Languages and Computation, Third Edition, Prentice Hall of India 2.Harry R Lewis and Christos H Papadimitriou, —Elements of the Theory of Computation, Second Edition, Prentice Hall of India, Pearson Education, New Delhi.</li> <li>Peter Linz, —An Introduction to Formal Language and Automata, Third Edition, Narosa Publishers.</li> <li>KamalaKrithivasan and Rama. R, —Introduction to Formal Languages, Automata Theory and Computation, Pearson Education.</li> </ol>

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	<ol> <li>A. Silberschatz &amp; P.B. Galvin, Operating System concepts and principles, Wiley India.</li> <li>A. Tanenbaum, Modern Operating Systems', Prentice Hall India</li> <li>W. Stallings, _Operating Systems: Internals and design Principles, Pearson Ed.</li> <li>M.J. Bach, Design of Unix Operating system', Prentice Hall.</li> <li>Additional Reading:</li> <li>D.M. Dhamdere, Operating Systems: a concept based approach', Tata McGraw-Hill Pubs.</li> <li>G. Glass, Unix for programmers and users-a complete guide, Pearson Ed.</li> </ol>

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.

r		T
1	Code of the subject	EE201
2	Title of the subject	Signals & Systems
3	Any prerequisite	Engineering Mathematics
4	L-T-P	3-1-0
5	Learning Objectives of the subject	This course trains students for an intermediate level of fluency with signals and systems in both continuous time and discrete time, in preparation for more advanced subjects in digital signal processing (including audio, image and video processing), communication theory, and system theory, control and robotics
6	Brief Contents	Classification of signals, Continuous-time and discrete- time signals, Basic system properties, Discrete-time LTI systems: convolution sum, Continuous-time LTI systems, Properties of LTI systems, Causal LTI systems described by difference equations (Natural, Forced, and Complete Response), Representation of Periodic (Continuous Time & Discrete-Time) Signals Using Fourier Series, Continuous-time Fourier transform, the discrete-time Fourier transform (DTFT), discrete Fourier transform (DFT) Sampling theorem, Laplace transform, z-transform.
7	Contents for lab	NA
8	List of text books/references	<ul> <li>Signals and systems by A.V. Oppenheim, A.S. Willsky and S. H. Nawab, Prentice Hall India.</li> <li>Linear Systems and Signals by B. P. Lathi, Oxford University Press.</li> <li>Signals &amp; Systems by Simon &amp; Haykins, John Wiley &amp; Sons.</li> </ul>

	•	Digital Signal Processing: Principles, Algorithms and Applications by Proakis, PHI.

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 of the subject (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>J.A. Bondy and U.S.R. Murty: Graph Theory and Applications.</li> <li>West, Douglas B., Introduction to Graph Theory, Pearson Education, 2002.</li> <li>Mott J.L., Kandel, A. and Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 2001.</li> <li>Reinhard Diestel, Graph Theory, Springer International Edition, 2004.</li> <li>D.B. West: Introduction to Graph Theory, Prentice-Hall of India/Pearson, 2009</li> <li>Deo Narsingh, Graph Theory With Applications To Engineering And Computer Science, Prentice Hall of India, 1992.</li> </ol>

### <u>SEMESTER – V</u>

1	Code of the subject	MS603
2	Title of the subject	Business Economics
3	Any prerequisite	No
4	L-T-P	3-0-0
5	Learning Objectives	To equip students with the necessary theory and
		techniques and the ability to apply them in order to inform
		and enhance managerial decision making.

6	Brief Contents	Introduction to Economics; Nature and Scope of
		Management Economics, Significance in decision-making
		and fundamental concepts, Consumer behaviour and
		typical characteristics of Indian consumer, Consumer
		decision making process, Indian market: characteristics,
		Objectives of a firm, Demand Analysis, Law of Demand,
		Exceptions to the law of Demand, Determinants of
		Demand. Elasticity of Demand- Price, Income, Cross and
		Advertising Elasticity, Uses of Elasticity of Demand for
		managerial decision making, Measurement of Elasticity of
		Demand, Demand forecasting meaning, significance and
		methods, Supply Analysis, Law of Supply, Supply
		Elasticity, Analysis and its uses for managerial decision
		making, Production concepts & analysis, Production
		function, single variable-law of variable proportion, two
		variable-Law of returns to scale, Cost concept and
		analysis, short-run and long-run cost curves and its
		managerial use, Market Equilibrium and Average Revenue
		Concept, Market Structure: Perfect Competition, features,
		determination of price under perfect competition,
		Monopoly: Feature, pricing under monopoly, Price
		discrimination, Monopolistic: Features, pricing under
		monopolistic competition, product differentiation,
		Oligopoly: Features, kinked demand curve, cartels, price
		leadership, Pricing strategies Price determination, Full cost
		pricing, Product line pricing, Price skimming, Penetration
		pricing, National Income; Concepts and various methods
		of its measurement, Inflation, types and causes, Business
		cycle, Profit concept and major theories of profits;
		Dynamic Surplus theory, Risk & Uncertainty bearing
		theory and Innovation theory
7	<b>Contents for lab</b>	No

1	Code of the subject	EE206
2	Title of the subject	Microprocessor and Interfacing
3	Any prerequisite	EE103
4	L-T-P	3-0-2
5	Learning Objectives of	Upon completion of this course, the student will be able to:
	the subject	<ul> <li>To develop background knowledge and core expertise in microprocessor.</li> <li>To study the concepts and basic architecture of 8085, and 8086 processor.</li> <li>To know the importance of different peripheral devices and their interfacing to 8086.</li> </ul>
		<ul> <li>To know the design aspects of basic microprocessor.</li> <li>To write assembly language programs in microprocessor for various application</li> </ul>

6	Brief Contents	Microprocessors-Evolution and Introduction, Microprocessor based system, Origin of Microprocessor, Classification of Microprocessors, Types of Memory, I/O Devices, Technology Improvements Adapted to Microprocessors and Computers, Introduction to 8085 processor, Architecture of 8085, Microprocessor instructions, classification of instructions, Instruction set of 8085, Basic 80x86 Architecture, Role of Microprocessor in Micro Computer, Features of 8086, Internal Block Diagram of 8086, Execution Unit, Bus Interface Unit, Programming of x86 processor, Interrupt mechanism of x86 & Interfacing of chips, Advanced Processor Technologies Interfacing of Data Converters (D-To-A and A-To-D), Programmable Interfacing Devices Like 8255A PPI, 8253/8254 Timer, 8259A PIT, Serial I/O Concepts, SID And SOD, 8251A USART. Interfacing of above chips with 8085.
7	Contents for lab	Assembly language programs for 8085 and 8086, Programs involving Arithmetic & logical operations, Programs involving data transfer instructions, programs involving bit manipulation instructions, programs involving branch/ loop instructions, Interfacing Experiments.
8	List of text books/references	<ul> <li>Text/ Reference Books:</li> <li>Microprocessors and Interfacing by Douglas V. Hall</li> <li>The 8051 Microcontroller and Embedded Systems by M.A. Mazidi and J. G. Mazidi, PHI.</li> <li>The Intel Microprocessors by Barry B. Brey, Prentice Hall.</li> <li>The 8088 and 8086 Microprocessors by Walter A. Triebel, Avtar Singh, Prentice Hall Inc.</li> <li>8086/8088 family: Design, Programming and Interfacing by John Uffenbeck, Prentice Hall.</li> <li>Advanced Microprocessor and Peripherals, Architecture Programming and Interfacing by A. K. Ray and K. M. Burchandi, Tata McGraw Hill.</li> <li>Microcontroller and Embedded Systems by M. A. Mazidi, Pearson Education.</li> <li>8051 Microcontroller and Embedded Systems by R. Kapadia, Jaico Publishing House.</li> <li>Fundamentals of Microprocessors and Microcomputers by B. Ram, Dhanpat Rai Publications.</li> </ul>

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	<ol> <li>Alfred V. Aho, Monica S.Lam, Ravi Sethi, Jeffrey D.Ullman, Compilers : Principles, Techniques and Tools, Second Edition, Pearson Education.</li> <li>Randy Allen, Ken Kennedy, Optimizing Compilers for Modern Architectures: A Dependence-based Approach, Morgan Kaufmann Publishers.</li> <li>Steven S. Muchnick, Advanced Compiler Design and Implementation, Morgan Kaufmann Publishers - Elsevier Science, India, Indian Reprint.</li> <li>Keith D Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann Publishers Elsevier Science.</li> <li>V. Raghavan, Principles of Compiler Design, Tata McGrawHill Education Publishers.</li> </ol>

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	<ol> <li>Computer Graphics, C Version Donald D Hearn, M. Pauline Baker</li> <li>Computer Graphics: Principles and Practiceby James</li> <li>Foley, Andries van Dam , Steven K. Feiner</li> </ol>

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	<ol> <li>S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 2nd Ed, Prentice Hall, 2003</li> <li>Elaine Rich and Kevin Knight. Artificial Intelligence, Tata McGraw Hill Reference Books:         <ol> <li>Patrick Henary Winston, Artificial Intelligence, Pearson publication</li> <li>Deepak Khemani. A First Course in Artificial Intelligence, McGraw Hill Education (India)</li> <li>Eugene Charnaik and Drew McDermott, Introduction to Artificial Intelligence, Pearson publication</li> <li>Nils John Nilsson, The Quest for Artificial Intelligence: A History of Ideas and Achievements, Morgan Kaufman</li> <li>Dennis Rothman, Artificial Intelligence by Example</li> </ol> </li> </ol>

## <u>SEMESTER – VI</u>

1	Code of the subject	ENxxx
2	Title of the subject	Art of Engineering Research
3	Prerequisite	Engineering mathematics, programming
4	L-T-P	2-0-0
5	Learning Objectives	<ul> <li>Knowledge and understanding to recognize the ethical principles of conducting applied research, to identify various sources of information, to identify and formulate research problem.</li> <li>Intellectual skills to carry out literature searches and ability to critically evaluate literature, to design/conduct experiments, devise appropriate measurements, analyse data and form conclusions.</li> <li>Professional and practical skills to undertake and manage a research projects, to document all aspects of the development of an engineering project.</li> <li>General and transferrable skills to apply project management skills to research activities, to communicate effectively in written and oral ways</li> </ul>
6	Brief Contents	<ul> <li>Introduction and Overview: Introduction to Research Methodology, Research types and applications, Research management, Research phases, Research problem formulation, Academic honesty.</li> <li>Literature Review: How to read journal papers, Literature review process, Information sources, Synthesizing information, Writing the literature review, Referencing.</li> <li>Thesis Proposals: Thesis Proposal main sections, How to write Thesis Proposals.</li> <li>Modeling and Simulation: MATLAB Tool Boxes overview, Building math models in MATLAB or any other tool, Simulation and results analysis.</li> <li>Engineering Experiments: Experiment set-up (Lab Work), Running experiments (Lab Work), Data collection and analysis.</li> <li>Writing Research Papers: How to write research paper, Technical writing, Where to submit, How to submit.</li> <li>Writing and submit research paper.</li> </ul>
7	Text /references	<ol> <li>Engineering Research Methodology: A Computer Science and Engineering and Information and Communication Technologies Perspective by Krishnan Nallaperumal 1st edition PHI Learning Privtae Limited, New Delhi, India 2014</li> </ol>

2. Research Methodology: Methods and Techniques by
Kothari 2nd edition 2004
3. Research Guide for Post-Graduate Students by Andre
Buys. University of Pretoria 2007
4. Emerging Methodologies in Engineering Education
Research by Case and Light, Journal of Engineering
Education 2011
5. Designing Requirements Engineering by Wieringa and
Heerkens
6. Development Research Methods: Creating Knowledge
from Instructional Design and Development Practice by
Richev and Klein. Journal of Computing in Higher
Education 2005
7. Scientific Research Methodologies and Techniques by
Luis Camarinha-Matos
8 How to Read an Engineering Research Paper by
William Griswold UC at San Diago
Winnani Griswold, CC u Sun Diago
10 How to Write an Effective Literature Review by
Sonia Martinez, University of California
11 Models of Dissertation Research in Design by
Poggennahl and Sata Illinois Institute of Technology
12 On the ability to design anging avantiments by
Du European and Mourtes, 8th LICEE A april
Du, Furman, and Mourios. Sin UICEE Annual
Conference on Engineering Education
13. How to write a research journal article in engineering
and science by Socolofsky

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 of the subject (in about 50 words)	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 (If applicable)	Experiments will be based on the theory covered as above.
8	List of textbooks/references	<ol> <li>Boyd, Stephen, Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.</li> <li>D. Bertsekas Nonlinear programming, 2nd Edition, Athena Scientific, 1999, Nashua.</li> <li>V. Chvatal Linear programming, W. H. Freeman, 1983, New York.</li> <li>E. K. P. Chong and S. Zak, An introduction to optimization, 2nd Edition, 2004, John Wiley and Sons (Asia) Pvt. Ltd., Singapore</li> <li>R. Fletcher, Practical methods of optimization, 2nd Edition, Wiley, 2000, New York</li> <li>D. Luenberger, Linear and nonlinear programming, 2nd Edition, 1984, Kluwer Academic Publisher, New York</li> <li>O. L. Mangasarian, Nonlinear programming, SIAM, 1987, Philadelphia</li> </ol>

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 of the subject (in about 50 words)	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 (If applicable)	Experiments will be based on the theory covered as above.
8	List of textbooks/references	1. Christopher Bishop. Pattern Recognition and Machine Learning, 2 <sup>nd</sup> Edition
		2. Ethem Alpaydin, Introduction to Machine Learning, 2 <sup>nd</sup> Edition.
		3. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2 <sup>nd</sup> 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 of the subject (in about 50 words)	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 (If applicable)	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, 2 <sup>nd</sup> Edition. Pearson Education India, 2010.

## <u>SEMESTER – VII</u>

1	Code of the subject	EE404
2	Title of the subject	IC Technology
3	Any prerequisite	Nil
4	L-T-P	3-0-0
5	Learning Objectives of	Students will be able to learn:
	the subject	<ul> <li>Fundamental principles of fabrication of VLSI devices and circuits.</li> <li>To demonstrate a clear understanding of CMOS fabrication flow and technology scaling</li> <li>To demonstrate a clear understanding of various MOS</li> </ul>
		fabrication processes, semiconductor measurements, packaging testing and advanced semiconductor technologies.
6	Brief Contents	Historical perspective, processing overview, crystal growth, wafer fabrication and basic properties of Silicon Wafers, Clean Rooms, Wafer Cleaning, Epitaxy, Thermal Oxidation of Silicon, Lithography, Wet and Dry Etching, Thin film deposition technique (ALD), Diffusion, Ion Implantation, Metallization, Process Integration: Passive components, Bipolar Technology, MOSFET Technology, CMOS Technology, MESFET Technology, MEMS Technology, IC Manufacturing: Electrical Testing, Packaging, Yield, Future trends and Challenges: Challenges for integration, system on chip, Novel Devices.
7	Contents for lab	NA
8	List of text books/references	<ul> <li>Text/ Reference Books:</li> <li>Fundamentals of Semiconductor Fabrication by G. S. May and S. M. Sze, Wiley.</li> <li>Silicon VLSI Technology, Fundamentals, Practice and Modeling by J. D. Plummer, M. D. Deal and P. B. Griffin, Pearson education.</li> <li>VLSI Technology by S. M. Sze, TMH.</li> <li>Semiconductor Devices: Physics and Technology by S. M. Sze, Wiley.</li> <li>Semiconductor Integrated Circuit Processing Technology by W. R. Runyan and K. E. Bean, Addison Wesley Publishing Company</li> </ul>

	•	The Science and Engineering of Microelectronic Fabrication by S. A. Campbell, Oxford University Press. Fundamentals of Microfabrication by M. J. Madou, CRC Press.
		T undamentals of Wherofabrication by Wi. J. Madou, CRC Tress.

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	<ol> <li>Cloud Computing: Principles and Paradigms, Editors: RajkumarBuyya, James Broberg, Andrzej M. Goscinski, Wiley</li> <li>Enterprise Cloud Computing - Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press</li> <li>Cloud Computing Bible, Barrie Sosinsky, Wiley-India</li> <li>Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley</li> </ol>

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	<ol> <li>Digital Image Processing 2nd Edition, Rafael C.</li> <li>Gonzalvez and Richard E. Woods. Published by: Pearson Education.</li> <li>R.J. Schalkoff ,Digital Image Processing and Computer Vision John Wiley and Sons, NY.</li> <li>William K. Prat, Digital Image Processing, John Wiley and Sons, NY</li> </ol>

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.
/	Contents for lab (11 applicable)	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	IT498
2	Title of the subject	Colloquium (Based on industrial training)/ MOOC
3	Prerequisite	
4	L-T-P	0-0-6
5	Learning Objectives of the subject	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	<ol> <li><u>https://www.careereducation.columbia.edu/resources/10-tips-make-most-internship</u></li> <li><u>https://in.indeed.com/career-advice/career-advi</u></li></ol>

## <u>SEMESTER – VIII</u>

1	Code of the subject	IT499
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

## **Electives**

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 about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Forsyth and Ponce, Computer vision: A modern approach, Pearson, 2002.</li> <li>Simon J.D. Prince, Computer vision: models, learning and inference, Cambridge University, 2012.</li> <li>E. R. Davies, Computer Vision: Principles, Algorithms, Applications, Learning, Academic Press; 5th edition, 2017</li> </ol>

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 (in about 50 words)	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 (If applicable)	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 (in about 50 words)	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 (If applicable)	N/A

8	List of books/references	text	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.
			<ol> <li>Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.</li> </ol>
			<ol> <li>Lawrence R. Rabiner, Ronald W. Schafer, Digital Processing of Speech Signals</li> </ol>

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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>David A. Grossman and Ophir Frieder, Information Retrieval- Algorithms and Heuristic, second edition. Publisher: Springer.</li> <li>R. Baeza-Yates and B. Ribeiro-Neto, "Modern Information Retrieval".</li> <li>S. Büttcher, C. Clarke, and G. Cormack, Information Retrieval: Implementing and Evaluating Search Engines</li> </ol>

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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Alan Dix, Janet E. Finlay, Gregory D. Abowd, Russell Beale, Human-Computer Interaction. Harlow, England: Prentice Hall, 2004.</li> <li>Yvonne Rogers, Helen Sharp, Jenny Preece, Interaction Design: Beyond Human Computer Interaction, 3rd Edition, Wiley, 2011</li> <li>Preece, Jenny, et al. Human-computer interaction. Addison-Wesley Longman Ltd., 1994.</li> </ol>

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	At the end of this course, students will able to understand
	the subject (in about	the knowledge within the area of intelligent video
	50 words)	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 Jab (If	N/A
/	applicable)	
8	List of text	1. Alan Bovik, The Essential Guide to Video
	books/references	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 course objectives are to expose students to learn
	the subject (in about 50	several advanced machine learning topics including
	words)	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 (If	N/A
	applicable)	
8	List of text	1 Goodfellow Ian Yoshua Bengio and Aaron Courville
Ŭ	hooks/references	Deep learning, MIT press, 2016.
	boons, references	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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Alan Bovik, The Essential Guide to Video Processing.</li> <li>Mark Nelson, <i>The Data Compression Book</i>, M&amp;T Books, 1995.</li> <li>Khalid Sayood, <i>Introduction to Data Compression</i>, Morgan Kaufmann, 1996.</li> <li>J.F.K, Buford, Multimedia Systems, ACM Press, 1994</li> </ol>

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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, Morgan Kauffman, Digital Watermarking and Steganography, 2007</li> <li>Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Morgan Kauffman, Digital Watermarking principles, 2007.</li> <li>Introduction to Watermarking Techniques and Applications, AP Lambert Academic, 2020</li> </ol>

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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>G. J. Awcock, Ray Thomas, Applied Image Processing, McGraw-Hill, 1996</li> <li>Rafael C. Gonzalvez and Richard E. Woods, Digital Image Processing 2nd Edition, Published by: Pearson Education.</li> <li>R.J. Schalkoff, Digital Image Processing and Computer Vision John Wiley and Sons, NY.</li> <li>William K. Prat, Digital Image Processing, John Wiley and Sons, NY.</li> </ol>

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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Hoseyin Arslan (Ed.), "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems," Ser. Signals and Communication Technology, xviii, I. edition, Springer, Aug. 2007</li> <li>Joseph Mitola, III, "Cognitive Radio Architecture: The Engineering Foundations of Radio XML," John Wiley and Sons Ltd., 2006.</li> <li>Kwang-Cheng Chen and Ramjee Prasad, —Cognitive Radio Networks, John Wiley &amp; sons, 2009.</li> <li>Ahmed Khattab, Dmitri Perkins, Magdy Bayoumi, —Cognitive Radio Networks: From Theory to Practice, Springer, 2013.</li> </ol>

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	After successful completion of this course students will
5	Learning Objectives of	After successful completion of this course, students will
	the subject (in about 50	able to learn emerging network technologies, their
	words)	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 I ANS WANS Ontical Networks Wire-line
		and Wireless Networks. General nacket radio service
		(CDDS), CDDS and neglect data network network
		(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 (If	N/A
,	annlicable)	
	appricable)	
8	List of text	1. Neill Wilkinson, "Next Generation Networks Services,
	books/references	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.
		5. Iti Saha Misra, "Wireless Communications and
		Networks, 3G and beyond", TMH, 2013

1	Code of the subject	IT013
2	Title of the subject	Queuing Theory
3	Any prerequisite	Basic knowledge of Engineering Mathematics and Statistics
4	L-T-P	3-0-0
5	Learning Objectives of the subject (in about 50 words)	To teach the applications of queuing theory related to computer networks.

6	Brief Contents	<ul> <li>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.</li> <li>Transition probabilities, Limiting distributions, Poisson Process - Properties, Poisson Process - Problems</li> <li>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.</li> <li>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.</li> <li>Priority queues-Queues with preemption, queues with time dependent priorities</li> </ul>
		Series queues, Open Networks, Closed Networks, batch service, batch arrival.
7	Contents for lab (If applicable)	N/A
8	List of text books/references	<ol> <li>K. S. Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, John Wiley and Sons, 2nd edition, 2002.</li> <li>A.O. Allen, Probability, Statistics and Queuing Theory with Computer Applications, Elsevier, 2nd edition, 2005.</li> <li>Srivastava, H. M., &amp; Kashyap, B. R. K. (1982). Special functions in queuing theory and related stochastic processes. ACADEMIC PRESS.</li> <li>Dimitri P. Bertsekas and Robert G. Gallager, "Data Networks," (2nd edition) Prentice Hall, 1992</li> <li>Leonard Kleinrock, Wiley-Interscience, Queueing Systems, Volume I; 1st edition (1 January 1975).</li> </ol>

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 (in about 50 words)	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 (If applicable)	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 Communication Theory
4	L-T-P	3-0-0
5	Learning Objectives of the subject (in about 50 words)	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.
		5)	A. Osseiran, J. F. Monserrat and P. Marsch, "5G Mobile and Wireless Communications Technology", 2016.

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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Multimedia Communications: Protocols and Applications, Prentice Hall, 1998</li> <li>Multimedia Communications: Protocols and Applications, F. Kuo, W. Effelsberg, and J.Garcia- Luna-Aceves, Prentice Hall PTR, 2000</li> <li>Multimedia over IP and Wireless Networks: Compression, Networking, and Systems, by M. Van der Schaar, P. Chou, Academic Press, 2007.</li> <li>Multimedia Communications Applications, Networks, Protocols and Standards Fred Halsall, Addison Wesley, 2001</li> </ol>

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 (in about 50 words)	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	<b>Brief Contents</b>	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Alasdair Gilchrist (Apress), "Industry 4.0: The Industrial Internet of Things"</li> <li>Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), "Industrial Internet of Things: Cyber manufacturing Systems".</li> <li>White papers and research articles.</li> </ol>

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, probability and random process.
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 (If applicable)	N/A	
8	List of text books/references	<ol> <li>H. L. Van Trees, Detection, Estimation and Modulation Theory, John Wiley and sons 2004.</li> <li>Signal detection and estimation by Mourad Barkat, Artech House 1991.</li> <li>An Introduction to Signal Detection and Estimation by Poor, H. Vincent, Springer 1998.</li> </ol>	

1	Code of the subject	IT019
2		
2	litle 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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Von Bochmann, Gregor, "Concepts for distributed systems design", Springer Science &amp; Business Media, 2012.</li> <li>Van Steen, Maarten, and Andrew S. Tanenbaum, "Distributed systems".</li> <li>Sukumar Ghosh, "Distributed systems", CRC Press</li> <li>Ajay D. Kshemkalyani and Mukesh Singhal, "Distributed computing: Principles, algorithms and systems", Cambridge press.</li> </ol>

1	Code of the subject	IT020
2	Title of the subject	Information Theory and Coding
3	Any prerequisite	Students should have brief idea about linear algebra.
4	L-T-P	3-0-0
5	Learning Objectives of the subject (in about 50 words)	This course gives brief knowledge about the basic algebraic relationships of entropy, relative entropy, and mutual information. In this course students are going to 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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Joy A. Thomas and Thomas M. Cover, Elements of Information Theory, John Wiley and Sons.</li> <li>John G. Proakis, McGraw Hill, Digital Communication Singapore, 4<sup>th</sup> Edition, 2001.</li> <li>Bernard Sklar, Digital Communications: Fundamentals and Applications, 2nd Ed., Pearson Prentice Hall, 2001.</li> </ol>

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 (in about 50 words)	To learn the concepts and applications of optimization for solving real world problems.
6	Brief Contents	<ul> <li>Linear Programming: Convex sets, Mathematical Model, Assumptions of linear programming, Graphical method Simplex method, Big M Method, Two-Phase Method, Exceptional cases in LPP.</li> <li>Duality in Linear Programming: Dual simplex method, revised simplex method, sensitivity or Post-optimal analysis, Transportation problem, Assignment Problem.</li> <li>Integer Programming Problem: Cutting plane method, Gomory's cut method, Branch and bound technique, Travelling salesman problem, Cargo loading problem.</li> <li>Non-linear Programming: Quadratic forms and classical methods, Convex functions and Kuhn-Tucker theory, Beale's method, Separable programming.</li> <li>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.</li> </ul>
7	Contents for lab (If applicable)	N/A
8	List of text books/references	<ol> <li>Taha, H.A., 1992. Operations Research (5th edn), Prentice Hall Publication.</li> <li>Hillier, F.S. and Lieberman, G.J., 1967. Introduction to operations research. San Francisco: Holden-Day.</li> <li>Ravindran, A, Phillips, DT, Solberg, JJ. 1987. Operations Research: Principles and Practice, John Wiley &amp; Sons</li> <li>Boyd, Stephen, Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.</li> </ol>

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 (in about 50 words)	The objective of the course makes students familiar about Digital watermarking and steganography.

6	Brief Contents	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
7	Contents for lab (If applicable)	N/A
8	List of text books/references	<ol> <li>Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, Morgan Kauffman, Digital Watermarking and Steganography, 2007.</li> </ol>
		<ol> <li>Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Morgan Kauffman, Digital Watermarking principles, 2007</li> </ol>
		<ol> <li>Frank Y. Shih, Digital Watermarking and Steganography: Fundamentals and Techniques, Second Edition CRC Press.</li> </ol>

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 (in about 50 words)	To enhance the ability to analyse, identify and define the computing requirements for data security.

6	Brief Contents Contents for lab (If	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. N/A
	applicable)	
8	List of text books/references	<ol> <li>William Stallings, Cryptography and Network security,</li> <li>4e, Prentice Hall of India, New Jersey, 2008.</li> <li>Christof Paar, Jan Pelzl, Understanding Cryptography,</li> <li>Springer-Verlang, Berlin, 2010</li> <li>Behrouz A Forouzan, Cryptography and Network security, Tata Mc-Graw Hill, New York, 2007.</li> </ol>

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 (in about 50 words)	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 defenses 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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Anirban Chakrabarti, Distributed Systems Security: Issues, Processes and Solutions 1st Edition by Abhijit Belapurkar (Author), Wiley, 2009.</li> <li>Ajay D. Kshemkalyani and MukeshSinghal, "Distributed Computing: Principles, Algorithms, and Systems", Cambridge University Press, 2011.</li> <li>Andrew S. Tanenbaum and Maarten van Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Pearson Prentice-Hall, 2007.</li> </ol>

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 (in about 50 words)	To realize the activities carried using forensic technologies in detection of cyber crime. 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	<b>Brief Contents</b>	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 (If applicable)	N/A

8	List of	text	1.Raghu Santanam, Sethumadhavan, MohitVirendra, Cyber
	books/references	1	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 (in about 50 words)	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 protos: Touch of complexity theory, SHA-3 news, 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 (If applicable)	N/A

8	List of	text	1.	Douglas R. Stinson, Cryptography: Theory and Practice, CRC
	books/references			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	IT028
2	Title of the subject	Malware Analysis
3	Any prerequisite	Networks and Operating Systems, A general understanding of computer security.
4	L-T-P	3-0-0
5	Learning Objectives of the subject (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Michael Sikorski and Andrew Honig, Practical Malware Analysis, No Starch Press,2012</li> <li>Reverend Bill Blunden, The Rootkit Arsenal: Escape and Evasion in the Dark Corners of the System, Second Edition</li> <li>Jamie Butler and Greg Hoglund, Rootkits: Subverting the Windows Kernel.</li> <li>Dang, Gazet, Bachaalany, Practical Reverse Engineering, Wiley,2014</li> </ol>

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 (in about 50 words)	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 (If	N/A
	applicable)	
8	List of text	1. Edward Griffor, Handbook of System Safety and Security.
	books/references	<ol> <li>Ulrich Kühne, Rolf Drechsler, Formal Modeling and Verification of Cyber-Physical Systems.</li> <li>Michael Huth and Mark Ryan, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge Univ. Press, 2nd edition</li> </ol>

1	Code of the subject	IT030
2	Title of the subject	IoT and its security
3	Any prerequisite	Computer Basics
4	L-T-P	3-0-0
5	Learning Objectives of the subject (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Chintan Patel Nishant Doshi, Internet of Things Security: Challenges Advances and Analytics, T&amp;F/CRC Press.</li> <li>Cheruvu, Apress, Demystifying Internet of Things Security.</li> <li>Al-Turjman, Security In Iot-Enabled Spaces, CRC Press.</li> <li>Russell, Brian and Drew Van Duren, Practical Internet of Things Security, Packt Publishing, 2016.</li> </ol>

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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Narayanan, Arvind, et al. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.</li> <li>Lewis, Antony. The basics of bitcoins and blockchains: an introduction to cryptocurrencies and the technology that powers them. Mango Media Inc., 2018.</li> <li>Antonopoulos, Andreas M. Mastering Bitcoin: unlocking digital cryptocurrencies. " O'Reilly Media, Inc.", 2014.</li> </ol>

1	Code of the subject	IT032
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 (in about 50 words)	To learn the concepts and applications of optimization for solving real world problems.
6	Brief Contents	<ul> <li>Linear Programming: Convex sets, Mathematical Model, Assumptions of linear programming, Graphical method Simplex method, Big M Method, Two-Phase Method, Exceptional cases in LPP.</li> <li>Duality in Linear Programming: Dual simplex method, revised simplex method, sensitivity or Post-optimal analysis, Transportation problem, Assignment Problem.</li> <li>Integer Programming Problem: Cutting plane method, Gomory's cut method, Branch and bound technique, Travelling salesman problem, Cargo loading problem.</li> <li>Non-linear Programming: Quadratic forms and classical methods, Convex functions and Kuhn-Tucker theory, Beale's method, Separable programming.</li> <li>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.</li> </ul>
7	Contents for lab (If applicable)	N/A
8	List of text books/references	<ol> <li>Taha, H.A., 1992. Operations Research (5th edn), Prentice Hall Publication.</li> <li>Hillier, F.S. and Lieberman, G.J., 1967. Introduction to operations research. San Francisco: Holden-Day.</li> <li>Ravindran, A, Phillips, DT, Solberg, JJ. 1987. Operations Research: Principles and Practice, John Wiley &amp; Sons</li> <li>Boyd, Stephen, Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.</li> </ol>

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 subject (in about 50 words)	The Course exposes the learner to know the various parallel and distributed computing paradigms.
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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Chandra et al, —Parallel Programming in OpenMP, Morgan Kaufmann.</li> <li>Chapman, Jost, and van der Pas, —Using OpenMP: Portable Shared Memory Parallel Programming, MIT Press.</li> <li>Tanenbaum, Andrew S. Distributed operating systems. Pearson Education India, 1995.</li> <li>Programming Massively Parallel Processors (3rd Edtion)</li> </ol>

-		-
1	Code of the subject	IT034
2	Title of the subject	Scientific Computing and Numerical Methods
3	Any prerequisite	Basic 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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Balagurusamy, E., Numerical Methods, Tata McGraw Hill Education Pvt. Ltd., 1999.</li> <li>Sastry, S. S., Introductory Methods of Numerical Analysis, PHI Learning Pvt Ltd., 2012.</li> <li>Jain, M. K., Iyengar, S.R.K and Jain, R.K, Numerical Methods for Scientific and Engineering computation, Wiley Eastern Ltd., 1985.</li> </ol>

1	Code of the subject	IT035
2	Title of the subject	Game Theory
3	Any prerequisite	Basic knowledge of Engineering Mathematics and Statistics
4	L-T-P	3-0-0
5	Learning Objectives of the subject (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	1. Martin Osborne, An Introduction to Game Theory, Oxford
		2 Duality Press, 2005
		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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Kuan-Ching Li, Hai Jiang, Laurence T. Yang, and Alfredo Cuzzocrea. Big Data: Algorithms, Analytics, and Applications. Chapman &amp; Hall/CRC Big Data Series, 2015.</li> <li>Thomas Erl, Wajid Khattak, and Dr. Paul Buhler. Big Data Fundamentals: Concepts, Drivers &amp; Techniques. The Prentice Hall Service Technology Series, 2016.</li> <li>Wajid Khattak, Paul Buhler, Thomas Erl, Big Data Fundamentals: Concepts, Drivers &amp; Techniques, John Wiley &amp; Sons, Inc</li> </ol>

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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>S N Sivanandam and S N Deepa, Principles of Soft Computing, Wiley India</li> <li>Andries P. Engelbrecht, Computational Intelligence: An Introduction, Jhon Wiley &amp; Sons.</li> <li>S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, PHI.</li> </ol>

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 (in about 50 words)	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, Adam.
7	Contents for lab (If applicable)	N/A
8	List of text books/references	<ol> <li>Ian Goodfelllow, Yoshua Benjio, Aaron Courville, Deep Learning-, The MIT Press.</li> <li>Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, John Wiley &amp; Sons Inc.</li> <li>Wani, M. Arif, et al. Advances in deep learning. Springer, 2020.</li> </ol>

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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Edsger Wybe Dijkstra. A Discipline of Programming. Prentice Hall PTR, Upper Saddle River, NJ, USA, 1997.</li> <li>Michael Huth and Mark Ryan. Logic in Computer Science: Modelling and Reasoning about Systems. Cambridge University Press, New York, NY, USA, 2004.</li> <li>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.</li> </ol>

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 (in about 50 words)	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 (If applicable)	N/A
8	List of text books/references	<ol> <li>Halim, Steven, Felix Halim, and Suhendry Effendy. Competitive programming 4: The new lower bound of programming contests in the 2020s, 2018.</li> <li>Laaksonen, Antti. Guide to competitive programming. Cham: Springer, 2020.</li> <li>Skiena, Steven S., and Miguel A. Revilla. "Programming challenges: The programming contest training manual." Acm SIGACT News 34.3 (2003): 68-74.</li> </ol>