Course Structure

Department of Engineering Sciences

BTech. in Mathematics and Scientific Computing

(From Batch 2023)

ABV-Indian Institute of Information Technology & Management, Gwalior

4 year (8 semester) B.Tech. in Mathematics and Scientific Computing

Total credits 182

Semester-1

Sl No	Code	Name of the course	L-T-P	Credit
1.	EE101	Fundamentals of Electrical and Electronics	3-0-2	4
2.	ES101	Engineering Physics	3-0-2	4
3.	ES102	Engineering Mathematics	3-1-0	4
4.	EE102	Engineering Design Principles	2-0-2	3
5.	CS101	Principles of Computer Programming	3-0-2	4
6.	HS101	Freshman Skills	2-0-0	2
7.	HS102	Sports and Physical Education	0-1-2	2
			Total Credits	**23**

Semester-2

Sl No	Code	Name of the course	L-T-P	Credit
1.	EE103	Digital Electronics	3-0-2	4
2.	ES103	Probability and Statistics	3-1-0	4
3.	CS102	Data Structures	3-0-2	4
4.	EE104	Hardware Workshop	1-0-4	3
5.	IT103	Object Oriented Programming	3-0-2	4
6.	HS103	Ecology and Environment Sciences	2-0-0	2
7.	CS104	Mobile Application Technologies	0-1-2	2
			Total Credits	**23**

***Summer Project or MOOC (Optional) of 2 credits**

Exit after 1st year (46 credits) leads to "Certificate in (Engineering Sciences)"

Semester-3

Sl No	Code	Name of the course	L-T-P	Credit
1.	HS201	Indian Culture, Ethics and Moral Values	2-0-0	2
2.	ES201	Discrete Structures	3-1-0	4
3.	ES202	Differential Equations and Integral Transforms	3-0-0	3
4.	ES203	Real and Functional Analysis	3-0-0	3
5.	CS203	Design and Analysis of Algorithms	3-0-2	4
6.	CS204	Database Systems	3-0-2	4
7.	ES204	Complex Analysis	3-0-0	3
			Total Credits	**23**

Semester-4

Sl No	Code	Name of the course	L-T-P	Credit
1.	MS619	Entrepreneurship and Innovation	2-0-0	2
2.	CS207	Operating Systems	3-0-2	4
3.	CS210	Software Engineering	3-0-2	4
4.	EE206	Microprocessor and Interfacing	3-0-2	4
5.	ES204	Multivariate Data Analysis	3-0-2	4
6.	ES205	Advanced Numerical Methods	3-0-0	4
			Total Credits	**22**

***Summer Project-1**

Exit after 2nd year (91 credits) leads to "Diploma in Mathematics & Scientific Computing"

Semester-5

Sl No	Code	Name of the course	L-T-P	Credit
1.	ES301	Fuzzy Sets and Applications	3-0-0	3
2.	ES302	Trustworthy Artificial Intelligence	3-0-2	4
3.	ES303	Vector Calculus	3-0-0	3

4.	CS302	Computer Graphics	3-0-0	3
5.	ES304	Software Reliability	3-0-0	3
6.	ES0XX	Department Elective-1		3/4
7.	ES0XX	Department Elective-2		3/4
8.	MS603	Business Economics	3-0-0	3
			Total Credits	**25-27**
			MOOC Course (Optional)	2

Semester-6

Sl No	Code	Name of the course	L-T-P	Credit
1.	ES305	Quantum Computing	3-0-0	3
2.	ES306	Optimization Techniques	3-1-0	4
3.	ES307	Statistical Inference	3-1-0	4
4.	ES308	AI and Machine Learning	3-0-0	3
5.		Multidisciplinary/Open Elective-1/MOOC		3/4
6.		Department Elective -3		3/4
7.	ENXXX	Art of Engineering Research	3-0-0	3
			Total Credits	**23-25**
			MOOC, NPTEL Course (Optional)	2

***** Colloquium of 2 credits in summer semester (MOOC, NPTEL etc. in lieu of colloquium)

Exit after 3rd year (143 credits) leads to "BSc in Mathematics & Scientific Computing"

Semester-7

Sl No	Code	Name of the course	L-T-P	Credit
1.	ES401	Modelling and Simulation	3-0-2	4
2.	ES402	Data Mining and Data warehousing	3-0-2	4
3.	ES403	Advanced Graph Theory	3-0-0	3

4.	ES404	Modern Cryptography	3-0-2	4
5.		Multidisciplinary/Open Elective-2/MOOC		3/4
6.	ES0XX	Department Elective-4		3/4
7.	ES498	Colloquium (Based on industrial training)/MOOC	0-0-6	3
			Total Credits	**24-25**

Semester-8

Sl No	Code	Name of the course	L-T-P	Credit
1.	ES499	Internship/ BTech Project	0-0-24	12
2.		Multidisciplinary/Open Elective- 3/MOOC		3/4
			Total Credits	**15-16**

Exit after 4th year (182-188 credits) leads to "B.Tech. in (Mathematics & Scientific Computing)

Minor in Mathematics and Scientific Computing

Sl No	Code	Name of the course	L-T-P	Credit
1.	ES205	Advanced Numerical Methods	3-0-2	4
2.	ES203	Real and Functional Analysis	3-0-0	3
3.	ES204	Multivariate Data Analysis	3-0-2	4
4.	ES301	Fuzzy Sets and Applications	3-0-0	3
5.	ES401	Modelling and Simulation	3-0-2	4
6.	ES307	Statistical Inference	3-1-0	4

NOTE: A Minor in Mathematics and Scientific Computing 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: ES301 and ES307 are offered in the 5^{th} and 6^{th} semesters. A student can opt for these courses along with his regular courses in 5^{th} semester OR he can take one of the two courses in 5^{th} semester and the other in his 7^{th} 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.

Elective Choices in (Mathematics & Scientific Computing)

Sl.	Code	Name of the course	L-T-P	Credit
1.	ES001	Parallel Computing	3-0-2	4
2.	ES002	Computational Biology	3-0-0	3
3.	ES003	Stochastic Processes and Applications	3-1-0	4
4.	ES004	Topology and Differential Geometry	3-1-0	4
5.	ES005	Data Economics	3-0-0	3
6.	ES006	Intuitionistic Fuzzy Sets and Applications	3-1-0	4
7.	ES007	Financial Mathematics	3-0-0	3
8.	ES008	Cluster Computing	3-0-0	3
9.	ES009	Digital Image Processing	3-0-2	4
10.	ES010	Big Data Analytics	3-0-2	4

11.	ES011	Wavelet Analysis	3-0-0	3
12.	ES012	Introduction to Game Theory	3-0-0	3
13.	ES013	Computer Vision	3-0-2	4
14.	ES014	Business Statistics and Industrial Applications	3-1-0	4
15.	ES015	Distributed Computing	2-0-2	3
16.	ES016	Robotics	3-1-0	4

SYLLABUS

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**	After the completion of the course, the students will be able to: • Demonstrate the use of semiconductor diodes in various applications. • Discuss and explain the working of transistors, their configurations and applications. • Apply networks laws and theorems to solve electric circuits. • Analyze transient and steady state response of DC circuits. • Explain and analyse the behaviour of transformer. • Elucidate the principle and characteristics of DC motor and DC generator.
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**	• Electronic Devices and Circuit Theory by R.L. Boylestad and L. Nasheisky, Pearson. • Basic Electrical Engineering by J. Nagrath and D. P. Kothari, TATA Mc Graw Hill. • Electric Circuits by D. A. Bell, Oxford Higher Education. • Modern Semiconductor Device Physics by S.M. Sze, Wiley. • 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 Lasers 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**	• Engg. Physics- Kakani & Kakani, CBS Publications. • David J Griffith, *Introduction to Quantum Mechanics,2*nd ed. , PHI, 2013. (Text Book). • Avadhanulu, M. N, & Kshirsagar, S. G., *A Textbook of Engineering Physics*, S. Chand, 2014. (Text Book) • Neeraj Mehta, *Applied Physics for Engineers*, PHI Learning Pvt. Ltd., 2011. (Text Book) • Fiber optic communication- J Keiser (McGraw Hill) (Text Book) • David J Griffith, *Introduction to Electrodynamics*, 4th ed. , PHI, 2014. (Ref.). • Paul Dirac, *Principles of Quantum Mechanics*, 4th ed., Oxford Uni. Press, 2004. (Ref.) • Kittel, C., *Introduction to Solid State Physics*, 8th 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 **Linear Transformation,** 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**	1. Linear Algebra and its Applications, Gilbert Strang. 2. Fundamentals of Linear Algebra, James B. Carrell 3. Functions of Several Variables, Wendell Fleming

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. • Create awareness on legal and ethical issues in Design an Quality Engineering.
6	**Brief Contents**	Design process, Morphology of Design, Design Drawings, 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 Design, Finite Element Modeling, Optimization, Search 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 section view of an object, Create 2-D computer drawing, Create 3-D computer drawing : using Computer Aided Design (CAD) software
8	**Text /references**	• Fundamentals of Engineering Drawing by W.J. Luzadder and J.M. Duff, PHI. • Engineering Design - "A Materials and Processing Approach" by Dieter, George E., McGraw Hill. • Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw Hill. • Engineering Design by Pahl, G, and Beitz, W., Springer – Verlag, NY. • Elements of Engg. Design by Ray, M.S., Prentice Hall Inc. • The principles of Design by Suh, N. P., Oxford University Press, NY.

		• Visualization, Modeling, and Graphics for Engineering Design by D.K. Lieu and S.A. Sor, Cengage Learning. • Fundamentals of Computer Graphics by Shirley, Peter, Michael Ashikhmin, Steve Marschner, CRC Press.

1	**Code of the subject**	CS101
2	**Title of the subject**	Principles of Computer Programming
3	**Prerequisite**	No
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To understand the basic principles of programming languages. To provide design & development of C and Python programming skills. To introduce problem solving methods and program development.
6	**Brief Contents**	Basics of Computer Languages C, Compilers, Interpreter, Programming Environments and Debugging: types of errors and debugging techniques. Programming features: Data types, Expressions and Operators, Control statements, Iterations. Functions: Scope of variables, call by value, call by reference, Recursion, Pointers. Array, String, Structures and Unions. File handling, File redirection, File pointers. Applications of C programming concepts in different data structures. Python: Introduction, Program Organization, Functions, Modules and Libraries.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text/references**	1. Kernighan, B.W. and D. M. Ritchie (1998): The C programming language, 2nd ed. Prentice Hall of India. 2. Kanetkar, Y (2016): Let us C, 15thed .BPB Publications. 3. King K.N (2008): C Programming: A Modern Approach. 2nd ed. W. W. Norton & Company.

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

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**	• Students will get knowledge and understanding of the facts, concepts and practice relating to a range of sports-both indoor and outdoor. • To teach the students how to keep them fit, to increase his/her concentration, team coordination ability, which will help them as a professional.
6	**Brief Contents**	• he course will be taught in two components • 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

7	**Contents for Field Sessions**	• Indoor/ Outdoor: Cricket/ Football/ Volleyball/ Basketball/Badminton/ Table-Tennis/ Lawn-Tennis/ Athletics/ Yoga
8	**Text/references**	• Nation at Play: Ronojoy Sen • The Art of Captaincy: What Sports teaches us about Leadership by Mike Brearley • The Anatomy of Exercise and Movement for the Study of Dance, Pilates, Sports, and Yoga by Jo Ann Staugaard-Jones • Stress and Its Management by Yoga, by K.N. Udupa, R.C. Prasad • THE WINNING WAY: Learning from Sport for Managers by Anita Bhogle, Harsha Bhogle • Think Like a Champion by Webster, Rudi V. • Attitude is Everything, by Jeff Keller

SEMESTER-2

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**	After the completion of the course, the students will be able to: • Recognize and apply the number systems and Boolean 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 of combinational circuits, Design of sequential circuits, 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 gates, Study of code converters (BCD to excess-3, binary to gray 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 books/references**	**Text/ Reference Books:** • 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. • Digital Design by M. M. Mano and M.D. Ciletti, Pearson, Prentice Hall. • Digital Principles and Design by Donald D Givone, 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**	1. Johnson, R. A., Miller & Freund's Probability and statistics for engineers, Pearson Education, 2000. 2. Ross S. M., Introduction to Probability and Statistics for Engineers and Scientists 5th Edition, Elsevier. 3. Hogg R. V., Craig A., Probability and Statistical Inference, 6th edition, Pearson Education.

1	**Code of the subject**	CS102
2	**Title of the subject**	Data Structures
3	**Any prerequisite**	Basic Computer Programming
4	**L-T-P**	3-0-2
5	**Learning Objectives of the subject (in about 50 words)**	*To enable* students to learn how to store data while maintaining 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. *Data Structures and Algorithms in Java* , John Wiley and Sons, Inc. 3. Fundamentals of Data Structures in C -- by Horowitz, Sahni and Anderson-Freed (Silicon Press 2007). 4. Data Structure Using C and C++ -- by Y. Langsam, M. J. Augenstein and A. N. Tanenbaum (Pearson Education, 2nd Edition, 2015).

1	**Code of the subject**	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**	• To familiarize students with various electronic devices and their specifications. • Develop skill for Design and testing of different types of electronic subsystems using Analog and Digital IC's • Familiarize students with PCB layout tool to prepare PCB print for assigned projects. • Develop skills of writing a structured technical document for project and its presentation. • 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 show the functioning
7	**Contents for lab**	Hardware Based Projects for smart city applications, industries, healthcare, education, agriculture, transportation, power, including social development sector etc.
8	**List of text books/references**	• https://electronicsforu.com/ • https://electronicsforu.com/tag/mini-projects. • 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. • 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. • 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 books/references**	1. HM Deitel and PJ Deitel —C++ How to Program, Seventh Edition, 2010, Prentice Hall. 2. Brian W. Kernighan and Dennis M. Ritchie, —The C programming Language, 2006, Prentice-Hall. 3. E Balagurusamy, —Object oriented Programming with C++, Third edition, 2006, Tata McGraw Hill. 4. Bjarne Stroustrup, —The C++ Programming language, Third edition, Pearson Education. 5. Horstmann —Computing Concepts with C++ Essentials,Third Edition,2003, John Wiley. 6. Robert Lafore, —Object Oriented Programming in C++, 2002, Pearson education.

1	**Code of the subject**	HS103
2	**Title of the subject**	**Ecology and Environment Sciences**
3	**Prerequisite**	No
4	**L-T-P**	2-0-0
5	**Learning Objectives**	Upon course completion, students will be able to: 1. Understand the basic principles of ecology and ecosystem function. 2. Describe the interrelationships between land, sea, the atmosphere, and the living things that occupy these environments. 3. Determine the role that humans play in affecting the characteristics of the environment. 4. Evaluate current environmental issues and problems including the solutions and management practices that have been used or offered to address these issues and problems.
6	**Brief Contents**	**Environment and Human Intervention** 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) **Environmental Pollution** Water pollution, waste-water treatment- case studies, land pollution, air pollution, noise pollution, Pollution and public health issues, pollution and environment, greenhouse effect **Environment Protection Policies** Environment policies, forests, biosphere reserves, flora and wildlife, environment laws/acts, environmental movements, environment ethics and awareness, role of government and non-government organizations, introduction to GST-CGST and SGST, Swachh Bharat Abhiyan- 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, 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 Pub. 3. Martell, L., 2013. *Ecology and Society: An introduction.* 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**	1. Android Programming: The Big Nerd Ranch Guide 4th Edition, Bill Phillips, Brian Hardy 2. The Busy Coder's Guide to Android Development, Mark Murphy.

SEMESTER-3

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**	Upon course completion, students will be able to: 1. Identify and analyze an ethical issue in the subject matter

		under investigation or in a relevant field. 2. Articulate what makes a particular course of action ethically defensible. 3. Assess their own ethical values and the social context of problems. 4. Evaluate the concept of karma that helps to maintain work life balance. 5. Demonstrate contemporary approaches to leadership who inspires human being to reach their goals
6	**Brief Contents**	**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. **Work Ethos and Values** 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 **Indian Ethos-An Overview** 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. **Contemporary Approaches to Indian Ethos** 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**	ES201
2	**Title of the subject**	Discrete Structures
3	**Prerequisite**	Engineering Mathematics
4	**L-T-P**	3-1-0
5	**Learning Objectives**	To prepare for a background in abstraction, notation, and critical thinking for the mathematics most directly related to computer science. To foster rigorous thinking skills that can enhance the quality of work of computing professionals. To relate and apply these concepts to practical applications of computer science.
6	**Brief Contents**	Fundamentals of Logicand their use in program proving, resolution principle. Set Theory and Functions, Graph Theory, Group Theory, Elementary Combinatorics etc.
7	**Text/references**	1.Bernanrd Kolman, Robert C Busby, S.Ross, Discrete Mathematical Structures, PHI Learning 2. Kenneth H. Rosen, Discrete Mathematics and Its Appications, Tata McGraw-Hill Edition 3. I.N. Herstein, Topics in Algebra, John Wiley Publications 4. Ralph P. Grimaldi, B.V. Ramana, Discrete and Combinatorial Mathematics, Pearson Education

1	**Code of the subject**	**ES202**
2	**Title of the subject**	**Differential Equation and Integral Transformation**
3	**Any prerequisite**	
4	**L-T-P**	3-0-0

6	**Learning Objectives of the subject (in about 50 words)**	➢ To present the foundations of many basic Mathematical tools and concepts related Engineering. ➢ To provide a coherent development to the students for the courses of various branches of Engineering like ➢ Control Theory, Circuits and Networks, Digital Logic design, Fluid Mechanics, Machine Design etc. ➢ To enhance the student's ability to think logically and mathematically. ➢ To give an experience in the implementation of Mathematical concepts which are applied in various field of Engineering
7	**Brief Contents (module wise)**	**Unit-I** formation and solution, Geometric meaning of y' = f(x,y), Direction fields, Exact differential equations, Reduction of Non exact differential equation using , Integrating factor, Linear differential equations, Bernoulli equations, Homogeneous equation –reduction to separable form ,Applications – Geometrical; tangent, normal of curves, orthogonal trajectories of curves. Growth and Decay. **Unit-II** Higher Order Ordinary Differential Equations: Basic- General solution and particular integral, Auxiliary equation, complementary function. Linear differential equations of second and higher order: Homogeneous linear differential equations of second order, Euler-Cauchy Equations, Wronskian, Non-homogeneous equations, Solution by undetermined coefficients, Solution by variation of parameters. System simultaneous linear differential equations. Higher order linear differential equations, Higher order homogeneous with constant coefficient, Higher order non-homogeneous equations. Solution by [1/f(D)] r(x) method for finding particular integral. Applications- Mass spring Mechanical System -Free, damped, undammed & forced Oscillations. RLC circuits. Simple Pendulum. **Unit-III** Partial Differential Equations and Applications: Basic Concepts-Formation PDEs, Order, Linearity & Homogeneity of PDE, Solution of Partial Differential equations f(x,y,z,p,q) = 0, Nonlinear PDEs first order, Some standard forms of nonlinear PDE, Linear PDEs with constant coefficients, Equations reducible to Homogeneous linear form, Non Homogeneous Linear PDE, Classification of second order linear PDEs. Method Separation of variables. Applications- One Dimensional Wave equation, One Dimensional Heat equation, Two Dimensional Laplace equation. Integral Transform **Unit-IV** Definition of the Laplace transform, Inverse Laplace transform, Linearity, Shifting theorem. Laplace transforms of derivatives and integrals. Unit step function, Dirac's delta function, Properties of inverse Laplace transform. Convolution Theorem. Complex inversion formula. Application of Laplace Transformation. **Unit-V** Periodic function, Trigonometric series, Fourier series, Functions of any period, Even and odd functions, Half range Expansion.
8	**Contents for lab (If applicable)**	Yes
9	**List of text books/references**	1. "Advanced Engineering Mathematics (8th Edition)", by E. Kreyszig, Wiley-India (2007). 2."Differential Equations",E.Rukumangadachari, Pearson.

		3. “Elementary Differential Equations (8th Edition)”,W. E. Boyce and R. DiPrima, John Wiley 4. M.D Raisinghania, Ordinary and Partial Differential Equations, S Chand & Co. 5. Gerald B Folland, Introduction to Partial Differential Equations, 2nd edition, Prentice – Hall of India (2001.) 6. C. E. Froberg, Introduction to Numerical Analysis (2nd Edition), Addison-Wesley,

1	**Code of the subject**	CS203
2	**Title of the subject**	Design and Analysis of Algorithms
3	**Prerequisite**	Data Structures, Principles of Computer Programming, Engineering Mathematics
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To understand the performance aspects of algorithms in programming the computing systems
6	**Brief Contents**	Introduction, Asymptotic complexity, Searching in list, Concepts of graphs and shortest path estimation algorithms, Divide and conquer approaches, Search Trees, Greedy : Interval scheduling, Greedy :Proof strategies,Greedy : Human coding, Dynamic Programming: weighted interval scheduling Dynamic Programming, Intractability: NP completeness, Intractability :reductions and examples
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text/references**	1. Introduction to Algorithms (Eastern Economy Edition) by Thomas H Cormen and Charles E Leiserson. 2. Design and Analysis of Algorithms by S Sridhar. 3. Design and Analysis of Computer Algorithms by AHO.

1	**Code of the subject**	CS204
2	**Title of the subject**	Database Systems

3	**Prerequisite**	
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To understand a Database application, the design and performance aspects from the perspective of Database systems of the past, present and future.
6	**Brief Contents**	Introduction to Databases, Relational Data Model, Relational Algebra, SQL and NoSQL concepts, Database Normalization, Indexing, Database Transactions, Recovery Systems, Transaction Schedules, Concurrency Control, Query Processing and Query Optimization.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text /references**	1. Abraham Silberschatz, Henry Korth, and S. Sudarshan. Database Systems Concepts (5ed.). McGraw-Hill, New York, USA. 2. Ramez A. Elmasri, Shankrant B. Navathe. Fundamentals of Database Systems Addison-Wesley Longman Publishing Co. 3. Paul DuBois. Mysql. New Riders Publishing 4. C. J. Date. Database in Depth: Relational Theory for Practitioners. O'Reilly Media, Inc. 5. Bipin C. Desai. An Introduction to Database Systems. West Publishing Co.

1	**Code of the subject**	**ES204**
2	**Title of the subject**	**Complex Analysis**
3	**Any prerequisite**	
4	**L-T-P**	3-0-0
6	**Learning Objectives of the subject**	This course is aimed to provide an introduction to the theory of function of a complex variable. The concepts of analyticity, Cauchy-Riemann equations and harmonic functions are introduced. Students will acquire the skill of contour integration to evaluate complicated real integrals.
7	**Brief Contents (module wise)**	**UNIT – I** Function of a complex variable, Limit, Continuity, Uniform continuity, Differentiability, Analytic functions, Cauchy- Riemann equations, Harmonic functions and Harmonic conjugate. Exponential function, Trigonometric function, Logarithmic function, Branches of multi-valued functions **UNIT – II** Complex integration, Cauchy-Goursat theorem, Cauchy integral formula, Higher order derivatives, Morera's theorem, Liouville's theorem, Fundamental theorem of algebra, Zeroes of analytic function, maximum modulus principle, Schwarz's Lemma. **UNIT - III** Taylor's, Laurent's series, Singularities of complex functions, Casorati-Weierstrass theorem, Poles, Residues, Residue theorem and its applications to real integrals: Integration around unit circle, Integration over semi-circular contours (with and without real poles), Integration over rectangular contours, Argument principle, Rouche's theorem. **UNIT - IV** Definition of conformal mapping, Bilinear transformation, Cross ratio, the mappings from disc to disc, disc to half plane and half plane to half plane. Poisson integral formula, Dirichlet problem in the unit disc, Dirichlet problem in the half plane.
8	**Contents for lab**	No
10	**List of text books/references**	1) E.T. Copson, An Introduction to Theory of Functions of a Complex Variable, Oxford University Press (1970). 2) L.V. Ahlfors, Complex Analysis, Tata McGraw-Hill (1979). 3) S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House (2007). 4) R.V. Churchill & J.W. Brown, Complex Variables and Applications, Tata McGraw-Hill (2008). 5) R.E. Greene & S.G. Krantz, Function theory of one complex variable, American Math. Soc. 3rd Ed. (2006).

SEMESTER-4

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**	CS207
2	**Title of the subject**	Operating Systems
3	**Prerequisite**	Computer Organization; Data Structures and Computer Programming
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To study the importance of the operating system and its function, techniques of the operating system to achieve its goals as resource manager. Application interaction with the operating system and the operating systems interaction with the machine.
6	**Brief Contents**	Introduction and history of Operating systems, Process concepts and scheduling, Storage management, Processor management, Interprocess communication, CPU scheduling, Process Synchronization, Memory Management, Virtual memory concepts, Deadlocks, Device management, File management, File Systems, Free space Management: Bit vector, Linked list. Some case Studies of traditinal and modern operating systems.

7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text /references**	1. A. Silberschatz & P.B. Galvin, Operating System concepts and principles, Wiley India. 2. A. Tanenbaum, Modern Operating Systems', Prentice Hall India 3. W. Stallings, _Operating Systems: Internals and design Principles, Pearson Ed. 4. M.J. Bach, Design of Unix Operating system', Prentice Hall. Additional Reading: 1. D.M. Dhamdere, Operating Systems: a concept based approach', Tata McGraw-Hill Pubs. 2. G. Glass, Unix for programmers and users-a complete guide, Pearson Ed.

1	**Code of the subject**	CS210
2	**Title of the subject**	Software Engineering
3	**Prerequisite**	
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To impart software engineering concepts helpful for designing software systems for standalone and networked applications.
6	**Brief Contents**	Introduction, Software development process, project management process. Software requirement Analysis and specification; Software planning, Software design, Verification and validation techniques, Software quality and reliability, System Reliability and Reliability measures
7	**Contents for lab**	Use of software design tools (UML etc.) for design, software applications design and testing on vrious application centric measures, Fintech software design etc.
8	**Text /references**	1. Pham, Hoang. System software reliability. Springer Science & Business Media, 2007. 2. Jalote Pankaj, An Integrated Approach to Software Engineering, Narosa Publishing House 3. Pressman, Roger S., Software Engineering : A practitioner's

		Approach, McGraw-Hill, Inc.

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 the subject**	Upon completion of this course, the student will be able to: • To develop background knowledge and core expertise in microprocessor. • To study the concepts and basic architecture of 8085, and 8086 processor. • To know the importance of different peripheral devices and their interfacing to 8086. • To know the design aspects of basic microprocessor. • To write assembly language programs in microprocessor for various application
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**	**Text/ Reference Books:** • Microprocessors and Interfacing by Douglas V. Hall • The 8051 Microcontroller and Embedded Systems by M.A. Mazidi and J. G. Mazidi, PHI. • The Intel Microprocessors by Barry B. Brey, Prentice Hall. • The 8088 and 8086 Microprocessors by Walter A. Triebel, Avtar Singh, Prentice Hall Inc. • 8086/8088 family: Design, Programming and Interfacing by John Uffenbeck, Prentice Hall. • Advanced Microprocessor and Peripherals, Architecture Programming and Interfacing by A. K. Ray and K. M. Burchandi, Tata McGraw Hill. • Microcontroller and Embedded Systems by M. A. Mazidi, Pearson Education. • 8051 Microcontroller and Embedded Systems by R. Kapadia, Jaico Publishing House. • Fundamentals of Microprocessors and Microcomputers by B. Ram, Dhanpat Rai Publications.

1	**Code of the subject**	**ES204**
2	**Title of the subject**	Multivariate Data Analysis, 3-0-2
3	**Any prerequisite**	NIL
4	**L-T-P**	3-0-2
5	**Learning Objectives of the subject (in about 50 words)**	
6	**Brief Contents (module wise)**	**Getting started with multivariate:** Introduction, sampling theory, linear algebra [Ch. 1-3] Multivariate normal distribution theory [Ch. 4], **Inference about mean vectors:** Inference on a single vector [Ch. 5] Inference on several mean vectors [Ch. 6] Multivariate response linear regression (brief) [Ch. 7] **Analysis of covariance structure:** Principal components [Ch. 8] Factor analysis/factor models [Ch. 9] Canonical correlations (brief) [Ch. 10] **Classification and clustering:** Discrimination and classification [Ch. 11] Clustering [Ch. 12]
7	**Contents for lab**	
8	**List of text books/references**	**Required textbook:** Applied Multivariate Statistical Analysis, 6th edition, Pearson/PrenticeHall 2007, by Johnson Richard A.

		and Wichern, Dean W. Everitt, B. and Hothorn, T. An Introduction to Applied Multivariate Analysis with R. Springer 2011. Koch, I. Analysis of multivariate and high-dimensional data. Cambridge University Press, 2013.

1	**Code of the subject**	**ES205**
2	**Title of the subject**	**Advanced Numerical Methods**
3	**Any prerequisite**	Mathematics-I, Mathematics-II
4	**L-T-P**	3-0-0
5	**Will this course require visiting faculty**	No
6	**Learning Objectives of the subject (in about 50 words)**	➢ To demonstrate 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. ➢ To analyse and evaluate the accuracy of common numerical methods. ➢ To write efficient, well-documented MATLAB code and present numerical results in an informative way.
7	**Brief Contents (module wise)**	**Module-I:** Bisection Method, False Position Method, Newton-Raphson Method, Convergence of Bisection, Newton-Raphson's and False Position Methods, Fixed Point Iterative Method, Gauss Elimination Method, Gauss-Jordan Method, Gauss-Seidel Method, Convergence of Iterative Methods. **Module-II:** Finite Difference Operators and Their Relationships, Difference Tables, Newton Forward and Backward Interpolation Formula, Lagrange Interpolation Formula, Divided Difference Operator, Newton Divided Interpolation Formula. **Module-III:** 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 **Module-IV:** Numerical solution of ODE's, Singlestep methods, Multistep methods, Predictor Corrector methods, Shooting methods **Module-V:** Taylor Series Method, Picard's Method, Euler and Modified Euler Method, Runge-Kutta Methods, Milne's Method, Finite Differences Approximations of Partial Derivatives, Solution of Laplace Equation (Elliptic) By Standard 5 – Point Formula, Solution of One Dimensional Heat Equation (Parabolic) By Bender-Schmidt Method, Crank-Nicolson Method, Solution of One Dimensional Wave Equation (Hyperbolic) by Iterative Method.
8	**Contents for lab (If applicable)**	Yes

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

SEMESTER-7

1.	**Code of the subject**	**ES301**
2.	**Title of the subject**	FUZZY SETS AND APPLICATIONS
3.	**L-T-P**	3 -0-0
5.	**Learning Objectives of the subject**	The course aims to provide concepts of wavelets and their applications to various disciplines.
6.	**Brief Contents**	**UNIT-I** Fuzzy sets – introduction, Basic types and Basic concepts, Additional properties of α-cuts, Representation of fuzzy sets, Extension principles. **UNIT-II** Type of operators on fuzzy sets and fuzzy complements, Fuzzy intersection and fuzzy unions, and Combination of operations. **UNIT-III** Fuzzy numbers and arithmetic operations on intervals, Arithmetic operations on fuzzy numbers, Fuzzy equations and fuzzy relations, Binary fuzzy relations and binary relation on a single set, Fuzzy equivalence relations. Fuzzy Arithmetics - Fuzzy number, Addition of fuzzy numbers, Subtraction of fuzzy numbers, Multiplication of fuzzy numbers, Division of Fuzzy numbers, Fuzzy Max and Fuzzy Min, L-R Fuzzy number, Triangular(or Trapezoidal) Fuzzy Number. **UNIT-IV**Classification by equivalence relations-Crisp relations, Fuzzy relations, Cluster Analysis, Cluster Validity, c-means Clustering- Hard c-means(HCM), Fuzzy c-Means(FCM). **UNIT-V** Fuzzy Decision making – introduction, Conversion of linguistic variables to fuzzy numbers, Individual Decision Making, Multiperson Decision Making, Multicriteria decision Making, Fuzzy ranking methods.
7.	• **Book(s):**	1.George J.Klir, Bo Yuan, Fuzzy Sets and Fuzzy logic – Theory and Applications, Prentice Hall India, New Delhi, 1997. 2.. H.J Zimmermann, Fuzzy sets, Decision making and expert systems, Kluwer, Bosten, 1987.

		2. S.J. Chen and C.L.Hwang, Fuzzy Multiple Attributes Decision Making, Springer verlag, Berlin Heidelberg, 1992.

1	**Code of the subject**	ES302
2	**Title of the subject**	Trustworthy Artificial Intelligence
3	**Prerequisite**	Algorithms and Data Structures
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To understand the techniques and concepts related to machine based reasoning systems through various applications of AI
6	**Brief Contents**	Introduction to AI and intelligent agents. Problem solving methods in AI, Informed and uninformed search strategies, knowledge representation, Uncertain Knowledge and Reasoning, Probabilities, Bayesian Networks. Overview of different forms of learning, Learning Decision Trees, Artificial Neural Networks and Fuzzy Approaches; Logic in AI, Prolog, Modern AI language and tools etc.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**Text /references**	1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 2nd Ed, Prentice Hall, 2003 2. Elaine Rich and Kevin Knight. Artificial Intelligence, Tata McGraw Hill Reference Books: 1. Patrick Henary Winston, Artificial Intelligence, Pearson publication 2. Deepak Khemani. A First Course in Artificial Intelligence, McGraw Hill Education (India) 3. Eugene Charnaik and Drew McDermott, Introduction to Artificial Intelligence, Pearson publication 4. Nils John Nilsson, The Quest for Artificial Intelligence: A History of Ideas and Achievements, Morgan Kaufman 5. Dennis Rothman, Artificial Intelligence by Example

1	**Code of the subject**	**ES402**
2	**Title of the subject**	Data Mining and Data Warehouse
3	**Any prerequisite**	Basic Statistics
4	**L-T-P**	3-0-2

5	**Learning Objectives of the subject**	• Extract knowledge using data mining techniques • Design a data mart or data warehouse for any organization • Explore recent trends in data mining such as web mining, spatial-temporal mining
6	**Brief Contents**	**Module I:** Data Mining Concepts, Input, Instances, Attributes and Output, Knowledge Discovery process, Date preprocessing, Data Cleaning, Data Integration & Transformation, Data Reduction, Data Warehouse, Data Warehousing schemas, Data cube analysis, Mapping Data Warehouse to Multiprocessor Architecture, DBMS Schemas for Decision Support **Module II:** Associations, Maximal Frequent & Closed Frequent item sets, Covering Algorithms & Association Rules, Mining Association Rules from Transactional databases, Apriori algorithm, Variations of Apiori algorithm, FP-growth algorithm, Mining Association Rules from Relational databases, Correlation analysis & Constraint-based Association Mining, Multi-level and Multidimensional association mining **Module III:** Issues regarding Classification & Prediction, Classification by Decision Tree induction using Information gain, Gini indexing method, Bayesian classification, Classification by Back Propagation, k- Nearest Neighbor Classifiers, SVM algorithm **Module IV:** Types of data in Clustering Analysis, Categorization of Major Clustering methods, Hierarchical methods, Distance-based methods, Density-based methods, Grid-based methods, Model-based Clustering methods **Module V:** Applications of data mining**,** Text mining, TF-IDF model for text mining, Web page mining, Recommender systems building, Fuzzy set theoretical approach in data mining.
9	**Contents for lab**	Programming of association mining, classification and clustering algorithms
10	**List of text books/references**	1. Jiawei Han and Micheline Kamber, ―Data Mining: Concepts and Techniques‖, Morgan Kaufmann Publishers, 2000 (ISBN: 1-55860-489-8). 2. Ian H. Witten and Eibe Frank, ―Data Mining: Practical Machine Learning Tools and Techniques with Java implementations‖, Morgan Kaufmann Publishers, San Fransisco, CA (2000). 3. D. Pyle, ―Data Preparation for Data Mining‖, Morgan Kaufmann, (1999)

1	**Code of the subject**	CS302
2	**Title of the subject**	Computer Graphics
3	**Prerequisite**	
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To expose onto the primary tools by which the flood of information from Computational Science is analyzed.

6	**Brief Contents**	Introduction of computer graphics, Graphic Displays and the algorithms; Three Dimensional aspects of graphics; Transformations; Windowing and Clipping concepts; Hidden Lines and Surfaces etc.
7	**Contents for lab**	Experiments are based on the theoretical contents and their applications
8	**List of text books/references**	1.Computer Graphics, C Version Donald D Hearn, M. Pauline Baker 2. Computer Graphics: Principles and Practiceby James D. Foley, Andries van Dam , Steven K. Feiner

1	**Code of the subject**	**ES304**
2	**Title of the subject**	Software Reliability
3	**Any prerequisite**	NIL
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	
6	**Brief Contents (module wise)**	**Fundamentals of Testing:** Human and errors, Defects, Faults, Failures, Defect Rate and Reliability, Defect Prevention, Reduction and Containment, Testing and Debugging, Software Quality **Approaches to Testing:** Static Testing, Structured Group Examinations, Static Analysis, Control flow & Data flow, Determining Metrics, Dynamic Testing, Black Box Testing, White Box Testing, Reliability testing, Acceptance testing **Software Reliability:** Defining Software Reliability, Software Reliability Attributes and Specification, Concept of Introduction to Measurement and Inspection Process, Documents and Metrics, Basics of Reliability Theory, Software Reliability Problem, Modeling Process, Software Reliability Models (SRGM), preliminary Concepts of Reliability Engineering, Parameter Estimation, Model Validation **Software Reliability Growth Models:** Execution Time Models, Calendar Time Models, Erlang Model, Modeling Fault Dependency and Debugging Time Lag, Testing Effort Dependent Modeling, Distributed Environment, Imperfect Debugging, Testing-Domain Models, Change-Point, Unified Approach Concepts, Artificial Neural Networks based SRGM, Introduction to Discrete SRGM
7	**Contents for lab**	

8	**List of text books/references**	1. Johnson, R. A., Miller & Freund's Probability and statistics for engineers, Pearson Education, 2000. 2 2. D Srinivasan and R Gopalswamy; "Software Testing: Principles and Practices", Pearson Education, 2006 3. Pham, Hoang. System software reliability. Springer Science & Business Media, 2007.

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	**Contents for lab**	No

SEMESTER-6

1	**Code of the subject**	ES305
2	**Title of the subject**	**Quantum Computing**
3	**Any prerequisite**	No
4	**L-T-P**	3-0-0
5	**Learning Objectives**	
6	**Brief Contents**	• **Qubits and quantum states : C**lassical & quantum information, qubits, quantum computing and laws of physics, quantum information, quantum computers, vector spaces, postulates of quantum mechanics, linear combinations, basis & dimensions, inner products, Cauchy-schwartz and triangle inequalities. • M**atrices & Operators** - Pauli operators, outer products & matrix representation, Hermitian, unitary & normal operators, eigenvalues and eigen vectors, characteristic equation, trace of an operator, expectation value of an operator, projection operators**.** • **Entanglement & Quantum Gates:** Entanglement, exchange of information using entangled particles, Bell's theorem, Bipartite systems and the Bell basis. classical logic gates and circuits, one qubit quantum gates, the Hadamard gate, two qubit quantum gates- the CNOT gate, three qubit quantum gates- The Fredkin gate, The Toffoli gate, quantum circuits, universal quantum gates. • **Quantum Algorithms & Cryptography:** classical to quantum Turing machines, computational complexity, quantum algorithms, quantum interference, Deutsch's algorithm, The Deutsch-Josza Algorithm, Shor's Algorithm, Grover's Algorithm, quantum cryptography, BB84-emergence of quantum cryptography, quantum noise and error correction.
7	**Contents for lab**	No
8	**List of text books/references**	1. Quantum Computing Explained- David McMahon, Wiley Interscience 2. Quantum computing- Mika Hirvensalo 3. Quantum Computation and Quantum Information- Michael Nielsen & Chuang 4. An introduction to quantum computing- Phillip Kaye 5. Lectures on Quantum Information- Dagmar Brub, Gerd Leuchs 6. Quantum Computing- J. Stolze, Dieter Suter

1	**Code of the subject**	ES306
2	**Title of the subject**	Optimization Techniques
3	**Prerequisite**	Engineering mathematics, programming
4	**L-T-P**	3-1-0
5	**Learning Objectives**	To equip with the engineering problem formulation skills and optimization approaches to solve the problems along with quantitative analysis of those.
6	**Brief Contents**	Types of OR models, linear programming, problem formulation, graphical solution, simplex method, artificial variables techniques, two–phase method, big-M method etc. Transportation and assignment problems, Sequencing and Replacement, Theory of games and inventory, Dynamic Programming, engineering applications.
7	**List of text books/references**	1. J. K. Sharma, "Operations Research", Macmillan, 5th Edition, 2012. 2. R. Pannerselvan, "Operations Research", 2nd Edition, PHI Publications, 2006

1	**Code of the subject**	**ES307**
2	**Title of the subject**	**Statistical Inference**
3	**Any prerequisite**	NIL
4	**L-T-P**	3-1-0
5	**Learning Objectives of the subject**	

6	**Brief Contents**	**Concepts:** Population, Sample, Parameter, statistic, Sampling distribution, Standard error. convergence in probability and convergence in distribution, law of large numbers, central limit theorem (statements only). Student's t-distribution, F – Distribution, χ^2-Distribution: Definitions, properties and their applications. **Theory of estimation:** Estimation of a parameter, criteria of a good estimator – unbiasedness, consistency, efficiency, &sufficiency and. Statement of Neyman's factorization theorem. Estimation of parameters by the method of moments and maximum likelihood (M.L), properties of MLE's. Binomial, Poisson &Normal Population parameters estimate by MLE method. Confidence Intervals. **Testing of Hypothesis:** Concepts of statistical hypotheses, null and alternative hypothesis, critical region, two types of errors, level of significance and power of a test. One and two tailed tests. Neyman-Pearson's lemma. Examples in case of Binomial, Poisson, Exponential and Normal distributions. **Large sample Tests:** large sample test for single mean and difference of two means, confidence intervals for mean(s). Large sample test for single proportion, difference of proportions. standard deviation(s) and correlation coefficient(s). **Small Sample tests:** t-test for single mean,difference of means and paired t-test. □2-test for goodness of fit and independence of attributes. F-test for equality of variances.
7	**Contents for lab (If applicable)**	As per the theoretical contents covered
8	**List of text books/references**	1. Statistical inference by George Casella, Duxbury advanced series 2. An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E. Saleh. Modern Mathematical Statistics by E.J. Dudewicz & S.N. Mishra5. Introduction to the Theory of Statistics by A.M. Mood, F.A. Graybill and D.C. Boes

1	**Code of the subject**	**ES308**
2	**Title of the subject**	**Machine Learning**
3	**Any prerequisite**	NIL
4	**L-T-P**	3-0-0
5	**Learning Objectives of the subject**	
6	**Brief Contents (module wise)**	**Introduction to Data Science and AI & ML:** Data Science, Use Cases in Business and Scope, Modeling Concepts, Data exploration (histograms, bar chart, box plot, line graph, scatter plot), Measure

		of Central Tendency , Measure of Positions, Measure of Dispersion, Relationship between attributes: Covariance, Correlation Coefficient, Chi Square, Measure of Distribution (Skewness and Kurtosis), Probability Distribution **Predictive Analytics:** Sampling and Estimation, Linear Regression, Multiple Linear Regression, Non-Linear Regression. **Machine Learning:** Foundations for ML, Clustering, Naïve Bayes Classifier,K-Nearest Neighbors, Support Vector Machines, Decision Trees, Ensembles methods. **Artificial Intelligence:** Foundations for AI, Convolution Neural Networks, Recurrent Neural Networks, Deep Learning
7	**Contents for lab (If applicable)**	No
8	**List of text books/references**	1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press 2. Tom M. Mitchell, Machine Learning - McGraw Hill Education, International Edition 3. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, Inc. 2nd Edition 4. Ian Goodfellow, Yoshoua Bengio, and Aaron Courville, Deep Learning MIT Press Ltd, Illustrated edition 5. Christopher M. Bishop, Pattern Recognition and Machine Learning - Springer, 2nd edition 6. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction - Springer, 2nd edition

SEMESTER - 7

1	**Code of the subject**	**ES401**
2	**Title of the subject**	**Modeling and Simulation**
3	**Any prerequisite**	Engineering Mathematics and Probability & Statistics
4	**L-T-P**	3-0-2
5	**Learning Objectives of the subject (in**	To teach the application of mathematics and statistics in real life problems.

	about 50 words)	
6	**Brief Contents (module wise)**	Introduction: Concept of a system, System Environment, Modeling and Simulation of Real world problems, Classification of Models and examples, Static and Dynamic models, Principles used in modeling System Studies: Subsystems, A Corporate models, Block diagram of modeling and simulation, System Analysis, System Design Mathematical Models: Mathematical models in population dynamics, Epidemic Models, some mathematical modeling in Biology and Medicine Innovation diffusion models in marketing System Simulation: The technique of simulation, the Monte Carlo Method, Types of system simulation, Continuous and Discrete time Simulation, Probability Concepts in Simulation: Stochastic variables, Discrete and continuous probability distributions, Measures of probability functions, Random numbers generation, Stochastic Processes: Poisson Process, Markov Process, Queuing Theory, Reliability. Linear programming in Simulation: Introduction, Transportation problem, Assignment problem and other simulation techniques in Operation research. Software in System Simulation: Numerical computation technique for continuous and discrete models (MATLAB)
7	**Contents for lab (If applicable)**	As per the theoretical contents
8	**List of text books/references**	1. Banks, J., Carson, I. I., Nelson, B. L., &Nicol, D. M. (2005). Discrete-event system simulation. Pearson. 2. Kishor S Trivedi, Probability & Statistics With Reliability, Queuing And Computer Science Applications, 2nd Ed, Wiley. 3. Geoffrey Gordon, System Simulation, Prentice-Hall.

1	**Code of the subject**	**ES402**
2	**Title of the subject**	**Data Mining and Data Warehouse**
3	**Any prerequisite**	Basic Statistics
4	**L-T-P**	3-0-2
5	**Learning Objectives of the subject**	• Extract knowledge using data mining techniques • Design a data mart or data warehouse for any organization • Explore recent trends in data mining such as web mining, spatial-temporal mining

6	**Brief Contents**	**Module I:** Data Mining Concepts, Input, Instances, Attributes and Output, Knowledge Discovery process, Date preprocessing, Data Cleaning, Data Integration & Transformation, Data Reduction, Data Warehouse, Data Warehousing schemas, Data cube analysis, Mapping Data Warehouse to Multiprocessor Architecture, DBMS Schemas for Decision Support **Module II:** Associations, Maximal Frequent & Closed Frequent item sets, Covering Algorithms & Association Rules, Mining Association Rules from Transactional databases, Apriori algorithm, Variations of Apiori algorithm, FP-growth algorithm, Mining Association Rules from Relational databases, Correlation analysis & Constraint-based Association Mining, Multi-level and Multidimensional association mining **Module III:** Issues regarding Classification & Prediction, Classification by Decision Tree induction using Information gain, Gini indexing method, Bayesian classification, Classification by Back Propagation, k- Nearest Neighbor Classifiers, SVM algorithm **Module IV:** Types of data in Clustering Analysis, Categorization of Major Clustering methods, Hierarchical methods, Distance-based methods, Density-based methods, Grid-based methods, Model-based Clustering methods **Module V:** Applications of data mining**,** Text mining, TF-IDF model for text mining, Web page mining, Recommender systems building, Fuzzy set theoretical approach in data mining
7	**Contents for lab**	Programming of association mining, classification and clustering algorithms
8	**List of text books/references**	4.Jiawei Han and Micheline Kamber, ―Data Mining: Concepts and Techniques‖, Morgan Kaufmann Publishers, 2000 (ISBN: 1-55860-489-8). 5.Ian H. Witten and Eibe Frank, ―Data Mining: Practical Machine Learning Tools and Techniques with Java implementations‖, Morgan Kaufmann Publishers, San Fransisco, CA (2000). 6.D. Pyle, ―Data Preparation for Data Mining‖, Morgan Kaufmann, (1999)

1	**Code of the subject**	**ES403**
2	**Title of the subject**	**Advanced Graph Theory**
3	**Any prerequisite**	NIL
4	**L-T-P**	3-0-0
6	**Objectives of the subje (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 ➢ To foster rigorous thinking skills that can enhance the quality of work of computing professionals ➢ To relate and apply the concepts to practical applications of computer science
7	**Brief Contents**	**Module I** Introduction to graphs: Finite and Infinite Graphs, Incidence and Degree, Isolated Vertex, Pendant Vertex, and Null Graph, Paths and Circuits: Isomorphism, Connected Graphs, Disconnected Graphs, and Components, Euler Graph, Hamiltonian Graph.

		Module II Trees and Fundamental Circuits: Spanning Tree, Rooted and Binary Trees, Matrix Tree Theorem, Cut-sets and Cut vertices: Fundamental Circuits and Cut-Sets, Connectivity and Separability, Network Flows **Module III** Planar and Dual graphs: Embedding, Detection of Planarity, Kurtowski Theorem, Euler Identity. Matrix representation of Graphs: Incidence Matrix, Fundamental Circuit Matrix and Rank of B, Cut-Set Matrix, Path Matrix. **Module IV** Coloring, Covering and Partitioning: Chromatic number, Chromatic polynomial, Coverings, Underlying graph, Outdegree, in-degree, Connectivity, Orientation, Directed graph: Eulerian directed graphs, Hamilton directed graphs, Arborescence, Tournaments. **Module V** Enumeration of graphs: Types of Enumeration, Graph enumeration with Pólya's Counting Theorem, Graphs in switching and Coding theory: Synthesis of Contact Networks, Sequential Switching Networks, Electrical Network Analysis.
8	**Contents for lab**	NA
10	**List of text books/references**	1. Narsingh Deo, Graph Theory with Applications to Engineering And Computer Science, Prentice Hall of India, 1992 2. West, Douglas B., Introduction to Graph Theory, Pearson Education, 2002 3. Reinhard Diestel, Graph Theory, Springer International Edition, 2004

1	**Code of the subject**	**ES404**
2	**Title of the subject**	Modern Cryptography
3	**Any prerequisite**	NIL
4	**L-T-P**	3-0-2
5	**Learning Objectives of the subject (in about 50 words)**	➢ To develop a framework to understand and implement cryptographic aspects. ➢ To enhance an ability to analyze a problem, and identify and define the computing requirements for data security. ➢ To prepare abstract and critical thinking background for Data science students.

6	**Brief Contents (module wise)**	**Module I- Introduction** Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Stream Cipher and Block Cipher, Random Number Generator, One-time Pad. **Module II- Finite Field and Number Theory** Groups, Rings, Fields, Modular Arithmetic, Euclid's Algorithm, Finite Fields of Form GF (p) And GF (2^n). Polynomial Arithmetic, Prime Numbers, Fermat's And Euler's Theorem, Testing for Primality, The Chinese Remainder Theorem. **Module III- Private Key Cryptography** Block Cipher Principles, Data Encryption Standard (DES), Multiple Encryption, Triple DES, Advanced Encryption Standard (AES). **Module IV- Public Key Cryptography** Principles of Public Key Cryptosystems, The RSA Algorithm, Key Management, Diffie–Hellman Key Exchange, Discrete Logarithm Problem, Elgamal Encryption Scheme, Elliptic Curve Arithmetic, Elliptic Curve Cryptography. **Module V-Cryptographic Protocols** Authentication Requirement, Authentication Function, MAC, Hash Functions, Security of Hash Function, Digital Signatures.
7	**Contents for lab (If applicable)**	Programming session for different symmetric/ asymmetric algorithms.
8	**List of text books/references**	1. William Stallings, Cryptography and Network security, 7e, Prentice Hall of India, New Jersey, 2017. 2. Christof Paar, Jan Pelzl, Understanding Cryptography, Springer-Verlang, Berlin, 2010. 3. Behrouz A Forouzan, Cryptography and Network security, Tata Mc-Graw Hill, New York, 2008.

1	**Code of the subject**	ES498
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**	1. https://www.careereducation.columbia.edu/resources/10-tips-make-most-internship 2. https://in.indeed.com/career-advice/career-development/internship-report

SEMESTER - 8

1	**Code of the subject**	ES499
2	**Title of the subject**	BTech Project/ Internship
3	**Any prerequisite**	
4	**L-T-P**	0-0-24
5	**Learning Objectives**	To develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study.
6	**Brief Contents**	The purpose of this course is to enable the student to develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study. The student is expected to demonstrate the abilities of the major subject/field of study, including deeper insight into hardware/software application development work. Develop the capability to create, analyse and critically evaluate different technical/architectural solutions.

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