

B.Tech. in Mathematics and Scientific Computing (182-188 credits)

SEMESTER - 1	Sl no.	Course Code	Subject	Credits	L-T-P
	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
	5.	CS101	Principles of Computer Programming	4	3-0-2
	6.	HS101	Freshman Skills	2	2-0-0
	7.	HS102	Sports and Physical Education	2	0-1-2
				Total	23 credits

SEMESTER - 2	Sl no.	Course code	Subject	Credits	L-T-P
	1.	EE103	Digital Electronics	4	3-0-2
	2.	ES103	Probability and Statistics	4	3-1-0
	3.	CS102	Data Structures	4	3-0-2
	4.	EE104	Hardware Workshop	3	1-0-4
	5.	IT103	Object Oriented Programming	4	3-0-2
	6.	HS103	Ecology and Environment Sciences	2	2-0-0
	7.	CS104	Mobile Application Technologies	2	0-1-2
				Total	23 credits

*Summer Project or MOOC (Optional) of 2 credits

EXIT AFTER YEAR - 1

Certificate in Engineering Sciences (46 credits)

SEMESTER - 3	Sl no.	Course code	Subject	Credits	L-T-P
	1.	HS201	Indian Culture, Ethics and Moral Values	2	2-0-0
	2.	ES201	Discrete Structures	4	3-1-0
	3.	ES202	Differential Equations and Integral	3	3-0-0
	4.	ES203	Real and Functional Analysis	3	3-0-0
	5.	CS203	Design and Analysis of Algorithms	4	3-0-2
	6.	CS204	Database Systems	4	3-0-2
	7.	ES204	Complex Analysis	3	3-0-0
				Total	23 credits

SEMESTER - 4	Sl no.	Course code	Subject	Credits	L-T-P
	1.	MS619	Entrepreneurship and Innovation	2	2-0-0
	2.	CS207	Operating Systems	4	3-0-2
	3.	CS210	Software Engineering	4	3-0-2
	4.	EE206	Microprocessor and Interfacing	4	3-0-2
	5.	ES204	Multivariate Data Analysis	4	3-0-2
	6.	ES205	Advanced Numerical Methods	4	3-0-0
				Total	22 credits

*Summer Project-1

EXIT AFTER YEAR - 2

Diploma in Mathematics & Scientific Computing (91 credits)

SEMESTER - 5	Sl no.	Course code	Subject	Credits	L-T-P
	1.	ES301	Fuzzy Sets and Applications	3	3-0-0
	2.	ES302	Trustworthy Artificial Intelligence	4	3-0-2
	3.	ES303	Vector Calculus	3	3-0-0
	4.	CS302	Computer Graphics	3	3-0-0
	5.	ES304	Software Reliability	3	3-0-0
	6.	ES0XX	Department Elective-1	3/4	
	7.	ES0XX	Department Elective-2	3/4	
	8.	MS603	Business Economics	3	3-0-0
	Total			25-27 credits	
	MOOC Course (Optional)			2	

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

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

EXIT AFTER YEAR – 3 → **B.Sc. in Mathematics & Scientific Computing (143 credits)**

SEMESTER - 7	Sl no.	Course code	Subject	Credits	L-T-P
	1.	ES401	Modelling and Simulation	4	3-0-2
	2.	ES402	Data Mining and Data warehousing	4	3-0-2
	3.	ES403	Advanced Graph Theory	3	3-0-0
	4.	ES404	Modern Cryptography	4	3-0-2
	5.		Multidisciplinary/Open Elective-2/MOOC	3/4	
	6.	ES0XX	Department Elective-4	3/4	
	7.	ES498	Colloquium (Based on industrial training)/MOOC	3	0-0-6
	Total			24-25 credits	

SEMESTER - 8	Sl no.	Course code	Subject	Credits	L-T-P
	1.	ES499	Internship/ BTech Project	12	0-0-24
	2.		Multidisciplinary/Open Elective- 3/MOOC	3/4	
	Total			15-16 credits	

FINAL EXIT AFTER YEAR – 4 → **B.Tech. in Mathematics & Scientific Computing (182-188 credits)**

Minor in Mathematics and Scientific Computing (Total 22 credits required)

Sl no.	Course code	Subject	Credit	L-T-P
1.	ES205	Advanced Numerical Methods	4	3-0-2
2.	ES203	Real and Functional Analysis	3	3-0-0
3.	ES204	Multivariate Data Analysis	4	3-0-2
4.	ES301	Fuzzy Sets and Applications	3	3-0-0
5.	ES401	Modelling and Simulation	4	3-0-2
6.	ES307	Statistical Inference	4	3-1-0
		Total credits	22	

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 5th and 6th semesters. A student can opt for these courses along with his regular courses in 5th semester OR he can take one of the two courses in 5th semester and the other in his 7th 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.

Electives in Mathematics & Scientific Computing

Sl.	Code	Name of the course	Credit	L-T-P
1.	ES001	Parallel Computing	4	3-0-2
2.	ES002	Computational Biology	3	3-0-0
3.	ES003	Stochastic Processes and Applications	4	3-1-0
4.	ES004	Topology and Differential Geometry	4	3-1-0
5.	ES005	Data Economics	3	3-0-0
6.	ES006	Intuitionistic Fuzzy Sets and Applications	4	3-1-0
7.	ES007	Financial Mathematics	3	3-0-0
8.	ES008	Cluster Computing	3	3-0-0
9.	ES009	Digital Image Processing	4	3-0-2
10.	ES010	Big Data Analytics	4	3-0-2
11.	ES011	Wavelet Analysis	3	3-0-0
12.	ES012	Introduction to Game Theory	3	3-0-0
13.	ES013	Computer Vision	4	3-0-2
14.	ES014	Business Statistics and Industrial	4	3-1-0
15.	ES015	Distributed Computing	3	2-0-2
16.	ES016	Robotics	4	3-1-0

CODE WITH ESxxx

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	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>
8	Contents for lab	Practical experiments based on theory contents.
9	Text /references	<ul style="list-style-type: none">□ Engg. Physics- Kakani & Kakani, CBS Publications.□ David J Griffith, <i>Introduction to Quantum Mechanics</i>, 2nd ed. , PHI, 2013. (Text Book).□ Avadhanulu, M. N, & Kshirsagar, S. G., <i>A Textbook of Engineering Physics</i>, S. Chand, 2014. (Text Book)□ Neeraj Mehta, <i>Applied Physics for Engineers</i>, PHI Learning Pvt. Ltd., 2011. (Text Book)□ Fiber optic communication- J Keiser (McGraw Hill) (Text Book)

		<input type="checkbox"/> David J Griffith, <i>Introduction to Electrodynamics</i> , 4 th ed. , PHI, 2014. (Ref.). <input type="checkbox"/> Paul Dirac, <i>Principles of Quantum Mechanics</i> , 4 th ed., Oxford Uni. Press, 2004. (Ref.) <input type="checkbox"/> Kittel, C., <i>Introduction to Solid State Physics</i> , 8 th ed., Wiley, 2014. (Ref.) <input type="checkbox"/> Malik and Singh, Engg Physics, TMH
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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	<input type="checkbox"/> To explore the connections of mathematical foundation courses (Algebra, Calculus and Differential Equations) to the mathematics in the later engineering subjects. <input type="checkbox"/> 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, <u>Gilbert Strang</u> . 2. Fundamentals of Linear Algebra, James B. Carrell 3. Functions of Several Variables, Wendell Fleming

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	To introduce students about basics of probability theory and statistics.
7	Brief Contents	<p>Introduction: Measures of Central Tendency, Measures of Dispersion, Measures of Skewness, and Measures of Kurtosis, Moments about mean and about any point.</p> <p>Probability: Basic terminology, Types of Probability, Probability rules, Bayes Theorem, Probability distribution, Binomial, Poisson, Negative-Binomial, Geometric, Hypergeometric, Uniform, Exponential, Normal distribution, log-normal, beta and gamma distributions.</p> <p>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).</p> <p>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.</p> <p>Testing Hypotheses-2: Two Sample Tests, Testing for differences between means/proportions.</p> <p>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).</p> <p>Nonparametric tests (Self Study): The sign-test, Rank-sum, test of randomness, Kolmogorov-Smirnov, Anderson-Darling test.</p> <p>Simple Regression and Correlation: Estimation using the regression line, Correlation analysis, making inferences about population parameters.</p> <p>Multiple Regression: Multiple regression and correlation analysis, Finding multiple regression equation, Inferences about population parameters.</p>
8	Contents for lab	NA
10	List of text books/references	<ol style="list-style-type: none"> 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	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 Logic and 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
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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	<input type="checkbox"/> To present the foundations of many basic Mathematical tools and concepts related Engineering. <input type="checkbox"/> To provide a coherent development to the students for the courses of various branches of Engineering like <input type="checkbox"/> Control Theory, Circuits and Networks, Digital Logic design, Fluid Mechanics, Machine Design etc. <input type="checkbox"/> To enhance the student's ability to think logically and mathematically. <input type="checkbox"/> To give an experience in the implementation of Mathematical concepts which are applied in various field of Engineering
7	Brief Contents	<p>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.</p> <p>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.</p> <p>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</p>

		equation, One Dimensional Heat equation, Two Dimensional Laplace equation. Integral Transform 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. Periodic function, Trigonometric series, Fourier series, Functions of any period, Even and odd functions, Half range Expansion.
8	Contents for lab applicable)	Yes
9	List of text books/references	1. "Advanced Engineering Mathematics (8th Edition)", by E. Kreyszig, Wiley-India 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 6. C. E. Froberg, Introduction to Numerical Analysis (2nd Edition), Addison-Wesley,

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	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	<p>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</p> <p>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.</p> <p>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, Rouché's theorem.</p> <p>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.</p>
8	Contents for lab	No
10	List of text books/references	<ol style="list-style-type: none"> 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).

1	Code of the subject	ES204
2	Title of the subject	Multivariate Data Analysis
3	Any prerequisite	NIL
4	L-T-P	3-0-2
5	Learning Objectives	
6	Brief Contents	<p>Getting started with multivariate: Introduction, sampling theory, linear algebra, Multivariate normal distribution theory</p> <p>Inference about mean vectors: Inference on a single vector</p> <p>Inference on several mean vectors, Multivariate response linear regression,</p> <p>Analysis of covariance structure: Principal components, Factor analysis/factor models, Canonical correlations</p> <p>Classification and clustering: Discrimination and Clustering</p>
7	Contents for lab	
8	List of text books/references	<ol style="list-style-type: none"> 1. Applied Multivariate Statistical Analysis, 6th edition, Pearson/PrenticeHall 2007, by Johnson Richard A. and Wichern, Dean W. 2. Everitt, B. and Hothorn, T. An Introduction to Applied Multivariate Analysis with R. Springer 2011. 3. 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	Any prerequisite	No
6	Learning Objectives	<ul style="list-style-type: none"> ➤ 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	<p>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.</p> <p>Finite Difference Operators and Their Relationships, Difference Tables, Newton Forward and Backward Interpolation Formula, Lagrange Interpolation Formula, Divided Difference Operator, Newton Divided Interpolation Formula.</p> <p>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</p> <p>Numerical solution of ODE's, Singlestep methods, Multistep methods, Predictor Corrector methods, Shooting methods</p> <p>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.</p>
8	Contents for lab	Yes
10	List of text books/references	<ol style="list-style-type: none"> 1. Balagurusamy, E., Numerical Methods, Tata McGraw Hill Education Pvt. Ltd., 1999. 2. Sastry, S. S., Introductory Methods of Numerical Analysis, PHI Learning Pvt Ltd., 2012. 3. Jain, M. K., Iyengar, S.R.K and Jain, R.K, Numerical Methods for Scientific and Engineering computation, Wiley Eastern Ltd., 1985.

1.	Code of the subject	ES301
2.	Title of the subject	FUZZY SETS AND APPLICATIONS
3.	L-T-P	3 -0-0
5.	Learning Objectives	The course aims to provide concepts of wavelets and their applications to various disciplines.

6.	Brief Contents	<p>Fuzzy sets – introduction, Basic types and Basic concepts, Additional properties of α-cuts, Representation of fuzzy sets, Extension principles.</p> <p>Type of operators on fuzzy sets and fuzzy complements, Fuzzy intersection and fuzzy unions, and Combination of operations. 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.</p> <p>Classification by equivalence relations-Crisp relations, Fuzzy relations, Cluster Analysis, Cluster Validity, c-means Clustering- Hard c-means(HCM), Fuzzy c-Means(FCM)</p> <p>Fuzzy Decision making – introduction, Conversion of linguistic variables to fuzzy numbers, Individual Decision Making, Multiperson Decision Making, Multicriteria decision Making, Fuzzy ranking methods.</p>
7.	Book(s)	<p>1.George J.Klir, Bo Yuan, Fuzzy Sets and Fuzzy logic – Theory and Applications, Prentice Hall India, New Delhi, 1997.</p> <p>2.. H.J Zimmermann, Fuzzy sets, Decision making and expert systems, Kluwer, Bosten, 1987.</p> <p>2. S.J. Chen and C.L.Hwang, Fuzzy Multiple Attributes Decision Making, Springer verlag, Berlin Heidelberg, 1992.</p>

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	<p>1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 2nd Ed, Prentice Hall, 2003</p> <p>2. Elaine Rich and Kevin Knight. Artificial Intelligence, Tata McGraw Hill</p> <p>1. Patrick Henary Winston, Artificial Intelligence, Pearson publication</p>

		2. Deepak Khemani. A First Course in Artificial Intelligence, McGraw Hill Education (India) 3. Eugene Charniak 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
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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	<input type="checkbox"/> Extract knowledge using data mining techniques. <input type="checkbox"/> Design a data mart or data warehouse for any organization <input type="checkbox"/> Explore recent trends in data mining such as web mining, spatial-temporal mining
6	Brief Contents	<p>Data Mining Concepts, Input, Instances, Attributes and Output, Knowledge Discovery process, Data 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 Associations, Maximal Frequent & Closed Frequent item sets, Covering Algorithms & Association Rules, Mining Association Rules from Transactional databases, Apriori algorithm, Variations of Apriori algorithm, FP-growth algorithm, Mining Association Rules from Relational databases, Correlation analysis & Constraint-based Association Mining, Multi-level and Multidimensional association mining</p> <p>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</p> <p>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</p> <p>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.</p>
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 2. Ian H. Witten and Eibe Frank, -Data Mining: Practical Machine Learning Tools and Techniques with Java implementations, Morgan Kaufmann Publishers, San Francisco, CA 3. D. Pyle, Data Preparation for Data Mining, Morgan Kaufmann

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	
6	Brief Contents	<p>Fundamentals of Testing: Human and errors, Defects, Faults, Failures, Defect Rate and Reliability, Defect Prevention, Reduction and Containment, Testing and Debugging, Software Quality</p> <p>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</p> <p>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</p> <p>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</p>
7	Contents for lab	
8	List of text books/references	<p>1. Johnson, R. A., Miller & Freund's Probability and statistics for engineers, Pearson Education, 2000. 2</p> <p>2. D Srinivasan and R Gopalswamy; "Software Testing: Principles and Practices", Pearson Education, 2006</p> <p>3. Pham, Hoang. System software reliability. Springer Science & Business Media, 2007.</p>

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	<p>Qubits and quantum states : Classical & 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.</p> <p>Matrices & Operators - Pauli operators, outer products & matrix representation, Hermitian, unitary & normal operators,</p>

		<p>eigenvalues and eigen vectors, characteristic equation, trace of an operator, expectation value of an operator, projection operators.</p> <p>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.</p> <p>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.</p>
7	Contents for lab	No
8	List of text books/references	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 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	
6	Brief Contents	<p>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.</p> <p>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.</p> <p>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.</p> <p>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).</p> <p>Small Sample tests: t-test for single mean, difference of means and paired t-test. χ^2-test for goodness of fit and independence of attributes. F-test for equality of variances.</p>
7	Contents for lab	As per the theoretical contents covered
8	List of text books/references	<p>1. Statistical inference by George Casella, Duxbury advanced series</p> <p>2. An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E. Saleh.</p> <p>Modern Mathematical Statistics by E.J. Dudewicz & S.N. Mishra</p> <p>5. Introduction to the Theory of Statistics by A.M. Mood, F.A. Graybill and D.C. Boes</p>

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	
6	Brief Contents	<p>Introduction to Data Science and AI & ML:</p> <p>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</p>

		<p>Square, Measure of Distribution (Skewness and Kurtosis), Probability Distribution</p> <p>Predictive Analytics: Sampling and Estimation, Linear Regression, Multiple Linear Regression, Non-Linear Regression.</p> <p>Machine Learning: Foundations for ML, Clustering, Naïve Bayes Classifier, K-Nearest Neighbors, Support Vector Machines, Decision Trees, Ensembles methods.</p> <p>Artificial Intelligence: Foundations for AI, Convolution Neural Networks, Recurrent Neural Networks, Deep Learning</p>
7	Contents for lab	No
8	List of text books/references	<p>1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press</p> <p>2. Tom M. Mitchell, Machine Learning - McGraw Hill Education, International Edition</p> <p>3. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, Inc. 2nd Edition</p>

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	To teach the application of mathematics and statistics in real life problems.
6	Brief Contents	<p>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)</p>
7	Contents for lab	As per the theoretical contents
8	List of text books/references	<p>1. Banks, J., Carson, I. I., Nelson, B. L., & Nicol, D. M. (2005). Discrete-event system simulation. Pearson.</p> <p>2. Kishor S Trivedi, Probability & Statistics With Reliability, Queuing And Computer Science Applications, 2nd Ed, Wiley.</p> <p>3. Geoffrey Gordon, System Simulation, Prentice-Hall.</p>

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	<input type="checkbox"/> Extract knowledge using data mining techniques <input type="checkbox"/> Design a data mart or data warehouse for any organization <input type="checkbox"/> Explore recent trends in data mining such as web mining, spatial-temporal mining
6	Brief Contents	<p>Data Mining Concepts, Input, Instances, Attributes and Output, Knowledge Discovery process, Data 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</p> <p>Associations, Maximal Frequent & Closed Frequent item sets, Covering Algorithms & Association Rules, Mining Association Rules from Transactional databases, Apriori algorithm, Variations of Apriori algorithm, FP-growth algorithm, Mining Association Rules from Relational databases, Correlation analysis & Constraint-based Association Mining, Multi-level and Multidimensional association mining</p> <p>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</p> <p>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</p> <p>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</p>
7	Contents for lab	Programming of association mining, classification and clustering algorithms
8	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 Francisco, CA (2000). 3. 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 subject	<ol style="list-style-type: none"> 1. To develop ability to solve real life problems, translating them one form to another, using appropriate mathematical and computational techniques 2. To prepare abstract and critical mathematical thinking, most directly related to computer science 3. To foster rigorous thinking skills that can enhance the quality of work of computing professionals 4. To relate and apply the concepts to practical applications of computer science
7	Brief Contents	<p>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. 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, 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. 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. 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.</p>
8	Contents for lab	NA
10	List of text books/references	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 1. To develop a framework to understand and implement cryptographic aspects. 2. To enhance an ability to analyze a problem, and identify and define the computing requirements for data security. 3. To prepare abstract and critical thinking background for Data science students.
6	Brief Contents	Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Stream Cipher and Block Cipher, Random Number Generator, One-time Pad. 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. Block Cipher Principles, Data Encryption Standard (DES), Multiple Encryption, Triple DES, Advanced Encryption Standard (AES). 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. Authentication Requirement, Authentication Function, MAC, Hash Functions, Security of Hash Function, Digital Signatures.
7	Contents for lab	Programming session for different symmetric/ asymmetric algorithms.
8	List of text books/references	<ol style="list-style-type: none"> 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	<p>To instill the ability to identify skills and gain practical work experience</p> <p>To provide an opportunity to observe and contribute in the workplace</p> <p>To take ownership and responsibility of a project assignment, given by a designated manager/supervisor</p> <p>To provide networking opportunities with other members of the organization</p> <p>To offer performance feedback and mentorship throughout the internship</p>
6	Brief Contents	An internship helps you train under experienced professionals and explore what your chosen career path would be like, and an internship with a company in your field can help you to develop the skills you require to thrive within a professional setting. At the end of the training period, the company may ask you to review your time with them and write a report based on

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

1	Code of the subject	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 the conclusions 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

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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	<p>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.</p> <p>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</p>
7	Text /references	

1	Code of the subject	<input type="checkbox"/> HS102
2	Title of the subject	<input type="checkbox"/> Sports and Physical Education
3	Prerequisite	<input type="checkbox"/> No
4	L-T-P	<input type="checkbox"/> 0-1-2
5	Learning Objectives	<input type="checkbox"/> Students will get knowledge and understanding of the facts, concepts and practice relating to a range of sports-both indoor and outdoor. <input type="checkbox"/> 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	<input type="checkbox"/> he course will be taught in two components <input type="checkbox"/> 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	<input type="checkbox"/> Indoor/ Outdoor: Cricket/ Football/ Volleyball/ Basketball/Badminton/ Table-Tennis/ Lawn-Tennis/ Athletics/ Yoga
8	Text/references	<input type="checkbox"/> Nation at Play: Ronojoy Sen <input type="checkbox"/> The Art of Captaincy: What Sports teaches us about Leadership by Mike Brearley

		<input type="checkbox"/> The Anatomy of Exercise and Movement for the Study of Dance, Pilates, Sports, and Yoga by Jo Ann Staugaard-Jones <input type="checkbox"/> Stress and Its Management by Yoga, by K.N. Udupa, R.C. Prasad <input type="checkbox"/> THE WINNING WAY: Learning from Sport for Managers by Anita Bhogle, Harsha Bhogle <input type="checkbox"/> Think Like a Champion by Webster, Rudi V. <input type="checkbox"/> Attitude is Everything, by Jeff Keller
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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	<p>Upon course completion, students will be able to:</p> <ol style="list-style-type: none"> 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	<p>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)</p> <p>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</p> <p>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.</p> <p>Applied issues in Ecology Sustainability, habitat degradation, degradation of urban and industrial landscape, conservation, threats to biodiversity, evolutionary ecology</p>
7	Contents for lab	NA

8	Text /references	1. Townsend, C.R., Begon, M. and Harper, J.L., 2003. <i>Essentials of ecology</i> (Ed. 2). Blackwell Science. 2. R. Rajagopalan, 2011. <i>Environmental Studies</i> , Oxford IBH Pub. 3. Martell, L., 2013. <i>Ecology and Society: An introduction</i> . John Wiley & Sons.
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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	<p>Upon course completion, students will be able to:</p> <ol style="list-style-type: none"> 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	<p>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.</p> <p>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</p> <p>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.</p> <p>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.</p>
7	Contents for lab	NA

8	Text /references	<ol style="list-style-type: none"> 1. Khandelwal, N. M., 2011. <i>Indian Ethos and Value for Management</i>. Himalaya Publishing House, 1st Edition. 2. Govindarajan, M., Natarajanad, S., SenthilKumar V.S., 2009. <i>Engineering Ethics includes Human Values</i>. PHI Learning Pvt. Ltd. 3. Nandagopal R., Ajith Rn., 2010. <i>Indian Ethos and Values in Management</i>. Tata McGraw Hill Education, 1st Edition. 4. Murthy, P.S.R., 2013. <i>Indian Culture, Values and Professional Ethics</i>. BS Publication
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1	Code of the subject	IT101
2	Title of the subject	Principles of Computer Programming
3	Prerequisite	No
4	L-T-P	3-0-2
5	Learning Objectives	To understand the basic principles of programming languages. To provide design & development of C and Python programming skills. To introduce problem solving methods and program development.
6	Brief Contents	Basics of Computer Languages C, Compilers, Interpreter, Programming Environments and Debugging: types of errors and debugging techniques. Programming features: Data types, Expressions and Operators, Control statements, Iterations. Functions: Scope of variables, call by value, call by reference, Recursion, Pointers. Array, String, Structures and Unions. File handling, File redirection, File pointers. Applications of C programming concepts in different data structures. Python: Introduction, Program Organization, Functions, Modules and Libraries.
7	Contents for lab	Experiments are based on the theoretical contents and their applications
8	Text/references	1. Kernighan, B.W. and D. M. Ritchie (1998): The C programming language, 2nd ed. Prentice Hall of India. 2. Kanetkar, Y (2016): Let us C, 15th ed. BPB Publications. 3. King K.N (2008): C Programming: A Modern Approach. 2nd ed. W. W. Norton & Company.

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

		<p>2. Goodrich, M. and Tamassia, R. <i>Data Structures and Algorithms in Java</i>, John Wiley and Sons, Inc.</p> <p>3. Fundamentals of Data Structures in C -- by Horowitz, Sahni and Anderson-Freed (Silicon Press 2007).</p> <p>4. Data Structure Using C and C++ -- by Y. Langsam, M. J. Augenstein and A. N. Tanenbaum (Pearson Education, 2nd Edition, 2015).</p>
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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	<p>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.</p> <p>Constructor and destructor concepts, Operator overloading and Type Conversion, Inheritance and polymorphism concepts</p> <p>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.</p> <p>Templates: Class template, class template with parameter, function template, function template with parameter and Exception handling</p>
7	Contents for lab	Experiments are based on the theoretical contents and their applications
8	List of text books/references	<p>1. HM Deitel and PJ Deitel —C++ How to Program, Seventh Edition, 2010, Prentice Hall.</p> <p>2. Brian W. Kernighan and Dennis M. Ritchie, —The C programming Language, 2006, Prentice-Hall.</p> <p>3. E Balagurusamy, —Object oriented Programming with C++, Third edition, 2006, Tata McGraw Hill.</p> <p>4. Bjarne Stroustrup, —The C++ Programming language, Third edition, Pearson Education.</p> <p>5. Horstmann —Computing Concepts with C++ Essentials, Third Edition, 2003, John Wiley.</p> <p>6. Robert Lafore, —Object Oriented Programming in C++, 2002, Pearson education.</p>

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 Logic and their use in program proving, resolution principle. Set Theory and Functions, Graph Theory, Group Theory, Elementary Combinatorics etc.
7	Text/references	1. Bernard Kolman, Robert C Busby, S. Ross, Discrete Mathematical Structures, PHI Learning 2. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw-Hill Edition 3. I.N. Herstein, Topics in Algebra, John Wiley Publications 4. Ralph P. Grimaldi, B.V. Ramana, Discrete and Combinatorial Mathematics, Pearson Education

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

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

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

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

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

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

1	Code of the subject	IT207
2	Title of the subject	Operating Systems
3	Prerequisite	Computer Organization; Data Structures and Computer Programming
4	L-T-P	3-0-2
5	Learning Objectives	To study the importance of the operating system and its function, techniques of the operating system to achieve its goals as resource manager. Application interaction with the operating system and the operating systems interaction with the machine.
6	Brief Contents	Introduction and history of Operating systems, Process concepts and scheduling, Storage management, Processor management, Interprocess communication, CPU scheduling, Process Synchronization, Memory Management, Virtual memory concepts, Deadlocks, Device management, File management, File Systems, Free space Management: Bit vector, Linked list. Some case Studies of traditional 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. Dhamdhere, Operating Systems: a concept based approach', Tata McGraw-Hill Pubs. 2. G. Glass, Unix for programmers and users-a complete guide, Pearson Ed.

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

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

1	Code of the subject	IT209
2	Title of the subject	Graph Theory
3	Any prerequisite	N/A
4	L-T-P	3-0-2
5	Learning Objectives	To develop ability to solve real life problems, translating them one form to another, using appropriate mathematical and computational techniques. To prepare abstract and critical mathematical thinking, most directly related to computer science
6	Brief Contents	Introduction to graphs, connected graphs and shortest paths, trees, independent set coverings and matchings, vertex colorings, planar graphs, directed graphs, tournaments, spanning tree, cut-set, vector space of a graph, Applications of graph theory.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. J.A. Bondy and U.S.R. Murty: Graph Theory and Applications. 2. West, Douglas B., Introduction to Graph Theory, Pearson Education, 2002. 3. Mott J.L., Kandel, A. and Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 2001. 4. Reinhard Diestel, Graph Theory, Springer International Edition, 2004. 5. D.B. West: Introduction to Graph Theory, Prentice-Hall of India/Pearson, 2009 6. Deo Narsingh, Graph Theory With Applications To Engineering And Computer Science, PHI, 1992.

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

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

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

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

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

8	List of textbooks/references	1. Boyd, Stephen, Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004. 2. D. Bertsekas Nonlinear programming, 2nd Edition, Athena Scientific, 1999, Nashua. 3. V. Chvatal Linear programming, W. H. Freeman, 1983, New York. 4. E. K. P. Chong and S. Zak, An introduction to optimization, 2nd Edition, 2004, John Wiley and Sons (Asia) Pvt. Ltd., Singapore 5. R. Fletcher, Practical methods of optimization, 2nd Edition, Wiley, 2000, New York 6. D. Luenberger, Linear and nonlinear programming, 2nd Edition, 1984, Kluwer Academic Publisher, New York 7. O. L. Mangasarian, Nonlinear programming, SIAM, 1987, Philadelphia
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1	Code of the subject	IT306
2	Title of the subject	Machine Learning
3	Any prerequisite	Introductory courses on probability theory and linear algebra. Knowledge of basic programming languages such as Python and MATLAB.
4	L-T-P	3-0-2
5	Learning Objectives	After successful completion of this course, students will be 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 from basic linear classifier/regression modeling problems to non-linear classification problems using deep neural networks.
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 Convolutional neural network (CNN): AlexNet, VGG architectures. Introduction to auto-encoder and generative adversarial networks (GAN).
7	Contents for lab	Experiments will be based on the theory covered as above.

8	List of textbooks/references	<p>1. Christopher Bishop. Pattern Recognition and Machine Learning, 2nd Edition</p> <p>2. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition.</p> <p>3. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2nd Edition, 2008.</p>
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1	Code of the subject	IT307
2	Title of the subject	Wireless Communication Technologies
3	Any prerequisite	Student should have basic knowledge of communication/data communication.
4	L-T-P	3-0-2
5	Learning Objectives	This course introduces the concepts of wireless/mobile communication using cellular technologies. It helps students to know about the various modulation techniques, propagation methods, and multi-access techniques used in mobile communication. It provides detailed ideas about path loss and shadow fading and how to solve such problems as also various types of diversity and their outage probability.
6	Brief Contents	Fundamentals of Communication: Fundamentals of Wireless Communication, Advantages, Limitations, and Applications, Multiple access technique: TDMA, CDMA, FDMA, CSMA, OFDMA, Frequency spectrum. Wireless Technology: The cellular concepts: Frequency Reuse, Channel assignment strategies, Handoff strategies Interference and System Capacity, Evolution of cellular networks, Path Loss and Shadowing Concepts, Diversity Techniques, Wireless local area networks, etc.
7	Contents for lab	Experiments will be based on the theory covered as above.
8	List of textbooks/references	<p>1. Andrea Goldsmith, Wireless communication, Cambridge University Press, 2005.</p> <p>2. Roy Blake, Wireless communication technologies, Leo Chartland, Delmar Cengage Learning, 1st edition, 2000.</p> <p>3. Modern Wireless Communications by Simon O. Haykin and Michael Moher, Pearson, 1st edition (March 4, 2004)</p> <p>4. Rappaport, Theodore S. Wireless communications: Principles and practice, 2nd Edition. Pearson Education India, 2010.</p>

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

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

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

4	L-T-P	3-0-0
5	Learning Objectives of the subject (in about 50 words)	This course is largely about proving methods in the field of cryptography. This course is expected to build fundamental and deeper theoretical knowledge related to cryptography.
6	Brief Contents	Basics of Symmetric Key Cryptography, Asymmetric Key Cryptography, Hardness of Functions, Goldwasser-Micali Encryption, Goldreich-Levin Theorem, Attacks under Message Indistinguishability: Chosen Plaintext Attack (IND-CPA), Chosen Ciphertext Attacks (IND-CCA1 and IND-CCA2), Message Non-malleability Attacks like NMCPA and NM-CCA2, Inter-relations among the attack model, Pseudo-random Generators (PRG), Relation between One-way functions and PRG, Pseudo-random Functions (PRF), Left or Right Security (LOR), Formal Definition of Weak and Strong MACs, Using a PRF as a MAC, Variable length MAC, Public Key Signature Schemes, Assumptions for Public Key Signature Schemes, Shamir's Secret Sharing Scheme, Formally Analyzing Cryptographic Protocols, Zero Knowledge Proofs and Protocols.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, 2. Hans Delfs, Helmut Knebl, CRC Press, "Introduction to Cryptography, Principles and Applications", 3. Wenbo Mao, Springer Verlag., "Modern Cryptography, Theory and Practice", 4. Shaffi Goldwasser and Mihir Bellare, Pearson Education (Low Priced Edition), Lecture Notes on Cryptography

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

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

1	Code of the subject	IT404
2	Title of the subject	Software Engineering
3	Any prerequisite	N/A
4	L-T-P	3-0-2
5	Learning Objectives	To help students to develop skills that will enable them to construct software of high quality – software that is reliable, and that is reasonably easy to understand, modify and maintain
6	Brief Contents	Introduction, software life-cycle models, software requirements specification, formal requirements specification and verification - axiomatic and algebraic specifications, function-oriented software design, object-oriented design, UML, design patterns, user interface design, coding and unit testing, integration and systems testing, debugging techniques, software quality - SEI CMM and ISO-9001. Software reliability and fault-tolerance, software project planning, monitoring, and control, software maintenance, computer-aided software engineering (CASE), software reuse, component-based software development, extreme programming.
7	Contents for lab	Experiments will be based on the theory covered as above.
8	List of text books/references	<ol style="list-style-type: none"> 1. Ian Sommerville, Software Engineering, Addison-Wesley 2. Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India. 3. Pankaj Jalote, An integrated approach to Software Engineering, Springer/Narosa. 4. Roger S. Pressman, Software Engineering: A practitioner's approach, McGraw Hill.

1	Code of the subject	IT405
2	Title of the subject	Data Mining
3	Any prerequisite	N/A
4	L-T-P	3-0-2
5	Learning Objectives	Extract knowledge using data mining techniques. Explore recent trends in data mining such as web mining, spatial-temporal mining. Be acquainted with the tools and techniques used for Knowledge Discovery in Databases.
6	Brief Contents	Data Mining Concepts, Input, Instances, Types of Data, Data Mining Functionalities, Interestingness of Patterns, Classification of Data Mining Systems, Data Mining Task Primitive, Data Cleaning, Data Integration & Transformation, Data Reduction , Mining Frequent Patterns, Associations and Correlations, Mining Methods, Mining various Kinds of Association Rules, Decision Tree Induction, Bayesian Classification, Rule Based Classification, Classification by Back propagation, Support Vector Machines, Associative Classification, Lazy Learners, K-means Partitioning Methods, Multidimensional analysis & Descriptive mining of Complex data objects, Mining Spatial Databases, Mining Multimedia Databases, Mining Timeseries & Sequence data, Mining Text databases, Mining World -Wide Web Data Mining Applications and Trends in Data Mining, Massive Datasets/Text mining, Agent-Based Mining
7	Contents for lab	Experiments will be based on the theory covered as above.
8	List of text books/references	<ol style="list-style-type: none"> 1. Jiawei Han and Micheline Kamber, —Data Mining: Concepts and Techniquesl, Morgan Kaufmann Publishers, 2000 . 2. Ian H. Witten and Eibe Frank, —Data Mining: Practical Machine Learning Tools and Techniques with Java implementationsl, Morgan Kaufmann Publishers, San Fransisco, CA (2000). 3. Dorian Pyle, —Data Preparation for Data Miningl, Morgan Kaufmann, (1999) 4. Korth, Silbertz, Sudarshan, —Database Conceptsl, McGraw Hill 5. Elmasri, Navathe, —Fundamentals of Database Systemsl, Addison Wesley

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

8	List of text books/references	<ol style="list-style-type: none"> 1. Pethuru Raj, Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press. 2. Arshdeep Bahga, Vijay Madisetti, Internet of Things: A Hands-on Approach", Universities Press.
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1	Code of the subject	IT407
2	Title of the subject	Mobile Computing
3	Any prerequisite	Computer Networks
4	L-T-P	3-0-0
7	Learning Objectives	Understand the basic concepts of mobile computing and different mobile platforms and applications.
8	Brief Contents	Introduction, Mobility Management, Data Management, Software Models, Context Sensing, Overview of Mobility models, Cloud-based services, Peer-to-peer applications, Delay-tolerance, Distributed transactions in mobile environments.
9	Contents for lab	N/A
10	List of text books/references	<ol style="list-style-type: none"> 1. Pitoura, Evaggelia, and George Samaras. Data management for mobile computing. Vol. 10. Springer Science & Business Media, 2012. 2. Hansmann, LotharMerk, Martin Niclous, Stober, Principles of Mobile Computing 3. Tomasz Imielinski, Mobile Computing, Springer.

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

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

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

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

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

1	Code of the subject	IT599
2	Title of the subject	M.Tech. Thesis Part-2
3	Any prerequisite	Art of Engineering Research, concerned research domain knowledge and M.Tech. Thesis Part-1
4	L-T-P	0-0-24
5	Learning Objectives	To continue research from M.Tech. Thesis Part-1, develop further deeper knowledge, understanding, capabilities and attitudes in the context of the thesis.
6	Brief Contents	The purpose of this course is to enable the student to develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study. The student is expected to demonstrate the abilities of the major subject/field of study, including deeper insight into hardware/software application development work. Develop the capability to create, analyse and critically evaluate different technical/architectural solutions. Equip with the needed skills to clearly present and discuss the conclusions 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
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1	Code of the subject	IT001
2	Title of the subject	Computer Vision
3	Any prerequisite	Machine learning
4	L-T-P	3-0-0
5	Learning Objectives of the subject	In this course, students will gain a broad understanding of the algorithms used for image segmentation, feature extraction and object detection. They will also understand the challenges involved in end-to-end machine vision system along with image acquisition, model deployment and actuation.
6	Brief Contents	Introduction to Image Processing system- Thresholding, Image Enhancement, Contrast Stretching, Image Histograms, Filters, Image Sharpening, Gradient based Edge Detection, finding corners, Using Scale and Orientation to Build neighborhood, SIFT, SURF, HOG feature detection, Computing local features, and Segmentation, Convolutional Neural Networks, Padding, Strided Convolution, Convolution over Volume, One layer Convolution, Pooling, object localization, object detection, Classic Networks, Transfer Learning, ImageNet Challenge, Feature extraction from videos and parallelization, Image Acquisition.
7	Contents for lab	N/A
8	List of text books/references	1. Forsyth and Ponce, Computer vision: A modern approach, Pearson, 2002. 2. Simon J.D. Prince, Computer vision: models, learning and inference, Cambridge University, 2012. 3. E. R. Davies, Computer Vision: Principles, Algorithms, Applications, Learning, Academic Press; 5th edition, 2017

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

8	List of text books/references	<ol style="list-style-type: none"> 1. Alan V. Oppenheim and Ronald W. Schaffer, 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.
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1	Code of the subject	IT003
2	Title of the subject	Pattern Recognition
3	Any prerequisite	Introductory courses on probability and linear algebra. Knowledge of basic programming languages.
4	L-T-P	3-0-0
5	Learning Objectives of the subject	After successful completion of this course, students should have a clear understanding of the basic steps of pattern recognition system, need of feature extraction and feature selection, and dimensionality reduction. Finally, students should have practical hands-on experience of implementing several pattern recognition techniques on real-time data.
6	Brief Contents	Introduction to pattern recognition (PR), data-sets, paradigms of PR. Representations of Patterns and Classes, Decision boundaries for binary-class/multiclass classification. problems. Supervised vs Unsupervised classification; Feature extraction and feature selection (dimensionality reduction). Bayesian Decision Theory, Linear Discriminant Function, Maximum Likelihood Estimation, and Bayesian Parameter Estimation and Support Vector Machines. Non-Parametric Techniques: Nearest Neighbor Methods and Parzen Window Method; Unsupervised Methods: PCA, LDA, LPP, K-means, and Mean-shift algorithm. State-space analysis: First-order Hidden Markov Models.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Christopher Bishop. Pattern Recognition and Machine Learning, Second Edition 2. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, Wiley, 2000. 3. Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad. 4. Lawrence R. Rabiner, Ronald W. Schaffer, Digital Processing of Speech Signals

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

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

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

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

3	Any prerequisite	N/A
4	L-T-P	3-0-0
5	Learning Objectives of the subject	At the end of this course, students will be able to understand the knowledge within the area of intelligent video technology, with emphasis on motion tracking, enhancement and restoration, video segmentation and optimization.
6	Brief Contents	Video Sampling and Interpolation, Basic Linear Filtering with Applications to Image Enhancement, Computational Models of Early Human Vision, Motion Detection and Estimation, Video Enhancement and Restoration, Video Segmentation, Motion Segmentation, Tracking: Motion Tracking in Video, 2D and 3D Motion Tracking in Digital Video, Methods using Point Correspondences, Optical Flow and Direct Methods, Optimization: Pel-Recursive Methods, Bayesian Methods, Applications: Video Stabilization and Mosaicing, A Unified Framework for Video Indexing, Summarization, Browsing and Retrieval, Video Surveillance.
7	Contents for lab (If applicable)	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Alan Bovik, The Essential Guide to Video Processing 2. A Murat Tekalp, Digital Video Processing 3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.

1	Code of the subject	IT007
2	Title of the subject	Advanced Machine Learning
3	Any prerequisite	Machine Learning
4	L-T-P	3-0-0
5	Learning Objectives of the subject	The course objectives are to expose students to learn several advanced machine learning topics including variants of deep-learning models. Also, students will be emphasized to solve several real-time projects based on the concepts learned in the course.
6	Brief Contents	Review of Machine Learning, Neural Network, Learning algorithms – Backpropagation algorithm, Optimization algorithms, Deep Neural Networks and their variants, Convolutional Neural Networks, Generative Adversarial Network, Recurrent Neural Network, Transformer, etc. Projects related to different domains like health care, agriculture, automobile, etc.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. Deep learning. MIT press, 2016. 2. David Dietrich, Barry Heller and Beibei Yang, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, EMC Education Services, Reprint 2015, Wiley. 3. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Taylor & Francis Group, Second Edition, 2015, Chapman & Hall / CRC Press.

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

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

8	List of text books/references	1. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, Morgan Kauffman, Digital Watermarking and Steganography, 2007 2. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Morgan Kauffman, Digital Watermarking principles, 2007. 3. Introduction to Watermarking Techniques and Applications, AP Lambert Academic, 2020
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1	Code of the subject	IT010
2	Title of the subject	Applied Image Processing
3	Any prerequisite	Image Processing
4	L-T-P	3-0-0
5	Learning Objectives of the subject	To introduce the basic concepts of Digital image processing with emphasis on applications in various field of recent research.
6	Brief Contents	Review of Image processing techniques, filtering in spatial and frequency domain, Image segmentations, object representations, Industrial applications of image processing, Biomedical applications of image processing, Image processing in healthcare and agriculture etc.
7	Contents for lab	N/A
8	List of text books/references	1. G. J. Awcock, Ray Thomas, Applied Image Processing, McGraw-Hill, 1996 2. Rafael C. Gonzalevez and Richard E. Woods, Digital Image Processing 2nd Edition, Published by: Pearson Education. 3. R.J. Schalkoff, Digital Image Processing and Computer Vision John Wiley and Sons, NY. 4. William K. Prat, Digital Image Processing, John Wiley and Sons, NY.

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

		to SDR. Evolution of SDR Baseband Requirements. SDR Architectures -Ideal SDR Architectures, Realistic SDR Architecture. SDR and Cognitive Radio Relationship.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Hoseyin Arslan (Ed.), "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems," Ser. Signals and Communication Technology, xviii, I. edition, Springer, Aug. 2007 2. Joseph Mitola, III, "Cognitive Radio Architecture: The Engineering Foundations of Radio XML," John Wiley and Sons Ltd., 2006. 3. Kwang-Cheng Chen and Ramjee Prasad, Cognitive Radio Networks, John Wiley & sons, 2009. 4. Ahmed Khattab, Dmitri Perkins, Magdy Bayoumi, Cognitive Radio Networks: From Theory to Practice, Springer, 2013.

1	Code of the subject	IT012
2	Title of the subject	Next Generation Networks
3	Any prerequisite	It is desirable to have the knowledge of Data networking and Telecommunications principles.
4	L-T-P	3-0-0
5	Learning Objectives of the subject	After successful completion of this course, students will able to learn emerging network technologies, their features, challenges, advantages, and disadvantages. To learn how broadband data and multimedia services are carried out to users over a common Multi-Service Infrastructure.
6	Brief Contents	Introduction To Next Generation Networks (NGN): Communication and Networking in coming Era, Technologies influencing change, NGN Services, Network Infrastructure convergence, services convergence etc., Overview of Wireless network and Technologies GSM, 1G, 2G, 3G and 4G, Bluetooth, Radio frequency, Overview Of TCP/IP, LANs, WANs. Optical Networks, Wire-line and Wireless Networks, General packet radio service (GPRS): GPRS and packet data network, network architecture, operation, and data services in GPRS. Applications of GPRS, Billing, and charging in GPRS, Ad-hoc network: Architecture and Protocols, Wireless LAN, IEEE802.11a, 802.11b standards, Wireless LAN architecture, Mobile ad hoc networks, and sensor network.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Neill Wilkinson, "Next Generation Networks Services, Technologies, and Strategies", Wiley, 2002. 2. Robet Wood, "Next Generation Network Services", Pearson, 2005. 3. YB. Lin and I Chlamtac, "Wireless and Mobile Network Architectures", Wiley, 2001 4. A.S. Tanenbaum, "Computer Networks", Pearson Education, 2003.

1	Code of the subject	IT013
2	Title of the subject	Queuing Theory
3	Any prerequisite	Basic knowledge of Engineering Mathematics and
4	L-T-P	3-0-0
5	Learning Objectives of the	To teach the applications of queuing theory related to
6	Brief Contents	<p>Basics of Probability and Statistics, Random processes- Introduction, classification, Stationary process – Wide Sense Stationary, Strict Sense Stationary, Markov Process, Markov Chain, Problems based on Markov Process. Transition probabilities, Limiting distributions, Poisson Process - Properties, Poisson Process - Problems</p> <p>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.</p> <p>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.</p> <p>Priority queues-Queues with preemption, queues with time dependent priorities.</p> <p>Series queues, Open Networks, Closed Networks, batch service, batch arrival.</p>
7	Contents for lab	N/A
8	List of text books/references	<p>1. K. S. Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, John Wiley and Sons, 2nd edition, 2002.</p> <p>2. A.O. Allen, Probability, Statistics and Queuing Theory with Computer Applications, Elsevier, 2nd edition, 2005.</p> <p>3. Srivastava, H. M., & Kashyap, B. R. K. (1982). Special functions in queuing theory and related stochastic processes. ACADEMIC PRESS.</p> <p>4. Dimitri P. Bertsekas and Robert G. Gallager, "Data Networks," (2nd edition) Prentice Hall, 1992</p> <p>5. Leonard Kleinrock, Wiley-Interscience, Queueing Systems, Volume I; 1st edition (1 January 1975).</p>

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	<p>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.</p>

6	Brief Contents	Review of all Network Technologies, Study of Various Quality of service aspects in wired and wireless Networks based on applicative scenarios and their optimization.
7	Contents for lab	N/A
8	List of text books/references	<p>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.</p> <p>2. D. Medhi and K. Ramasamy, Network Routing: Algorithms, Protocols, and Architectures, Morgan Kaufmann Publishers (an imprint of Elsevier), publication date: March 29, 2007.</p> <p>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.</p>

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

1	Code of the subject	IT016
2	Title of the subject	Multimedia Networks
3	Any prerequisite	N/A
4	L-T-P	3-0-0
5	Learning Objectives of the subject	The course is aimed at developing students' ability to understand and apply the fundamental ideas that govern the design of the architecture of modern multimedia communication networks to real problems.
6	Brief Contents	Multimedia networks principles, Audio video streaming, Jitter problems, Multicast, principles, and protocols, Multimedia Protocols – SIP, RTSP, etc., Traffic engineering and Quality of services, Queuing architectures, Content in Distributed network, CDN architecture.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Multimedia Communications: Protocols and Applications, Prentice Hall, 1998 2. Multimedia Communications: Protocols and Applications, F. Kuo, W. Effelsberg, and J. Garcia-Luna-Aceves, Prentice Hall PTR, 2000 3. Multimedia over IP and Wireless Networks: Compression, Networking, and Systems, by M. Van der Schaar, P. Chou, Academic Press, 2007. 4. Multimedia Communications Applications, Networks, Protocols and Standards Fred Halsall, Addison Wesley, 2001

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

8	List of text books/references	1. Alasdair Gilchrist (Apress), "Industry 4.0: The Industrial Internet of Things" 2. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), "Industrial Internet of Things: Cyber manufacturing Systems". 3. White papers and research articles.
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1	Code of the subject	IT018
2	Title of the subject	Detection and Estimation Theory
3	Any prerequisite	Student must have basic knowledge about linear algebra,
4	L-T-P	3-0-0
5	Learning Objectives of the subject (in about 50 words)	The students will learn to mathematically formulate appropriate detection and estimation problems, solve these problems to get good/best detectors and estimators and analyze their performance. This is a math-oriented course and will use concepts from probability and linear algebra.
6	Brief Contents	Review of Gaussian variables and processes, Statistical Decision Theory: Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio, composite hypothesis testing, Detection of Deterministic Signals: Matched filter detector and its performance. Detection of Random Signals: Estimator- correlator, linear model, general Gaussian detection. Nonparametric Detection: Detection in the absence of complete statistical description of observations. Estimation of Signal Parameters: Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics. Signal Estimation in Discrete-Time: Linear Bayesian estimation, Weiner filtering, dynamical signal model, discrete Kalman filtering.
7	Contents for lab	N/A
8	List of text books/references	1. H. L. Van Trees, Detection, Estimation and Modulation Theory, John Wiley and sons 2004. 2. Signal detection and estimation by Mourad Barkat, Artech House 1991. 3. An Introduction to Signal Detection and Estimation by Poor, H. Vincent, Springer 1998.

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

		etc.; analyze and design core architectures, components, and techniques in distributed systems.
6	Brief Contents	Introduction to Distributed Systems: Parallel versus distributed systems, challenges, CAP theorem; Functional requirements: Naming, replication, consistency, consensus; Non-functional requirements: Measuring NFRs, scalability and elasticity etc.; Resource management and scheduling: scheduling issues for small and large systems, centralized and decentralized schedulers, portfolio scheduling; System architecture and programming models: Communication, big data, machine learning, layering; Distributed ecosystems: massive processing, the super-distribution principle, cloud, edge, big data, Distributed ecosystems in online gaming etc.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Von Bochmann, Gregor, "Concepts for distributed systems design", Springer Science & Business Media, 2012. 2. Van Steen, Maarten, and Andrew S. Tanenbaum, "Distributed systems". 3. Sukumar Ghosh, "Distributed systems", CRC Press 4. Ajay D. Kshemkalyani and Mukesh Singhal, "Distributed computing: Principles, algorithms and systems", Cambridge press.

1	Code of the subject	IT020
2	Title of the subject	Information Theory and Coding
3	Any prerequisite	Linear algebra
4	L-T-P	3-0-0
5	Learning Objectives of the subject	<p>This course gives brief knowledge about the basic algebraic relationships of entropy, relative entropy, and mutual information.</p> <p>In this course students learn how to compress the data using source coding and how to make data transmission reliable using channel coding. It introduces the basic principles of encoding, decoding, error detecting and error correcting techniques.</p>
6	Brief Contents	Information Theory: Introduction, Discrete memory less source, Binary source. Entropy, Relative Entropy, and Mutual Information, Channel capacity, Data Compression Examples of Codes, Kraft Inequality, Optimal Codes, Bounds on the Optimal Code Length, Kraft Inequality for Uniquely Decodable Codes, Huffman Codes, Shannon–Fano Coding, etc. Error detecting and Error correcting code, Block Codes, Cyclic Codes, Convolution Codes
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Joy A. Thomas and Thomas M. Cover, Elements of Information Theory, John Wiley and Sons. 2. John G. Proakis, McGraw Hill, Digital Communication Singapore, 4th Edition, 2001. 3. Bernard Sklar, Digital Communications: Fundamentals and Applications, 2nd Ed., Pearson Prentice Hall, 2001.

1	Code of the subject	IT021
2	Title of the subject	Convex Optimization
3	Any prerequisite	Basic knowledge of Engineering Mathematics and Statistics
4	L-T-P	3-0-0
5	Learning Objectives of the subject	To learn the concepts and applications of optimization for solving real world problems.
6	Brief Contents	<p>Linear Programming: Convex sets, Mathematical Model, Assumptions of linear programming, Graphical method Simplex method, Big M Method, Two-Phase Method, Exceptional cases in LPP.</p> <p>Duality in Linear Programming: Dual simplex method, revised simplex method, sensitivity or Post-optimal analysis, Transportation problem, Assignment Problem.</p> <p>Integer Programming Problem: Cutting plane method, Gomory's cut method, Branch and bound technique, Travelling salesman problem, Cargo loading problem.</p> <p>Non-linear Programming: Quadratic forms and classical methods, Convex functions and Kuhn-Tucker theory, Beale's method, Separable programming.</p> <p>Dynamic Programming and Game Theory: Bellman's principle, Recursive relations, Solution of LPP by dynamic programming, Game theory, games with mixed strategy, Stochastic linear programming.</p>
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Taha, H.A., 1992. Operations Research (5th edn), Prentice Hall Publication. 2. Hillier, F.S. and Lieberman, G.J., 1967. Introduction to operations research. San Francisco: Holden-Day. 3. Ravindran, A, Phillips, DT, Solberg, JJ. 1987. Operations Research: Principles and Practice, John Wiley 4. Boyd, Stephen, Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.

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

6	Brief Content	Information Hiding, Steganography, and Watermarking, Importance of Digital Watermarking, Applications and Properties. Models of Watermarking: Communication-Based Models of Watermarking, Geometric Models of Watermarking, Modelling Watermark Detection by Correlation; Basic Message Coding: Mapping Messages into Message Vectors, Error Correction Coding, Detecting Multi-symbol Watermarks; Watermarking with Side Information: Informed Embedding, Watermarking Using Side Information, Dirty-Paper Codes; Robust Watermarking: Approaches, Robustness to Volumetric Distortions, Robustness to Temporal and Geometric Distortions; Watermark Security: Security Requirements, Watermark Security and Cryptography, Some Significant Known Attacks; Content Authentication: Exact Authentication, Selective Authentication, Localization, Restoration; Notation and Terminology, Information-Theoretic Foundations of Steganography, Practical Steganographic Methods, Minimizing the Embedding Impact; Steganalysis: Steganalysis Scenarios, Some Significant Steganalysis Algorithms.
7	Contents for lab (If applicable)	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, Morgan Kauffman, Digital Watermarking and Steganography. 2. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Morgan Kauffman, Digital Watermarking principles 3. Frank Y. Shih, Digital Watermarking and Steganography: Fundamentals and Techniques, Second Edition CRC Press.

1	Code of the subject	IT023
2	Title of the subject	Cryptography and Network Security
3	Any prerequisite	Linear Algebra
4	L-T-P	3-0-0
5	Learning Objectives of the subject	To enhance the ability to analyse, identify and define the computing requirements for data security.
6	Brief Contents	Classical Encryption Techniques, Finite Field and Number Theory, Polynomial Arithmetic, Prime Numbers, Fermat's And Euler's Theorem, Testing For Primality, Key Management, Elliptic Curve Arithmetic, Elliptic Curve Cryptography. Cryptographic Protocols, Digital Signatures. Authentication applications, IP security, Encapsulating Security Payload (ESP)-Internet Key Exchange (Phases of IKE, ISAKMP/IKE Encoding). Web Security: Web Security Considerations, Secure Socket Layer and Transport layer Security. System Security: Intrusion Detection, Virus and related threats, Firewalls, Trusted Systems.
7	Contents for lab	N/A

8	List of text books/references	1. William Stallings, Cryptography and Network security, 4e, Prentice Hall of India, New Jersey, 2008. 2. Christof Paar, Jan Pelzl, Understanding Cryptography, Springer-Verlang, Berlin, 2010 3. Behrouz A Forouzan, Cryptography and Network security, Tata Mc-Graw Hill, New York, 2007.
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1	Code of the subject	IT024
2	Title of the subject	Distributed System Security
3	Any prerequisite	Basics of Distributed System
4	L-T-P	3-0-0
5	Learning Objectives of the subject	This is a course that will cover advanced security concepts beyond traditional offerings. Emphasis will be made on all aspects of cyber security including vulnerabilities, threats, attacks and defences in distributed systems.
6	Brief Contents	Security Requirements of Distributed Systems; Security Violations, Security Goals, Security Services, Security Protocols, and Security Mechanisms; Attack on Security Protocols and Security Mechanisms; Secret Sharing Techniques and One-Way Functions; Discrete Logs, Block Encryption/Decryption Functions, Hash Functions, and MAC Functions; Algorithmic Implementation and Security Requirements of One-Way Functions; OS Security Violations and Techniques to Prevent Them; Access Control Models; Authenticated Diffie-Hellman Key Establishment Protocols; Group Key Establishment Protocols; Block Ciphers and Stream Ciphers; Block Cipher Modes of Encryption; Nonce, Timestamps and Authentication Protocols; Digital Page 1/6Signatures and Source Non-Repudiation Protocols; PKI and X.509 Authentication Service; Security Protocol Verification: Strand Space Theory; Kerberos; E-mail Security; Security Issues in Layered Communication Models: IP Security, Secure Socket Layer and Transport Layer Security; Secure Electronic Transactions; Intrusion Detection; Malicious Software Detection; Firewalls.
7	Contents for lab	N/A
8	List of text books/references	1. Anirban Chakrabarti, Distributed Systems Security: Issues, Processes and Solutions 1st Edition by Abhijit Belapurkar (Author), Wiley, 2009. 2. Ajay D. Kshemkalyani and MukeshSinghal, "Distributed Computing: Principles, Algorithms, and Systems", Cambridge University Press, 2011. 3. Andrew S. Tanenbaum and Maarten van Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Pearson Prentice-Hall, 2007.

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

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

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

6	Brief Contents	Review of the prerequisite Cryptography: Private-key cryptosystems; Advanced Encryption Standard (AES), Overview of modular arithmetic, discrete logarithms, and primality/factoring, Public-key cryptosystems; ElGamal cryptosystem, Basic signature schemes. Algebra and number theory: Rings of polynomials, Existence and finding primitive roots, Blum integers, Primes; Agrawal, Kayal, Saxena P-time algorithm for recognizing primes, Elliptic curves. Discrete logarithm-based cryptosystems and signatures: Elliptic Curve Cryptosystem (ECC), Digital Signature Standard (DSS), Selection of other signature schemes, Overview of discrete logarithm algorithms, Ethical aspects of public-key cryptosystems and signatures, Hashing, emerging SHA-3 standard. Interactive protocols: Touch of complexity theory, Interactive proof systems, 0-knowledge proof systems, 0-knowledge authentication, Electronic cash; Chaum and Brands schemes. Private information retrieval: AES news, SHA-3 news, Private/public/group/share key generation and management, Digital watermarking, digital fingerprinting, Steganography. Selected topics in quantum computing, Quantum computers, Shor's algorithm, future demise of RSA, Quantum cryptography, Quantum key distribution and reconciliation
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Douglas R. Stinson, Cryptography: Theory and Practice, CRC Press, fourth edition 2019. 2. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, CRC Handbook of Applied Cryptography, CRC Press. 3. Lawrence C. Washington, Elliptic Curves. Number Theory and Cryptography, Chapman and Hall, CRC Press 2003.

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

6	Brief Contents	Introduction to Information security and Secure coding, Injections (SQL, command, JSON), defenses, Broken authentication and Session management. Cross-site Scripting (reflected XSS HTML, reflected XSS JS), Insecure direct object reference, Security misconfiguration. Sensitive data exposure, Missing function level access control, Cross-site request forgery. Using components with known vulnerabilities, Invalidated redirects and forwards. Buffer overflows, Insecure interaction between components. Risky resource management, Porous defences, Active defences, Threat modeling.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. "Fundamentals of Cyber Security", Mayank Bhushan, Rajkumar Singh Rathore, Aatif Jamshed, <i>BPB Publications</i>. 2. "Building Secure Software: How to Avoid Security Problems the Right Way", Viega, John, Gary McGraw, <i>MAddison-Wesley Professional</i>. 3. "Foundations of Information Security: A Straightforward Introduction", Jason Andress, No Starch Press, US.

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

7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Michael Sikorski and Andrew Honig, Practical Malware Analysis, No Starch Press, 2012 2. Reverend Bill Blunden, The Rootkit Arsenal: Escape and Evasion in the Dark Corners of the System, Second Edition 3. Jamie Butler and Greg Hoglund, Rootkits: Subverting the Windows Kernel. 4. Dang, Gazet, Bachaalany, Practical Reverse Engineering, Wiley, 2014

1	Code of the subject	IT029
2	Title of the subject	Formal methods for Security Verifications
3	Any prerequisite	Operating Systems Concepts, Information System Security
4	L-T-P	3-0-0
5	Learning Objectives of the subject	To make use of mathematical background to understand and use formal methods like set theory, propositional logic and operational semantics
6	Brief Contents	Introduction to Formal Methods, Mathematical Background, Formal Specifications, Case Study Formal Specifications and Models, Model Checking and Formal Verification, Advanced models: Real-time models, Case Study Formal Verification, Static and Dynamic Analysis of programs, temporal logic: CTL and LTL, Buchi automata, Explicit model checking, BDDs and model-checking with BDDs, symbolic model checking, SAT and model-checking with SAT, Security verification, hybrid automata, hybrid system verification, applications of model checking to hardware, software, and protocols verification.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Edward Griffor, Handbook of System Safety and Security. 2. Ulrich Kühne, Rolf Drechsler, Formal Modeling and Verification of Cyber-Physical Systems. 3. Michael Huth and Mark Ryan, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge Univ. Press, 2nd edition

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

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

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

6	Brief Contents	Introduction to Parallel and Distributed Systems: Parallel Programming Paradigms, Parallel Architecture, Principals of Parallel Programming, Models of Parallel Computation, Complexity, PRAM, Memory Consistency & Performance Issues, Memory Consistency & Performance Issues, Shared Memory & Message Passing. OpenMP: Introduction to OpenMP, Work Sharing, Scheduling, Synchronization, Tasks, Environment Variables, and Run-Time Library Routines, Other Clauses and Directives. MPI: Basics of MPI, Cost Model, One-sided/two-side communication, Hybrid programming (MPI + OpenMP). Introduction to CUDA: GPU architecture, high-performance computing on GPUs, parallel algorithms, CUDA libraries, and applications of GPU computing. Introduction to the design of parallel algorithms and hands-on.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Chandra et al, —Parallel Programming in OpenMP, Morgan Kaufmann. 2. Chapman, Jost, and van der Pas, —Using OpenMP: Portable Shared Memory Parallel Programming, MIT Press. 3. Tanenbaum, Andrew S. Distributed operating systems. Pearson Education India, 1995. 4. Programming Massively Parallel Processors (3rd Edition)

1	Code of the subject	IT034
2	Title of the subject	Scientific Computing and Numerical Methods
3	Any prerequisite	Engineering Mathematics
4	L-T-P	3-0-0
5	Learning Objectives of the subject (in about 50 words)	To demonstrate an understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems. To apply numerical methods to obtain approximate solutions to mathematical problems.
6	Brief Contents	Introduction, types of errors, Bisection Method, False Position Method, Newton-Raphson Method, Gauss Jordan Methods, etc and their Convergence. Finite Difference Operators and Their Relationships, Difference Tables, Differentiation Continuous Functions, Differentiation of Tabulated Functions, Higher Order Derivatives Newton-Cotes Integral Formula, Trapezoidal Rule, Simpson's Rules, Boole's Rule and Weddle's Rule, Romberg Integration, Taylor Series Method, Picard's Method, Runge-Kutta methods, etc.

7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Balagurusamy, E., Numerical Methods, Tata McGraw Hill Education Pvt. Ltd., 1999. 2. Sastry, S. S., Introductory Methods of Numerical Analysis, PHI Learning Pvt Ltd., 2012. 3. Jain, M. K., Iyengar, S.R.K and Jain, R.K, Numerical Methods for Scientific and Engineering computation, Wiley Eastern Ltd., 1985.

1	Code of the subject	IT035
2	Title of the subject	Game Theory
3	Any prerequisite	Basic knowledge of Engineering Mathematics and
4	L-T-P	3-0-0
5	Learning Objectives of the subject	To learn the applications of game theory, auction and equilibrium.
6	Brief Contents	Introduction to Game Theory, Dominant Strategies and Nash Equilibrium, Alternate Strategies: Maximin, Maximax, and Minimax Regret Solvability, N-Player Games, Mixed Strategy, Subgame Perfection in Discrete Choice Games, Continuous Games and Imperfect Competition, Infinitely Repeated Games, Tacit Collusion, Simultaneous-play, Bayesian Games, Applications of Bayesian Games: Auctions and Voting, Cournot's Duopoly with Imperfect Information, Radio Spectrum, With Arbitrary Distribution of Valuations, Extensive Form Game with Perfect Information, Stackelberg Model of Duopoly, Buying Votes, Committee Decision-Making, Repeated games, The Prisoner's Dilemma, General Result, Supermodular Game and Potential Game, Wireless Networks: Resource Allocations, Admission Control, Routing in Sensor and Ad-Hoc Networks, Modeling Network Traffic and Strategic Network Formation, Rubinstein Bargaining Model with Alternating Offers, Nash Bargaining Solution, Multi armed bandit problem.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Martin Osborne, An Introduction to Game Theory, Oxford University Press, 2003 2. Prajit Dutta, Strategies and Games, MIT Press. 3. K H Ericson, Game Theory, Createspace Independent Publishing Platform.

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

6	Brief Contents	Overview of Big Data, State-of-the-art computing paradigms/platforms, Big data programming tools (e.g., Hadoop, MongoDB, Spark, etc.), Big data extraction and integration, Big data storage, Scalable big data indexing, Large-scale graph processing techniques, Big data stream techniques and algorithms, Large-scale probabilistic data analysis, Big data privacy, Big data visualizations, problems in real applications.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Kuan-Ching Li, Hai Jiang, Laurence T. Yang, and Alfredo Cuzzocrea. Big Data: Algorithms, Analytics, and Applications. Chapman & Hall/CRC Big Data Series, 2015. 2. Thomas Erl, Wajid Khattak, and Dr. Paul Buhler. Big Data Fundamentals: Concepts, Drivers & Techniques. The Prentice Hall Service Technology Series, 2016. 3. Wajid Khattak, Paul Buhler, Thomas Erl, Big Data Fundamentals: Concepts, Drivers & Techniques, John Wiley & Sons, Inc

1	Code of the subject	IT037
2	Title of the subject	Nature Inspired Computing
3	Any prerequisite	Basic Mathematics, Data Structures, and Algorithms
4	L-T-P	3-0-0
5	Learning Objectives of the subject	It introduces a new paradigm of computing and solving problems. It has great applications in Artificial Intelligence, Data Mining, Machine Learning, and real-world design and optimization problems.
6	Brief Contents	Introduction to Evolutionary Computation: Representation, Initial Population, Fitness Function, Selection, Reproduction Operators, Stopping Conditions, Evolutionary versus Classical Computation; Genetic Algorithm: Canonical Genetic Algorithm, Crossover, Mutation, Control Parameters, Genetic Algorithm Variants, Applications; Differential Evolution, Particle Swarm Optimization, Artificial Bee Colony Algorithm. ANN Introduction, Evolution, McCulloch-Pitts Neuron, Linear Separability, Hebb Network; Perceptron Networks, Adaptive Linear Neuron, Multiple Adaptive Linear Neuron, Back-Propagation Network, Radial Basis Function Network; Associative Memory Network, Heteroassociative Memory Network, Bidirectional Associative Memory, Hopfield Network, Iterative Autoassociative Memory Network, Temporal Associative, Self-organizing maps, Linear Vector Quantization, Counter Propagation Network.
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. S N Sivanandam and S N Deepa, Principles of Soft Computing, Wiley India 2. Andries P. Engelbrecht, Computational Intelligence: An Introduction, John Wiley & Sons. 3. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, PHI.

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

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

8	List of text books/references	<ol style="list-style-type: none"> 1. Edsger Wybe Dijkstra. A Discipline of Programming. Prentice Hall PTR, Upper Saddle River, NJ, USA. 2. Michael Huth and Mark Ryan. Logic in Computer Science: Modelling and Reasoning about Systems. Cambridge University Press, New York, NY, USA 3. Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman. Compilers: Principles, Techniques, and Tools (2nd Edition). Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA, 2006.
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1	Code of the subject	IT040
2	Title of the subject	Competitive programming
3	Any prerequisite	Data structures and algorithms
4	L-T-P	3-0-0
5	Learning Objectives of the subject	The focus of the course is the development and implementation of advanced algorithms, as well as the skills required for programming competitions.
6	Brief Contents	Introduction; Problem formats; Online judging systems; Parsing Input; Formatting Output, Review of Fundamental Data Structures), Divide and Conquer, Greedy, and Dynamic Programming Approaches; Graph Algorithms- search, shortest path, minimum spanning tree, network flow, bipartite graph matching, String Processing- edit distance, subsequences, suffixes) Numerical algorithms and Combinatorics, Chinese Remainder Theorem and modular math, Large number computations, generating and counting permutations and combinations, Applications of Geometric Algorithms 2D line segment and polygon queries –intersection, area; calculations on a sphere; 3D volume calculations; ray-surface intersection; convex hull; spatial subdivisions, Basic heuristic search, Advanced search and Simulation problems
7	Contents for lab	N/A
8	List of text books/references	<ol style="list-style-type: none"> 1. Halim, Steven, Felix Halim, and Suhendry Effendy. Competitive programming 4: The new lower bound of programming contests in the 2020s, 2018. 2. Laaksonen, Antti. Guide to competitive programming. Cham: Springer, 2020. 3. Skiena, Steven S., and Miguel A. Revilla. "Programming challenges: The programming contest training manual." Acm SIGACT News 34.3 (2003): 68-74.

CODE WITH MSxxx

1	Programme	MBA/IMG
2	Semester	I/VII
3	Type of course	Core
4	Code of the subject	MS601
5	Title of the subject	Principles and Practices of Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Element of Management is concerned with the way in which organizations manage their resources. The aim is to explore the concepts of management, managers, and organizations in today's dynamic environment. This course outline illustrates the varied backgrounds, skills, and characteristics required for successful managers. It continues with an examination of the functions of management, managerial roles and diverse nature of modern business organizations, and rewards and challenges offered by a career in management.
9	Brief Contents	Explain what is meant by the term management, Classify the three levels of managers and identify the primary responsibility of each group, Describe the difference between managers and operative employees, Explain the skills and roles manager, Describe the value of studying management, Identify the relevance of popular humanities and social science courses to management practices, Define planning. Explain the potential benefits of planning, Distinguish between strategic and tactical plans, Define management by objectives and identify its common elements, Outline the steps in the strategic management process, Explain SWOT analysis, Describe the steps in the decision-making process, Identify the assumptions of the rational decision-making model, Define certainty, risk, and uncertainty as they relate to decision making, Identify the two types of decision problems and the two types of decisions that are used to solve them, Describe the advantages and disadvantages of group decisions, Identify and define the six elements of organization structure, Contrast mechanistic and organic organizations, Summarize the effect of strategy, size, technology, and environment on organization structures, Contrast the divisional and functional structures, Define leader and explain the difference between managers and leaders, Describe the skills that visionary leader exhibit, Explain the styles and theories of leadership, Define Motivation at work, Techniques of motivation, Theories of motivation, Explain what is meant by the term learning organization, Define control, Describe three approaches to control, Explain why control is important, Describe the control process, Distinguish among the three types

		of control, Describe the qualities of an effective control system, Explain how controls can become dysfunctional
10	Contents for lab	No

1	Programme	MBA
2	Semester	I
3	Type of course	Core
4	Code of the subject	MS602
5	Title of the subject	Business Statistics
6	Any prerequisite	Basic knowledge of mathematics and statistics
7	L-T-P	3-0-0
8	Learning Objectives of the subject	To understand the role of statistics in the field of business management. To understand the process associated with statistical decisions, defining and formulating problems, analysing the data, and using the results in decision making.
9	Brief Contents	Introduction to Statistics, Charts and Graphs, Measures of central tendency, Measures of dispersion, Probability, Discrete probability distribution, Continuous probability distribution Sampling and sampling distributions, Statistical inference: Estimation for single populations, Statistical inference: Hypothesis testing for single population, Statistical inference: Hypothesis testing for two populations, Analysis of variance and Experimental designs, Hypothesis testing for categorical data (chi-square test), Simple linear regression analysis , Multiple regression analysis, Time series and Index numbers, Statistical quality control, Non-parametric statistics, Statistical decision theory
10	Contents for lab	Application of appropriate statistical software

1	Programme	MBA
2	Semester	I
3	Type of course	Core
4	Code of the subject	MS603
5	Title of the subject	Business Economics
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Managerial Economics is the use of economic theory and mathematical and statistical techniques in order to examine how a firm can make optimal managerial decisions given the constraints it faces. The main objective of this course is to equip students with the necessary theory and techniques and the ability to apply them in order to inform and enhance managerial decision making. Topics covered include: goals of the firm, optimization techniques, demand theory and estimation, forecasting and measurement, theory of production and estimation, cost theory and estimation, pricing and output determination under different market structures, game theory, and pricing in practice.
9	Brief Contents	Introduction to Economics; Nature and Scope of Management Economics, Significance in decision-making and fundamental

		<p>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</p>
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	I/VII
3	Type of course	Core
4	Code of the subject	MS604
5	Title of the subject	Business and Legal Environment
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	This course will give orientation to the students about different forms of organizations, functions in organizations, business environment and strategies, along with an exposure to basic elements of company laws, economics laws, industrial and labour laws, foreign exchange management act in business perspective.
9	Brief Contents	<p>Concepts of Vision and Mission statements, Types of Environments, Business Environment with reference to Global integration, Forms of business organisation: Scales of business; Emerging trends in business, Company Laws: The Companies Act 2013, Limited Liability Partnership Act, 2008, The insolvency and bankruptcy code 2016, Economic Laws: FDI Policy-Foreign Direct Investment in India and abroad, External Commercial Borrowing (ECB), Formalities-Establishment of Branch Office of a foreign entity in India, Foreign Trade Policy- Opportunities of commerce/finance professional in foreign</p>

		trade-Procedure of import and export-Export promotion schemes and initiatives, Competition Commission of India-Compliance of competition law, Industrial and Labour laws: Overview of Industrial Policy of Govt. of India, Regulatory Mechanism under IDRA, MSME Development Act, Advantages of MSMEs and their role and significance in economic development, Central and State Schemes for MSME Promotion-Udyog Aadhar, Foreign Exchange Management Act: Features and Application-Opportunities for Indian Business Challenges, Foreign Contribution (Regulation) Act 2010
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	I/VII
3	Type of course	Core
4	Code of the subject	MS605
5	Title of the subject	Financial Reporting and Control
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	After the completion of this course, students will be able to understand the role and relevance of financial accounting in management and its implications for a business entity, and utility of cost and management accounting information as a vital input for management and decision-making process.
9	Brief Contents	Introduction, nature and scope of financial and management accounting, GAAP and accounting environment, Principles, concepts and conventions of accounting, Accounting process, Construction of profit and loss statement, Balance sheet and cash flow statement, Concept of financial statements analysis, Horizontal and vertical Analysis, Trend analysis, Ratio analysis, Cash flow statement analysis, Cost accounting and information, Types of cost, Preparation of cost sheet, Activity-based costing, Concepts of budget and budgetary control, Static and flexible budgets, Preparation of sales budget, Production budget, Material budget, Cash budget, Master budget, Concept of standard costing and variance analysis, Setting of standards, Analysis of material variances, Labour variances and overhead variances, Marginal costing and absorption costing, Marginal costing, and its applications, Cost-volume-profit analysis, Concept of contribution and break-even analysis and its uses, Margin of safety and angle of incidence.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	I/VII
3	Type of course	Core
4	Code of the subject	MS606

5	Title of the subject	Organizational Behavior
6	Any prerequisite	General Understanding of Management Functioning
7	L-T-P	3-0-0
8	Learning Objectives of the subject	To provide a comprehensive analysis of individual and group behaviour in the organizations. To provide an understanding of how organizations can be managed more effectively and at the same time enhancing the quality of employees work life.
9	Brief Contents	What is organizational behaviour?, OB as an interdisciplinary subject ,The Individual: Diversity in the organizations, attitudes and job satisfaction, emotions and moods, personality and values, perception and individual decision making, motivation concepts, motivation: from concepts to applications The Group: Foundations of group behaviour, understanding work teams, communication, leadership, power and politics, conflict and negotiations, foundations of organization structure, The Organization system Organizational culture, human resource policies and practices, organizational change and stress management
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	I/VII
3	Type of course	Core
4	Code of the subject	MS607
5	Title of the subject	IoT and Big Data Management
6	Any prerequisite	Fundamentals of Computer/ Computer organization and any programming language
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon course completion, students will be able to: Understand deploying smart applications on different IoT platforms. Develop Interface of various sensors, I/O devices and I/O peripherals with N/W Protocols. Understand the impact of big data for business decisions and strategy. Gain hands-on experience on large-scale analytics tools to solve some open big data problems. Understand the concept and challenge of big data and why existing technology is inadequate to analyze the big data
9	Brief Contents	Design principles and needed capabilities, AI applications in IoT Applications, Sensing, Actuation, Basics of networking, M2M and IoT technology fundamentals- devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT, Components selection criterion for implementing IoT application, Hardware components computing (Node MCU, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces, Software components- programming API's (using Python/Node.js/Arduino), Sensors interfacing: Interfacing of temperature, Humidity, Light, Accelerometer, Ultrasonic, IR/PIR, Camera etc, Communication and I/O components,

		Interfacing: bluetooth, WiFi, GSM, Displays and touch sensor etc., Types of Digital Data, Introduction to Big Data, Big Data Analytics, Relational Databases & SQL, Data Cleansing and Preparation, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, analyzing data with Hadoop, Hadoop Streaming, IBM Big Data Strategy, Infosphere Big Insights and Big Sheets, HDFS (Hadoop Distributed File System): The Design of HDFS, HDFS concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data ingest with Flume and Scoop and Hadoop archives, NoSQL, Types of NoSQL database, Advantages, New SQL, Comparison of SQL, NoSQL and NewSQL., Supervised learning with regression and classification techniques, Bias-Variance trade-off, Model validation approaches, Logistic regression, Linear discriminant analysis, Quadratic discriminant analysis, Ensemble methods: random forest neural networks, Deep learning unsupervised learning and challenges for big data analytics, Clustering, associative rule mining, Challenges for big data analytics prescriptive analytics, Creating data for analytics through designed experiments, Creating data for analytics through active learning, Creating data for analytics through reinforcement learning.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	III/IX
3	Type of course	Core
4	Code of the subject	MS608
5	Title of the subject	International Business
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The goal of this course is to introduce participants to the field of international business. This course will make participants familiar with three basic areas: underlying theories of international business, environmental factors affecting international activities, and the management of business functional operations in an international context. In addition, participants will learn how to analyse international situations and evaluate contemporary issues in international business.
9	Brief Contents	Background for International Business: Globalization and International Business, Comparative Environmental Frameworks: The Cultural environments facing business, The Political and Legal environments facing business, The Economic environments facing business, Globalization and Society, Theories and Institutions: Trade and Investment: International trade and Factor mobility theory, Governmental Influence on trade, Cross-National cooperation and agreements

		World Financial Environment Global Foreign: Exchange markets, The Determination of Exchange rates, Global capital markets, Global Strategy, Structure, and Implementation: The Strategy of international business, Country evaluation and selection, Export and Import, Direct investment and Collaborative strategies, The Organization of international business, Managing International Operations: Marketing globally, Global operations and supply-chain management, International accounting and finance issues, International human resource management
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	II/VIII
3	Type of course	Core
4	Code of the subject	MS609
5	Title of the subject	Human Resource Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Human Resource Management (HRM) is concerned with the way in which organizations manage their people. The aim is to chart some of the broad terrain of a rapidly developing field of study in order to prepare the students for the more finely grained treatment of specific HRM topics. This course outline examines the recent rise of HRM, the effects of the changing context of work on HRM, what it involves, and the strategic nature of HRM practice, its impact on organizational performance and the changing role of HRM function.
9	Brief Contents	Define HRM, Describe the Nature, Feature and Scope of HRM, Describe the major activities of HRM, Explain the skills and roles of Human Resource manager, Why HRM is important to all managers, List the challenges and opportunities of HR manager, Define Job Analysis, Explain types of Job analysis, Understand Job Analysis Process, Describe the basic methods of collecting the Job analysis information, Define HR planning, Describe the need and objectives of HR planning, Understand the HR planning model, Explain the factors affecting HR planning, Define Recruitment, Explain essential steps for Recruitment Planning, Understand Recruitment model, Describe sources of Recruitment, Explain the Pros and Cons of recruitment, Define selection , Steps / process of selection, Define Employee training, Explain need and objectives of training, Differentiate between training and development, Describe the principles, areas and benefits of training, Understand the Training Methods, Describe Training system model, Understand levels of training evaluation, Define Career and its related terms, Understand stages of growth and career,

		Describe Career-planning process and its responsibility, Understand the benefits of Career development system, Know the career program for special target groups, Explain the Model or Designing organizational career development, Define Performance appraisal, Explain why it is important to effectively appraise performance, Understand features, purposes and objectives of performance appraisal. Describe the methods of performance appraisal. List the criticism of performance appraisal.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	II/VIII
3	Type of course	Core
4	Code of the subject	MS610
5	Title of the subject	Operations Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Understand the role of operations in both manufacturing and service organizations. Describe the importance of facilities location decision in the end-to-end supply chain. Develop understanding of a range of inventory models available their contextual suitability. Employ different quality prescriptive and the tools of statistical process control.
9	Brief Contents	Operations and strategy: nature, evolution and scope of production and operations management, Emerging trends in operations management, Operations strategy: linkage with competitive strategy and formulation of operations strategy, Facility Planning: facilities location: globalization of operations, Factors affecting location decisions, Location planning methods, Linkage with supply chain network design decisions, Process Management: Design of production process and facility layout, Process design and analysis, Design of products and services: process of product and service design, Tools, Critical chain, Just-in-time, Lean operations and Toyota production system, Inventory Management: deterministic models, Probabilistic models: multi-period and single period (news vendor) models, Selective inventory models, Aggregate production planning (APP), Master production schedule (MPS), Materials requirements planning (MRP), Quality management, Statistical process control (SPC), Process capability and Six Sigma.
10	Contents for lab	Simulation exercises on Arena

1	Programme	MBA/IMG
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2	Semester	II/VIII
3	Type of course	Core
4	Code of the subject	MS611
5	Title of the subject	Marketing Management
6	Any prerequisite	Basic understanding of microeconomics
7	L-T-P	3-0-1
8	Learning Objectives of the subject	To understand the fundamental marketing concepts and the processes that influences the market orientation of a firm. To understand the role of marketing within the organization. To recognize the importance of marketing in the competitive world. To analyze critically the marketing process and its relationship with the environment within which it operates. To broadly look at the role of Marketing as a key element within an organization's strategy.
9	Brief Contents	Introduction to Marketing- Definition of marketing, Marketing environment, Business models and value chain, Segmentation and targeting- Concept of segmentation, Bases of segmentation (B2C & B2B), Targeting, Application in real life scenario, Positioning and differentiation- Differentiation parameters, POP& POD, Competition, Consumer Behavior- Consumer decision making process, factors influencing consumer behavior, B2B Marketing- Organizational decision making process, buying roles, Marketing strategy (product, service and pricing decisions)- Product strategy, branding, service, pricing strategy, Marketing strategy (place decisions)- Channels of distribution, Distribution strategy, Marketing strategy (promotion decisions)- Integrated marketing communication, Advance topics in marketing- Predictive, contextual, augmented and agile marketing.
10	Contents for lab	Simulation on marketing environment Case study exercises Class projects and exercises Field projects and company visits

1	Programme	MBA/IMG
2	Semester	II/VIII
3	Type of course	Core
4	Code of the subject	MS612
5	Title of the subject	Financial Engineering and Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The course aims at providing an understanding of financial engineering and management concepts. This will enable to understand how corporations make investment & financing

		decisions with dynamic risk exposures. It will help develop the financial engineering fundamentals for proper risk mitigation.
9	Brief Contents	Changing Financial arena and associated risks, Financial engineering as a response to increased risks, Types of Risks and Risk management, Financial markets, Financial institutions, Financial services, Financial instruments,. Financial Management: Nature, Scope, and Objectives of financial management, Time value of money, Risk and return, Capital Structure and Cost of Capital: Capital structure theories and leverage, Optimum capital structure, Measurement of specific costs, Computation of overall cost of capital. Financing Decision: Long-term financing, Short-term financing, Term financing, Venture capital. Capital Budgeting: Principles, Techniques, Measurement, evaluation, and involved risk analysis, Working Capital Management: Planning of working capital, Working capital financing, Cash management, Receivable management and Inventory management. Dividend Policy Decision: Dividend and valuation, Determinants of dividend policy, The Futures Markets, Static and dynamic hedging, Devising a Hedging Strategy Using Futures, Stock Index Futures, Value at Risk (VaR), Short Term and Long Term Interest Rate Futures, Foreign Currency Futures and Commodity Futures, Options Markets; Properties of Stock Option Prices; Option Pricing Models – Binomial Model, Black-Scholes; Model, Single Period Options –Calls and Puts, Option Strategies, Multi-Period Options – Caps, Floors, Collars, Captions, Swaptions and Compound options, Cross-currency Futures and Options, Structure of a Swap, Interest Rate Swaps, Currency of Swaps, Commodity Swaps, Other Swaps, Credit Risk and Credit Derivatives, Credit default swaps, Role of a Swap Dealer. Basics of FRAs, Emerging Innovations and recent trends
10	Contents for lab	No

1	Programme	MBA
2	Semester	II
3	Type of course	Core
4	Code of the subject	MS613
5	Title of the subject	Business Research Methods
6	Any prerequisite	Basic knowledge of business statistics
7	L-T-P	3-0-0
8	Learning Objectives of the subject	To design and execute a basic survey research project. To understand the research tools and techniques for executing a business project and decision making.
9	Brief Contents	Introduction to business research: Business research methods: An introduction, business research process design, Research

		design formulation: Measurement and scaling, questionnaire design, sampling and sampling distributions, Sources and collection of data: Secondary data sources, data collection: survey and observations, experimentation, fieldwork and data preparation, Data analysis and presentation: Statistical inference: hypothesis testing for single population, hypothesis testing for two populations, analysis of variance and experimental designs, hypothesis testing for categorical data (chi-square test), non-parametric statistics, Correlation and simple linear regression analysis, Multivariate analyses (Multiple regression analysis, discriminant analysis, conjoint analysis, factor analysis, cluster analysis, multidimensional scaling, correspondence analysis), Result presentation: Presentation of results, report writing
10	Contents for lab	Data analysis and presentation: Statistical inference: hypothesis testing for single population, hypothesis testing for two populations, analysis of variance and experimental designs, hypothesis testing for categorical data (chi-square test), non-parametric statistics, Correlation and simple linear regression analysis, Multivariate analyses (Multiple regression analysis, discriminant analysis, conjoint analysis, factor analysis, cluster analysis, multidimensional scaling, correspondence analysis)

1	Programme	MBA
2	Semester	II
3	Type of course	Core
4	Code of the subject	MS614
5	Title of the subject	Decision Modelling and Optimization
6	Any prerequisite	Basic Knowledge of Mathematics, Probability distributions and Statistics.
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The objectives of the course is to acquaint the student with the applications of Operations Research to business and industry and help them to grasp the significance of analytical techniques in decision making
9	Brief Contents	Introduction to Operation Research, Overview of how Operations Research and Analytics professionals analyse problems, Introduction to Linear Programming Solving Linear Programming problems: The Simplex method, The Theory of the Simplex Method, Duality theory, Linear Programming under Uncertainty, Other Algorithms for Linear Programming, The Transportation and Assignment problems Network Optimization models Dynamic Programming, Integer Programming, Nonlinear Programming, Metaheuristics, Game Theory, Decision

		Analysis, Queueing Theory, Inventory Theory, Markov Decision Processes, Simulation
10	Contents for lab	No

1	Programme	MBA
2	Semester	II
3	Type of course	Core
4	Code of the subject	MS615
5	Title of the subject	Artificial Intelligence and Machine Learning
6	Any prerequisite	Statistics, linear algebra, matrix, probability, programming languages and data modelling.
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon course completion, students will be able to: Identify problems that are amenable to solution by AI methods, and which AI methods may be suited to solving a given problem. Formalize a given problem in the language/framework of different AI methods. Implement basic algorithms using basic machine learning libraries mostly in python. Gain hands-on experience in applying ML to problems encountered in various domains. Obtain exposure to high-level ML libraries or frameworks such as TensorFlow, PyTorch.
9	Brief Contents	Introduction to AI: Definitions, Historical foundations, Basic elements of AI, Characteristics of intelligent algorithm, AI application areas, Neural network representation, Neural networks as a paradigm for parallel processing, Linear discrimination, Gradient descent, Logistic discrimination, Perceptron, Training a perceptron, Multilayer perceptron, Back propagation algorithm, Recurrent networks, Dynamically modifying network structure, Basic concepts, Hypothesis space search, Genetic programming, Models of evolution and learning, Parallelizing genetic algorithms, State space search, Production systems, Search space control: depth-first, breadth-first search, Heuristic search - hill climbing, Best-first search, Branch and Bound, Problem reduction, Constraint satisfaction end, Means-end analysis, Need of machine learning, Types of machine learning, Supervised learning: k-nearest neighbours, Linear regression, Logistic regression, Classification, Support vector machines, Neural networks, Unsupervised learning: clustering (k-means, hierarchical, EM), Auto-encoders, Dimensionality reduction, Learning by agents, Intelligent agent, Online learning, Batch learning, Markov Decision Processes, Temporal difference learning, Dynamic programming, Hyperparameters, Deep learning, Optimization techniques.
10	Contents for lab	Use Python/Jupyter notebooks/ google Colab for programming and hand out assignments Machine learning platforms: TensorFlow, Scikit-Learn etc.

		It may be good to have both theory and programming components in the assignment/homework component, to allow students to appreciate and learn both aspects of AI and machine learning
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1	Programme	MBA/IMG
2	Semester	II/VIII
3	Type of course	Core
4	Code of the subject	MS616
5	Title of the subject	Project Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Students will be able to understand to manage the scope, cost, timing, and quality of the project, as defined by project stakeholders. Align the project to the organization's strategic plans and business justification throughout its lifecycle. Identify project goals, constraints, deliverables, performance criteria, control needs, and resource requirements in consultation with stakeholders. Implement project management knowledge, processes, lifecycle and the embodied concepts, tools and techniques in order to achieve project success. Apply project management practices to the launch of new programs, products, and services
9	Brief Contents	Introduction to Project Management: Concept of a project; categories of project, project development cycle, tools & techniques of project management, forms of project organizations, project management theory, various stages of planning, designing and managing projects, Development of Project Matrices, Critical Success factors and key performance indicators, Project Organization, Scheduling & Planning: Project Elements, Work Breakdown Structure (WBS), Types of WBS, Functions, Activities and Tasks, Project Life Cycle and Product Life Cycle, Project schedule, Scheduling Objectives, Building the project schedule, Scheduling terminology and techniques, Network Diagrams: PERT, CPM; Bar Charts, Milestone Charts, Gantt Charts, Estimating Project Costs and Project Selection: Estimation of activity and project costs, means of financing, financial projections, Qualitative and Quantitative Methods of Project identification and selection, Developing the Project Schedule: Activity Sequencing, Precedence Network Diagram, Project Resource levelling and allocation in projects, network techniques and timelines, crashing of projects: time vs. cost trade-off, Program Evaluation and Review Technique, Critical Path Method, Project Scheduling, Basics of Scheduling, project management tools, Project Execution and Control: Assessing and managing costs and gains, crashing of projects: time vs. cost trade-off, earned value method, Managing Project Risks: Probabilistic aspects of projects; risk management; Principles &

		Concepts of project Risks Management, Risk Assessment, Risk control; critical chain project management.
10	Contents for lab	No

1	Programme	IMG
2	Semester	VII
3	Type of course	Core
4	Code of the subject	MS617
5	Title of the subject	Business Data Mining
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Extract knowledge using data mining techniques. Explore recent trends in data mining such as web mining, spatial-temporal mining. Be acquainted with the tools and techniques used for Knowledge Discovery in Databases.
9	Brief Contents	Data Mining Concepts, Knowledge Representation, Supervised Learning framework, Concepts & hypothesis, Training & Learning, Types of Data, Data mining functionalities, Classification of data mining systems, Data mining task primitives, Data cleaning, Data integration & transformation, Data reduction, Mining Business data patterns, Associations and Correlations, Mining methods, Mining various kinds of association rules, Correlation analysis, Constraint based association mining, Classification and prediction, Basic concepts, Decision Tree induction, Bayesian classification, Rule based classification, Classification by back propagation, Support vector machines, Associative classification, Lazy learners, Other classification methods, Cluster analysis, Types of data, Categorization of major clustering Methods, K-means partitioning methods, Hierarchical methods, Density-based methods, Grid based methods, Model-based clustering methods, Clustering high dimensional data, Constraint based cluster analysis, Outlier analysis, Mining trends and business application of data
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	I/VII
3	Type of course	Core
4	Code of the subject	MS618
5	Title of the subject	Strategic Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	After the completion of this course students will be able to understand the organization and the environment in which it

		functions and competes. The student should be able to integrate acquired knowledge of other functional areas with the body of the knowledge of strategic management and be able to deploy all as a unified tool to analyse and formulate the actions that shall deliver the intended results.
9	Brief Contents	Concept of strategy and strategic management, Difference between corporate planning and strategic planning, Strategic management model, Different levels of strategies, Relevance of strategic management in 21st century, Strategic intent-vision and mission statement, Organisational objectives, Setting objectives, Organisational values and its impact, External and internal Environment and analytical tools- evaluating the company's strategic environment, SWOT analysis, PESTEL analysis, Competitive analysis, Porter's five force model, Internal Assessment- strategic capability: fit and stretch concept, Porter's value chain analysis, Core competencies, Organisational capabilities, Resource analysis and synergy, Strategies in action- Functional level- Achieving superior efficiency- Economics of scale, Experience curve, Just-in-Time, Six-sigma, Business level-cost leadership, Differentiation & focus strategies, Growth strategies, Corporate level- integration, Diversification, Acquisition, Mergers & joint venture, Short term corporate strategies-stability, Retrenchment, and turnaround, Portfolio and other analytical models- BCG matrix, GE/McKinsy matrix, Corporate parenting, Evaluation of strategy- suitability, Acceptability, and feasibility, Implementing strategies-resource allocation, Structure and strategy, Organisation culture, Balance score card.
10	Contents for lab	No

1	Programme	MBA
2	Semester	III
3	Type of course	Core
4	Code of the subject	MS619
5	Title of the subject	Entrepreneurship and Innovation
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	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.
9	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.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	III/IX
3	Type of course	Core
4	Code of the subject	MS620
5	Title of the subject	Business Process Management
6	Any prerequisite	Courses on functional areas of management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Describe and evaluate the development of process management and tasks of process holders in organizations. Assess the importance of the strategic perspective of business process management. Analyse and model strategic and operational business processes. Employ process performance indicators and measures.
9	Brief Contents	Orientation: Process perspective, Components of processes, Evolution of processes, Process life-cycle, Process identification, Process architecture, Process selection, Process modeling: Introduction to BPMN, Business objects, Process decomposition, Process Discovery: Process discovery, Methods, Process modeling, Process model quality assurance, Process Analysis: qualitative process analysis, Value-added analysis, Waste analysis, Stakeholder analysis, Root-cause analysis, Quantitative process analysis: flow analysis, Queues, Simulation, Process redesign, Transactional methods, Transformational methods, Process aware information systems: Types of process aware information systems, Process implementation with executable models, Process monitoring, Process as enterprise capability
10	Contents for lab	BPMN modeling software (open source) for modeling of processes

1	Program	MBA/ IMG/
2	Semester	III/IX
3	Type of course	Core
4	Code of the subject	MS621
5	Title of the subject	Business Ethics and Sustainability
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon course completion, students will be able to: Develop skills in recognizing and analysing ethical issues. Define cross cultural variations and similarities in organizational practices in corporate social responsibility and business ethics. Understand sources of organizational ethical culture and to design ethical programs designed to accomplish specific objectives in organizations. Develop ethical leadership skills and practices

9	Brief Contents	Business ethics- an overview, Concepts and theories of business ethics, Emerging business ethics issues, Ethical decision making in business, Creating an ethical organization globalization and business ethics, Stakeholders and business ethics, Social responsibility and ethics, Issues in social responsibility, Implementing stakeholders' perspective, Stakeholder and issue management approaches, Managing corporate responsibility with external stakeholders, Corporate governance and ethical leadership, Kohlberg's six stages of moral development, Levels of ethical analysis, Concept of corporate integrity, Issues in corporate governance, good corporate governance - obligations towards society and stake holders, Ethics in consumer protection, Role of government agencies, SEBI, judiciary in ensuring ethical practices, Ethics and Indian business, Marketing ethics, Ethics in human resource management, financial management, banking and insurance.
10	Contents for lab	No

1	Program	MBA/ IMG/
2	Semester	III/IX
3	Type of course	Core
1	Code of the subject	MS621
2	Title of the subject	Cloud Computing and Services
3	Any prerequisite	Basic understanding of computer system
6	Will this course require visiting faculty	No
4	L-T-P	3-0-0
7	Learning Objectives of the subject (in about 50 words)	<p>Upon course completion, students will be able to:</p> <ol style="list-style-type: none"> 6. Understand cloud computing and memorize the different cloud service and deployment models. 7. Describe the concerns of storage, processing, parallelism, distribution, consensus, and scalability as they relate to the cloud 8. Learn about the different levels of clouds services, which include IaaS (Infrastructure as a Service), PaaS (Platform as a Service), SaaS (Software as a Service), FaaS (Function as a Service (server-less architecture)), MBaaS (Mobile Backend as a Service (server-less architecture)), and Amazon Lambda. 9. Learn about many types of cloud-based storage services, including object storage, block-level storage, archival storage, and Big Data file systems. 10. Become familiar with the key concepts underlying Big Data and data streaming applications on the Cloud.

8	Brief Contents (module wise)	<p>Module-I: Introduction Introduction, Foundations of cloud computing, Big Clouds (such as the AWS Cloud, Google Cloud, Microsoft Azure Cloud, or IBM Cloud) via portals, APIs, and SDKs, Cloud Computing characteristics (e.g., elasticity, multi-tenancy, on-demand access, ubiquitous access, usage metering, self-service capability, SLA-monitoring), Cloud Computing and Service Oriented Architecture (SOA), Cloud Service Models/Types (i.e., Public, Private, Hybrid, and Community), Cloud deployment models (i.e., IaaS, PaaS, SaaS, and BPaaS), Cloud Return on Investment (ROI) models, Cloud Reference Architectures, Cloud Standards (e.g., OSDI APIs), Technology Providers vs. Cloud providers vs. Cloud vendors, Planning Cloud transformations</p> <p>Module-II: Cloud Storage Services Storage models and storage as a service, Using Amazon Cloud Storage Services via Portal and APIs, Using Microsoft Azure Cloud Storage Services via Portal and APIs, Using Google Cloud Storage Services via Portal and APIs, Using IBM Cloud Storage Services via Portal and APIs, Using OpenStack Cloud Storage Services via Portal and APIs</p> <p>Module-III: Cloud Networking Services and Service Platform Design Virtual Private Cloud Networking, High-Performance, Scalable Load Balancing, Cloud API Gateways, Global Content Delivery Networks, Cloud-Managed High-Performance Network Address Translation, Network Edge Connectivity, Reliable, Resilient, Low-Latency DNS Serving on the Cloud, Network Performance and Availability Optimization on the Cloud, Big Cloud Service Platforms Convergence and Service Offerings (Amazon AWS, Google GCP, Microsoft Azure, IBM Cloud, Force.com Cloud, Clouds at SGI, NASA, and CERN)</p> <p>Module-IV: Cloud Platforms in Industry Cloud platforms in industry, amazon web services, compute services, storage services, communication services, additional services, google AppEngine, architecture and core concepts, application life-cycle, cost model, observations, Microsoft Azure, Azure core concepts, SQL Azure, Windows Azure platform appliance, scientific applications, healthcare: ECG analysis in the cloud, cancer diagnosis, cloud machine learning services, business and consumer applications, CRM and ERP, productivity, social networking, media applications, multiplayer online gaming.</p>
9	Contents for lab (If applicable)	<ul style="list-style-type: none"> <input type="checkbox"/> Learn how to access the Cloud via Big Cloud vendors' websites, and their APIs/SDKs; install Python, Anaconda, and Jupyter to run lab notebooks as applicable. <input type="checkbox"/> Create a virtual machine on the various Big Clouds using both the Portals and the applicable python libraries. <input type="checkbox"/> It may be good to have both theory and programming components in the assignment/Lab component, to allow students to appreciate and learn various aspects of cloud computing

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS001
5	Title of the subject	Digital Production System
6	Any prerequisite	Operations Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Appreciate role of digital manufacturing. Analyse various computing models. Employ information and communication technologies for design of digital production systems.
9	Brief Contents	Science of digital manufacturing: operation mode and architecture of digital manufacturing system, Modeling theory and method of digital manufacturing science, Theory system of digital manufacturing science, Computing manufacturing in digital manufacturing science: computing manufacturing methodology, Manufacturing computational model, Theoretical units in manufacturing computing, Manufacturing informatics in digital manufacturing science: Principal properties of manufacturing information, Measurement, Synthesis and materialization of manufacturing information, Integration, sharing and security of manufacturing information, Intelligent manufacturing in digital manufacturing science: Intelligent multi-information sensing and fusion in the manufacturing process, Knowledge engineering in the whole life cycle of manufacturing product, Autonomy, Self-learning, Adapting of manufacturing system, Intelligent manufacturing system
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS002
5	Title of the subject	IT Products and Intellectual Property Rights

6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The course is designed to impart the value driven IT products development including software, and firmware/hardware of different industrial requirements. Through understanding of the Intellectual property rights, the learner acquaint with the protection of new IT product from business threat.
9	Brief Contents	Industry Need analysis for IT product development, The Design thinking for new IT product development, Tools and Techniques of IT product development, Software design analysis, Firmware design, Product prototyping, Value analysis, Intellectual property rights for Software and Firmware, Industry-Market fit performance, Evaluation of product
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS003
5	Title of the subject	Management of Digital Technologies
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The course has been designed to provide comprehensive and in-depth coverage of all important aspects of modern digital technologies on the principle of industrial applications to maximize the efficiency, effectiveness and business performance. It is primarily intended for students who wish to pursue a career in mapping industrial design on the digital system.
9	Brief Contents	Introduction of Industry 4.0. Business System engineering and Management through Digital Technologies, Digital Transformation and Business Transition to industrial revolution 5.0. Concepts of Industry 5.0-sustainability, human centricity and system resilience through digital technologies, Understanding Blockchain principles, technology and its applications, Introduction of sensory inputs, data acquisition and applications, Introduction of Business data cloud and management, Human-system interface concept, principles, and design, Introduction of Cyber Physical System and understanding design cases
10	Contents for lab	No

1	Program	MBA/IPG MBA
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS004

5	Title of the subject	Knowledge Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Develop an integrated and comprehensive perspective of knowledge management as a strategic function. Identify the strategic contexts of knowledge management and the role of organisational structure and processes. Discuss the frameworks, techniques, and the nature of IT support for managing knowledge. Delineate the role of innovations in knowledge creation. Raise and resolve issues in knowledge protection for sustaining competitive advantage. Provide a platform for sharing experiences in knowledge management.
9	Brief Contents	The Nature of knowledge: Introduction to knowledge management, The nature of knowing, Leveraging knowledge, Intellectual capital, Strategic management perspectives, Creating knowledge, Organisational learning, The learning organisation, Knowledge management tools and systems, Knowledge management tools: component technologies, Knowledge management systems, Mobilising knowledge, Enabling knowledge contexts and networks, Implementing knowledge management.
10	Contents for lab	Case study exercises
1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS005
5	Title of the subject	Service-Oriented Computing
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Service delivery lifecycle and associated phases. Analysis and conceptualization of services and micro-services. Service design through web. Modern service APIs and contract versioning techniques for web services
9	Brief Contents	Introduction of Service Oriented Architecture design and development , Case examples and case descriptions, Understanding Service-Orientation- Business Automation, Design paradigm, Design principles, Silo-based application architecture, Effects of service-orientation on the enterprise, Service-orientation and the concept of application and integration, The Service composition, Goals and benefits of Service-Oriented computing, Four pillars of Service-orientation, Understanding SOA- The Four characteristics of SOA: Business-driven, Vendor-neutral, Enterprise-centric, Composition-centric, Design priorities; The Four common types of SOA, The End result of Service-orientation and SOA, SOA Project delivery strategies, SOA project stages, SOA adoption planning, Service inventory analysis, SOA modelling, Contract, Logic design, Service development, Testing, Deployment and

		maintenance, Usage and monitoring, Understanding layers with services and micro services, Analysis and modelling with Web services and Micro services, Analysis and modelling with REST services and Micro services
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS006
5	Title of the subject	Social Networks Analytics
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The main learning objective with this course is to enable students to put Social Network Analysis projects into action in a planned, informed and efficient manner. This overarching goal involves the following subtasks: Formalize different types of entities and relationships as nodes and edges and represent this information as relational data .Plan and execute network analytical computations. Use advanced network analysis software to generate visualizations and perform empirical investigations of network data. Interpret and synthesize the meaning of the results with respect to a question, goal, or task. Collect network data in different ways and from different sources while adhering to legal standards and ethics standards.
9	Brief Contents	Overview on network analysis, The Network analysis process and methodology, Network visualization, When images do not suffice: Network analytical measures, Models and simulation of network evolution, Models and simulation of diffusion in networks, Subgroups and cliques clustering, Block models, Ego networks, Reciprocity, Social capital, structural holes, equivalence; Network Data: Ethics, Privacy, Legality, Introduction: Using text data for network analysis, natural Language Processing and Relation Extraction from Texts Construct: A model of meta-network dynamics, Usage of network analysis for investigating crime, Relational methods for analysing covert networks
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS007
5	Title of the subject	Software Project Management
6	Any prerequisite	No

7	L-T-P	3-0-0
8	Learning Objectives of the subject	The students will be able to understand the principles of project management. Comprehend the fundamental principles of project management, including project planning, scheduling, resource allocation, and risk management. Develop a project plan that includes a work breakdown structure, critical path analysis, resource allocation, budgeting and time management.
9	Brief Contents	Introduction and Software Project Planning: Fundamentals of software project management (SPM), Need identification, Vision and scope document, project management cycle, SPM objectives, Management spectrum, SPM framework, Software project planning, Planning objectives, Project plan, Types of project plan, Structure of a software project management plan, Software project estimation, Estimation methods, Estimation models, Decision process, Project Organization and Scheduling: Project Elements, Work Breakdown Structure (WBS), Types of WBS, Functions, Activities and Tasks, Project Life Cycle and Product Life Cycle, Ways to Organize Personnel, Project schedule, Scheduling objectives; Building the project schedule, Scheduling terminology and techniques, Network Diagrams: PERT, CPM, Bar Charts: Milestone Charts, Gantt Charts, Project Monitoring and Control: Dimensions of Project Monitoring & Control, Earned Value Analysis, Earned Value indicators: Budgeted Cost for Work Scheduled (BCWS); Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI), Schedule Performance Index (SPI), Interpretation of Earned Value Indicators, Error Tracking; Software Reviews, Types of Review: Inspections, Deskchecks, Walkthroughs, Code Reviews, Pair Programming, Software Quality Assurance and Testing: Testing Objectives, Testing Principles, Test Plans, Test Cases, Types of Testing, Levels of Testing, Test strategies, Program correctness, Program verification & validation, Testing automation & Testing tools, Concept of Software quality; Software quality attributes; Software Quality Metrics and indicators; The SEI Capability Maturity Model CMM), SQA activities, Formal SQA Approaches: Proof of correctness, Statistical quality assurance, Cleanroom process, Project Management and Project Management Tools: Software Configuration Management: Software Configuration items and tasks; Baselines; Plan for Change, Change control, Change Requests management, Version Control; Risk management: Risks and risk types, Risk Breakdown Structure (RBS); Risk Management process: Risk identification, Risk analysis, Risk planning, Risk monitoring; Cost Benefit analysis; Software Project management tools: CASE tools, Planning and Scheduling tools, MS-Project.

10	Contents for lab	No
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1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS008
5	Title of the subject	Software Quality Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	<p>Students will be able to develop a comprehensive understanding of the concepts and practices related to software quality management.</p> <p>Gaining knowledge of software quality standards, testing techniques, and software metrics. Evaluate the effectiveness of quality management strategies, such as continuous improvement, risk management, and quality assurance.</p>
9	Brief Contents	<p>Introduction to Software Quality: Defining Software Quality, Software quality, Attributes and specification, Cost of quality defects, faults, failures, Defect rate and reliability, Defect prevention, Reduction and containment, Overview of different types of software review, Introduction to measurement and inspection process, Documents and metrics, Software Quality Metrics: Product Quality Metrics: Defect density, Customer problems metric, Customer satisfaction metrics, Function points, In-process quality metrics: Defect arrival pattern, Phase-based defect removal pattern, Defect removal effectiveness, Metrics for software maintenance: Backlog management index, Fix response time, Fix quality, Software quality indicators, Software Quality Management and Models: Modeling process, Software reliability models: The Rayleigh model, Exponential distribution and Software reliability growth models, Software reliability allocation models, Criteria for model evaluation, Software quality assessment models: Hierarchical model of software quality assessment. Software Quality Assurance: Quality Planning and Control, Quality improvement process, Evolution of software quality assurance SQA, Major SQA activities, Major SQA issues, Zero defect software, SQA techniques, Statistical quality assurance, Total quality management, Quality standards and processes, Software Verification, Validation & Testing: Verification and validation, Evolutionary nature of verification and validation, Impracticality of testing all data and paths, Proof of correctness, Software testing, Functional, structural and Error-oriented analysis & testing, Static and dynamic testing tools, Characteristics of modern testing tools.</p>
10	Contents for lab	No

1	Program	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS009
5	Title of the subject	Programming for Business Intelligence
6	Any prerequisite	None
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon course completion, students will be able to: Derive actionable insights from data, thus allowing to make data-driven, strategic and tactical business decisions. Design and implement an algorithm to conduct technical calculations, manipulate data and create graphical user interfaces. Identify the technological architecture that makes up Business Intelligence systems
9	Brief Contents	Business Intelligence (BI): Effective and timely decisions, Data, Information and knowledge, Role of mathematical models, BI architectures, Ethics and BI, Decision support systems: definition of system, Representation of the decision-making process, Definition of decision support system, Development of a decision support system, Customer Relationship Management (CRM), ERP, and BI, Importance of data and relevance in industry, Statistical learning vs. machine learning, Types and phases of analytics, Data pre-processing and cleaning: data manipulation steps, Normalizing data, Sampling, Missing value treatment, Outliers, Exploratory data analysis: data visualization using matplotlib, Seaborn libraries, Creating graphs, Summarizing data, Descriptive statistics, Univariate analysis, Bivariate analysis, Querying and reporting, Building Ad-Hoc queries, Building on-demand self-service reports, Enhancing and modifying data access, Pull-oriented data access, Push-oriented data access dashboards, Executive Information System (EIS) engine, Metric system and KPIs, business intelligence dashboards, Learning SQL query structure with examples, Data management and query system OLTP and OLAP and their data models, Data warehousing, ETL and data integration dashboard creation using Tableau, Power BI, The relevance of BI in application to analytics industry and different domains such as marketing models: relational marketing, Sales force management, Logistic and production models: supply chain optimization, Optimization models for logistics planning, Revenue management systems.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS010
5	Title of the subject	Strategic Planning of Information Systems
6	Any prerequisite	No
7	L-T-P	3-0-0

8	Learning Objectives of the subject	The strategic use of information systems as a means for acquiring competitive advantage. Integration of concepts and methodologies with skills acquired in the field of information systems and technology in the development of a comprehensive information systems prototype. Measurable benefits in the alignment of business processes with information systems solutions. The course provides students with the opportunity to apply systems concepts and techniques in the design of an information system.
9	Brief Contents	Introduction to strategic information systems , Business environment issues, The process of strategic information systems , Current business situation analysis , Identify an opportunity , The role of business information systems , Information systems strategies , Strategic information systems management, Organization of the information systems technologies , Software , Hardware, Database , Communications ,Networking , Evaluation of possible IS solutions, Project Management, Cost Benefit Analysis, Functional requirement, System specifications , Information systems benefits , Strategic information management , Managing the information resource
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS011
5	Title of the subject	Business Systems Simulation
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Understanding the principles and techniques of simulation modeling for business systems. Understanding the key components of a business system and how they interact with each other. Learning how to analyse and interpret simulation results to make informed decisions. Understanding the limitations of simulation modeling and the assumptions that need to be made. Learning how to optimize simulation models to achieve business objectives. Understanding the ethical implications of simulation modeling and the importance of data privacy and security. Learning how to apply simulation modeling in different industries and applications, such as manufacturing, logistics, healthcare, finance, and customer service.
9	Brief Contents	Introduction to Business System Simulation: Overview of the benefits of simulation modeling, The various types of simulation models, and the different tools and software used for simulation modelling, System Dynamics: Modeling approach

		on the feedback loops and dynamic relationships between different variables in a system, Topics covered include stock and flow diagrams, feedback loops, and system dynamics models, Discrete-Event Simulation: Modeling the discrete events and processes that occur in a system, such as customer arrivals, order processing, and inventory movements, Topics covered include event scheduling, process modeling, and queuing theory, Agent-Based Simulation: Modeling individual agents or entities within a system, such as customers, employees, or machines. Topics covered include agent behaviour modeling, agent interactions, and emergent behaviour, Optimization and Analysis: Various techniques used to optimize a simulation model and analyse the results, including sensitivity analysis, scenario analysis, and statistical analysis. Applications of Business System Simulation: Case studies and examples of how simulation modeling is used in different industries and applications, such as manufacturing, logistics, healthcare, finance, and customer service.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS012
5	Title of the subject	Service Operations Management
6	Any prerequisite	Operations Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Define services along with their nature and classification. Assess factors related to location and capacity planning. Employ design principles in development of service delivery systems. Analyse requirements to ensure maintainability and reliability in services.
9	Brief Contents	Matrix of service characteristics, Taxonomy of services, Challenges in operations management of services, Aggregate capacity planning for services, Facility location, Subjective and objective factors, Service design and delivery systems, layouts in services, Job and work design in services-safety and physical environment, Effect of managing queues, Automation, Operations standards and work measurement, Determinants of quality in services, Measurement, control and improvement of quality of services, Concept of a total quality service, Dynamics of service delivery system, Scheduling for service operations, Personnel and vehicles, Supply chain and distribution of services, Maintainability and reliability in services, Total productive maintenance (TPM) in services, Case studies of exemplary professionally managed services.

10	Contents for lab	No
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1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS013
5	Title of the subject	Sustainable Supply Chain Management
6	Any prerequisite	Operations Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Develop an understanding of the role of supply chain in an overall value creation. Analyse different modes of transportation, different design options of transportation network in a supply chain, their applicability under different contexts and the trade-offs in transportation design. Describe the importance of reverse logistics in market places as well as market spaces. Design sustainable supply chains.
9	Brief Contents	Evolution of SCM, Issues of SCM, Competitive strategy vis-à-vis supply chain strategy, Achieving strategic fit, Managing inventory in a supply chain, Deterministic models, Probabilistic models (multi-period and single period). Managing risk and uncertainty in a supply chain: quick response strategy, Postponement strategy, Tailored sourcing strategy, Transportation in a supply chain: role of transportation in a supply chain, Modes of transportation and their performance characteristics, Design options for a transportation network, Trade-offs in transportation design, Supply chain coordination: Bullwhip effect - causes and consequences, Bullwhip effect quantification, Impact of centralized information on bullwhip effect, Mitigating strategies, Information sharing and incentives, Strategic sourcing in SCM: Role of sourcing in a supply chain, Framework for make/buy decisions, Supplier scoring and assessment, Supply contracts and supply chain performance, Big data analytics in SCM: Significance of big data in supply chain, Relevant tools, Reverse logistics: Reverse logistics in manufacturing organizations and ecommerce firms.
10	Contents for lab	SCM software like SAP SCM, Logility, Perfect Commerce, Oracle SCM etc.

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS014
5	Title of the subject	Technology Management

6	Any prerequisite	Operations Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Define types of innovation, innovators and innovation environment. Describe the nature and extent of technological change and potential roles of incremental and disruptive innovation in creating and sustaining firm competitiveness. Perform feasibility and viability of new product development proposal from various perspectives.
9	Brief Contents	Introduction, Understanding innovation, Levels and types of innovation, Key drivers of innovation, Sources of innovation, and the relationship between innovation and research and technology development. understanding creativity as a building block to innovation, Innovation management, Framework for the management of innovation, Public sector services innovation, Diffusion of innovation creating organizational innovative effectiveness, Strategic aspects of technology, Critical factors in managing technology innovations, Critical issues/factors in choice of technology and processes; Indian context, Technology portfolio, Open innovation, New technology transfer-channels, Modes, Levels and issues, Absorption, adaption and adoption of technology, Technology considerations in lean environment, Strategic role of R&D, New R&D approaches, Strategic evaluation of technology investments, New product development and life cycle management, Understanding product platform strategy, Commercialization of core competencies, Marketing new products and technologies, Role, rationale and requisites of a national technology policy, IPR and licensing issues, Role of WTO.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS015
5	Title of the subject	Technology and Operations Strategy
6	Any prerequisite	Operations Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Appreciate the nature, need and scope of operations strategy. Describe the strategic role of transformation processes and associated flows. Develop and analyse innovation, new product and process development strategies. Employ process of operations strategy in terms of sustainable alignment.
9	Brief Contents	Need for Operations Strategy, Impact of globalization on Operations Management, The Marketing link in the Operations Strategy -Role in competitive advantage, Time-based

		competitiveness and other criteria of success, The Sandcone model, Process of designing, analysing and implementing operations' strategies, Strategic management of transformation processes and flow strategies, Strategic choices in layout and capacity planning, Managing innovations and new product and process development strategies, Strategic purchasing and supply management, Outsourcing decisions, Strategic Purchasing Portfolio analysis, Operations improvement strategies, Breakthrough vs. continuous, The direct, Develop and deploy strategies, The market strategy, Bohn's stages of process matrix, Measures of performance, Process of Operations strategy, Sustainable alignment, Methodology of operations strategy formulation, Process of operations strategy formulation, Integrated management systems
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS016
5	Title of the subject	Total Quality Management
6	Any prerequisite	Basic Knowledge of Probability and Statistics
7	L-T-P	3-0-0
8	Learning Objectives of the subject	This course provides learners with an understanding of quality control and improvement systems. This course will help participants to: Understand the principles of total quality management. Choose appropriate statistical techniques for improving processes. Develop the organizational, competitive and economic potential of quality. Integrate fundamental principles with the practice of total quality management.
9	Brief Contents	Evolution and Importance of Total Quality Management: Introduction, Importance of Quality, Evolution of Quality, What is Total Quality Management, Quality Pioneers, Active Living and Health Environment for TQM: Quality Leadership and Management Commitment, Employee Empowerment, Organizational Culture and Change, Team Building, TQM Infrastructure: Supplier relation and partnership, Continuous Improvement process lesson, Developing TQM action plan, TQM and Other Continuous Improvement Systems: Quality Standards, Six Sigma, Benchmarking, Just in Time, Stabilizing and Improving a Process: Defining and Documenting a Process, Diagnosing and Improving a Process, Statistical Process Control, Variables and Attributes Charts, The Fork Model For Quality Management- Management's Commitment to Transformation Lesson, Education and Daily Management, Cross-Functional Management, Quality Policy Management

10	Contents for lab	No
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1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS017
5	Title of the subject	World Class Production Systems
6	Any prerequisite	Operations Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Appreciate the concept and need of world class manufacturing. Employ frameworks of various product and process design structures and systems in modern manufacturing. Analyse the implementation of TQM, JIT and Theory of Constraints. Appreciate philosophy and principles of Japanese manufacturing especially Toyota Production System (TPS).
9	Brief Contents	World Class Manufacturing (WCM): Concepts and Evolution, Understanding the linkage between Operations Strategy and WCM, Agile Manufacturing: Distinction between flexibility and agility, Model for implementing flexible and agile manufacturing, Flexible Manufacturing System (FMS), Concepts and components, Modern product and process design concepts and considerations, Assembly lines and batch manufacturing; group technology (GT), Total Quality Management (TQM): Roadmap to Implementation of TQM in manufacturing, Six Sigma approach, Just-in-Time (JIT) and Lean Operations, Theory of constraints (ToC), Japanese manufacturing techniques particularly Toyota Production System, Japanese vs American manufacturing focus, Critical elements of JIT, Operational Framework for concurrent implementation of TQM and JIT, Total Productive Maintenance (TPM): Concepts and Evolution, Metrics of TPM, Overall Equipment Effectiveness (OEE), Roadmap to TPM implementation in modern manufacturing, Computer Integrated Manufacturing System (CIMS): A framework for computer integrated enterprise issues involved in CIMS, Benchmarks for excellence in operational performance with global examples, Significance of implementation of concurrent operations management initiatives, Metrics of operational excellence in global context.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even

3	Type of course	Elective
4	Code of the subject	MS018
5	Title of the subject	Emerging areas in Operations and Technology Management
6	Any prerequisite	Operations management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Describe role of sustainable operations management. Design operations management along globally dispersed distributed networks. Develop nimble factories for supporting a lot size of one.
9	Brief Contents	Digital supply chains, Computer aided design and integrated manufacturing, A Focus on the employee experience, Flexible, blended workplace environments, Mobile communications and collaboration, Scaling production according to demand, Building the customer relationship.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS019
5	Title of the subject	New Products and Services Development
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	On completion of the course, students will be able to: Describe the nature and techniques of innovation and new product development. Discuss and reflect on the role of marketing in different phases of new product development. Explain the phases and intermediate results in new product development process. Apply theories of innovation to demonstrate the best level of practice in each problem situation within the context of new product development. Develop and implement a new product strategy for an enterprise.
9	Brief Contents	Product Conception: Product Basics Consumer problems and unmet need Empathy, Personas, User Stories Identifying New Product Opportunities using Data Market Research for New Product Development Idea Generation & Need Analysis Concept testing using Surveys-Customer Discovery Product potentiality and Conjoint analysis Design Thinking for B2C, B2B Products and Services, Product Design: Product Design Process - 7 Stages Product specifications and features Visual Design Elements Tools for Design of Digital Products User experience (UX) design Introduction to Software Tools used to design Engineering Products Quality Function Deployment, Value engineering methodology, Iterative design optimisation, Design for manufacturing, Prototyping: What is Minimum

		<p>Viable Products (MVP)? Types of MVP Hypothesis Testing, A/B Prototype development for Digital Products, Wireframing 3D Printing and 3D Cutting Material Selection for Engineering Product, Prototyping Prototype, Functionalisation using Electronics and Instrumentation, Role of Robotics and Automation in Prototyping, Usability and Beta Testing, Product Deployment: Production planning and control Material handling In-house Budgeting and Outsourcing Quality Assurance Protocols Principles of Lean: Lean Manufacturing and Management Regulations and Standards: ISO Intellectual Property and Trademarks Building Markets and Creating Demand for New products services, Simulated test marketing, and Launching of new products, Product Lifecycle Management: Organisation for Product Management Marketing Manager-Product Manager-Brand Manager Concept Approaches and Organisational role Product Manager-Functions and Tasks-Tools and Techniques The Product in Corporate Life, Corporate and Product Objective Product Strategy and Policy Optimum Product Pattern/Line Range Challenge Of Change-Opportunity and Risk-Product Innovation, Modification, Addition and Elimination Product Proposals-Sources, Generation, Processing and Selection Contemporary Challenges and opportunities in product Management, Product Sales and Marketing: Brand Awareness, Consumer Brand Knowledge Product-line Decisions (extension, reduction), Product Category expansion Pricing Model and Strategy Product Costing Segmentation Target Positioning Sales Forecasting Distribution Channels Lead Generation-Role of Contacts and social media Customer Acquisition Customer retention, Commercialisation and Start-up: Introduction to Business Model Canvas Funding Requirement and Avenues Bootstrapping Team Building and Collaborations Customers and End Users Market Competition and Creating Barriers to Entry Deployment and Distribution Strategy Launching of Start-up: Rules and Steps Social media, Websites, and Digital Marketing Scale-up model and Sustainable growth plan</p>
10	Contents for lab	No

1	Program	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS020
5	Title of the subject	Operational Intelligence
6	Any prerequisite	None
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Describe the importance of data-driven operations along supply

		chains. Assess unbiased estimates of demand forecasting as well as optimization using various statistical methods. Employ mathematical models to capture and analyze data on supply chain carbon footprint.
9	Brief Contents	Problem-driven to Data-driven operations along supply chains, Big data in supply chain, Analytics in demand planning: Capturing demand data from different sources, Demand prediction models, Price optimization, Analytics in sourcing and procurement: In-house or outsource, Logistics and transportation, Supply chain contracts, Analytics in sales and operations planning: Differentiated service level to different products and customers, Location of plants, Product line mix at plants, Production planning and scheduling, Analytics in distribution: Location of distribution centre, Transportation and distribution planning, Inventory policies/order fulfilment at locations, Vehicle routing for deliveries, Analytics in reverse logistics in traditional and e-commerce firms: Location of return centres, Reverse distribution plan, Vehicle routing for returns collection, Analytics in supply chain carbon footprint
10	Contents for lab	Proficiency in using various software like SAS Business Analytics (SAS BA), Excel, Tableau, Microsoft Power BI etc.

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS021
5	Title of the subject	Compensation Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The aim of this subject is to develop students' understanding of the concepts of compensation and rewards in the organization. In particular the subject is designed to develop the underpinning knowledge and skills required to understand the one of the complex management functions i.e. compensating employees and its importance. This subject introduces the student to the basics compensation structure and differentials. It familiarizes the students with the practice of various management techniques and its expected results like job evaluation etc. The learner is apprised about the latest issues in management related to compensation in order to make the students abreast about the recent trends in the area.
9	Brief Contents	Introduction to compensation and rewards, Objective of compensation and rewards, Introduction to framework of compensation policy, Labor market characteristics and pay relatives, Wage determination: Introduction to compensation, rewards, wage levels and wage structures, Introduction to wage determination process and wage administration rules; Introduction to factors influencing wage and salary structure and principles of wage and salaries administration, Introduction to

		the theory of wages: Introduction to minimum, fair and living wage, Introduction to nature and objectives of job evaluation; Introduction to principles and procedure of job evaluation programs, Introduction to basic job evaluation methods; Introduction to Implementation of evaluated job, Introduction to determinants of incentives, Introduction to classification of Rewards, Incentive payments and its objectives, Introduction to wage incentives in India; Introduction to types of wage incentive plans, Introduction to prevalent systems & guidelines for effective incentive plans; Introduction to non-monetary incentives, Introduction to cafeteria style of compensation, Introduction to problems of equity and bonus, Profit sharing & stock options, Introduction to features of fringe benefits, Introduction to history and growth factors, Coverage of benefits, Introduction to employee services & fringe benefits in India
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS022
5	Title of the subject	Change Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Effective management within organizations requires an understanding of various behaviour and processes. Managers need to know why people behave as they do in relation to their jobs, their work groups and their organizations. This knowledge of individuals' perceptions, motivational attitudes and behaviour will enable managers to not only understand themselves better, but also to adopt appropriate managerial policies and leadership styles to increase their effectiveness. The major objective of this course is to provide students with a better understanding of behavioural processes and thereby enable them to function more effectively in their present or future roles as managers of human resources.
9	Brief Contents	Definition of Organization Development (OD), OD and planned change from other forms of organization change, Describe the historical development of OD, Describe and compare three major perspectives on changing organizations, Introduce a General model of planned change, Describe how planned change can be adopted to fit different kinds of conditions, Understand the essential character of OD practitioners, Understand the necessary competencies required of an effective OD practitioner, Understand the

		<p>roles and ethical conflicts that face OD practitioners, Reinforce the definition of an OD practitioner as anyone who is helping a system to make planned change, Describe the steps associated with starting a planned change process, Equip students with a general framework of diagnostic tools from a systematic perspective, Define diagnosis and to explain how the diagnostic process provides a practical understanding of problems at the organizational level of analysis, Discuss criteria for effective interventions, Discuss issues, considerations, constraints, ingredients, and processes associated with intervention design, Give an overview of the various interventions, Understand the issues associated with evaluating OD interventions, Understand the process of institutionalizing OD interventions and the factors that contribute to it, Understand the importance of data feedback in the OD process, Describe the desired characteristics of feedback content, and Describe the desired characteristics of the feedback process.</p>
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS023
5	Title of the subject	Corporate Social Responsibility
6	Any prerequisite	None
7	L-T-P	3-0-0
8	Learning Objectives of the subject	<p>Upon course completion, students will be able to: Develop skills in recognizing and analysing ethical issues. Define cross cultural variations and similarities in organizational practices in corporate social responsibility and business ethics. Understand sources of organizational ethical culture and to design ethical programs designed to accomplish specific objectives in organizations. Develop ethical leadership skills and practices</p>
9	Brief Contents	<p>Business ethics- an overview, Concepts and theories of business ethics, Emerging business ethics issues, Ethical decision making in business, Creating an ethical organization globalization and business ethics, Stakeholders and business ethics, Social responsibility and ethics, Issues in social responsibility, Implementing stakeholders' perspective, Stakeholder and issue management approaches, Managing corporate responsibility with external stakeholders, Corporate governance and ethical leadership, Kohlberg's six stages of moral development, Levels of ethical analysis, Concept of corporate integrity, Issues in corporate governance, good</p>

		corporate governance - obligations towards society and stake holders, Ethics in consumer protection, Role of government agencies, SEBI, judiciary in ensuring ethical practices, Ethics and Indian business, Marketing ethics, Ethics in human resource management, financial management, banking and insurance.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS024
5	Title of the subject	Competency Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The aim is to give students a better idea of how to work with their employees to make today's competency-based performance reviews more effective and a more positive experience. Begin to think of it differently: as a partnership or a collaborative effort.
9	Brief Contents	Introduction to competency: definition and history of competency, Basic components of competency (Knowledge(K), Skill(S), Attitude(A)), Performance Vs competency, Difference between competence and competency, Type of competency generic vs key competency, Functional and technical competency, Leadership and managerial competency, Need for competency framework, Limitation and learning from competency framework, Myth about competency, Competency development & its models: Need and importance of competency development, Stages in developing competency model, Types of competency Model – core/generic, Job specific, Managerial / leadership, Custom, development of personnel competency framework, competency mapping: procedures / steps-determining objectives and scope, Clarifying implementation goals and standards, create an action plan, Define competency-based performance effectiveness (key result area (KRA) & key performance indicators (KPI)), Tools for data collection, Data analysis, Validating competency model, Mapping future jobs, and single incumbent jobs, Using competency profile in HR decisions, Mapping competency for recruitment and selection, Training and development, Performance and compensation, Competency driven career and culture: Role of competency in career progression, Transactional competency, Tradition competency and transformational competency, Evaluation of career through KSA (Knowledge, Skill, and Attitude) Competency-based

		succession and career planning, corporate competency driven culture.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS025
5	Title of the subject	Human Resource Information System
6	Any prerequisite	Human Resource Management
7	L-T-P	3-0-1
8	Learning Objectives of the subject	To review and understand the basic concepts and principles of human resource information system and to apply the same to the real world. To explore strategic value of HRIS and its contribution to organizational success. To review the leading HRIS software. To explore the ways of identifying best HRIS based on industry specificity and ROI.
9	Brief Contents	Introduction to HRIS, Acquisition and HRIS costs, Needs Assessment; HR metrics, Database concepts and applications in HRIS, Change management and data validation, HRIS design and implementation considerations, HR administration and HRIS, Job analysis, Security and privacy issues, Emerging trends in HRIS.
10	Contents for lab	Case study exercises Class projects and exercises

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS026
5	Title of the subject	Emerging Areas in Human Resource
6	Any prerequisite	Human Resource Management
7	L-T-P	3-0-1
8	Learning Objectives of the subject	To recap the major concepts and theories of HRM. To explore the emerging areas of HRM. To understand practical applications of theory relevant to today's workplace. To explore contemporary topics in Human Resource Management. To build strong foundation and relevant skill set required in today's workplace.
9	Brief Contents	Setting the hybrid work model for collaboration, Human leadership, Working in the metaverse, Managing international human resources, Managing human resources in small and medium enterprises, Strategic human resource management, Change management, People analytics, The transition from

		employee well-being to healthy organization, Diversity, equity and inclusion
10	Contents for lab	Case study exercises Class projects and exercises Role playing

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS027
5	Title of the subject	Organization Theory & Development
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Describe how the need to increase organizational efficiency and effectiveness has guided the evolution of management theory. Explain the principle of job specialization and division of labor, and tell why the study of person-task relationships is central to the pursuit of increased efficiency. Identify the principles of administration and organization that underlie effective organizations.
	Brief Contents	Explain what is meant by the term organization, Classify the three levels of managers and identify the primary responsibility of each group, Describe the difference between managers and operative employees. Explain the skills and roles manager, Describe the value of studying organization. Identify the relevance of popular humanities and social science courses to management practices, Trace the change in theories about how managers should behave to motivate and control employees, Explain the contributions of management science to the efficient use of organizational resources, Explain why the study of the external environment and its impact on an organization has become a central issue in management thought, Describe forces that act as stimulants to change, Summarize the sources of individual and organizational resistance to change, Summarize Lewin's three-step change model. Explain the values underlying most OD efforts, Contrast process reengineering and continuous improvement processes, Identify properties of innovative organizations, List characteristics of a learning organization, Describe potential sources of stress, Organizational Development Techniques, Explain individual difference variables that moderate the stress–outcome relationship
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS028

5	Title of the subject	Leadership & Talent Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Leadership and Talent Management primarily focus on managerial leadership as opposed to parliamentary leadership or emergent leadership in informal groups. The objective of this module is to present the theory and research on leadership and talent management in formal group.
9	Brief Contents	Define leader and explain the difference between managers and leaders, Summarize the conclusions of trait theories of leadership, Describe the Fiedler contingency model, Summarize the path goal model of leadership, Explain situational leadership, Identify the qualities that characterize charismatic leaders and authentic leaders, Meaning of talent, Talent or human capital of an organization, Why talent/human capital management? Functions of talent management.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS029
5	Title of the subject	Training & Development
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	To develop an understanding from the point of view of the individual employee. Improve the individual's level of awareness. Increase an individual's skill in one or more areas of expertise. Increase an individual's motivation to perform their job well.
9	Brief Contents	Overview of training, Trends in training, Career opportunities in training important concepts and meanings, Why conduct a training needs analysis, When to conduct a TNA, The TNA model, The framework for conducting a TNA, Output of TNA, Approaches to TNA, Introduction to the design of training organizational constraints developing objectives, Why use training objectives, Overview of the training design ,Matching methods with outcomes , Lectures and demonstrations , Games and simulations, On-the-job & off the job training, Development of training, implementation, transfer of training. Evaluation of training, Rationale for evaluation, Resistance to training evaluation
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective

4	Code of the subject	MS030
5	Title of the subject	Management of Employee Relations
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	To develop an understanding of the interaction pattern among labour, management and the State. To build awareness of certain important and critical issues in Industrial relations. To impart basic knowledge of the Indian Industrial relations system and its distinctive features.
9	Brief Contents	The evolution of Industrial relations, understand the scope and objectives of Industrial relations, Essential of Industrial relations, participants of Industrial relations and dynamics of their participation, perspective and approach, The system of industrial relation in India, the historical perspective of Industrial relations, Describe the trends in Industrial relations management, The changing characteristics of Industry and workforce in India, Describe the demand for labour, The challenges to industrial relations, Labour laws pertaining to Industrial relations viz Trade Union act, Industrial dispute act, Factories act, A paradigm shift from Industrial relations to Employee relations, Understand the Employee relations management. Describe the differences in perspective of employee relations and industrial relations.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS031
5	Title of the subject	Corporate Restructuring
6	Any prerequisite	Financial Reporting and Control Financial Engineering and Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The objective of this course is to sensitize the students about the need for corporate restructuring for achieving fast growth and maximize shareholders' value in the context of ever-increasing competition thrown up by liberalization and globalization of Indian economy. The focus of this course, however, will be to analyse the decisions in a financial perspective emphasizing valuation.
9	Brief Contents	Opening of the economy, Global view, Indian scenario, Economic liberalization, Corporate restructuring- mergers, acquisitions, and demergers, Mergers and amalgamations, Search for a merger partner, Negotiations, steps, and formalities, Demergers-divestitures, Spin off, Equity carved out, Split off, Split up, Reconstruction, Modes of demerger, Tax aspects, Advantages, and procedure of reverse merger- Requirements,

		Takeover by reverse bid, Techniques of and procedure for organizing takeover bids, Search for acquisition of target company, Procedure for takeovers and acquisitions, Valuation and exchange ratio-valuation of listed and unlisted companies, Modes of valuation, Fixing price for acquisition, Determination of share exchange ratio on merger, Feasibility analysis for cash acquisition, Valuation practices in India, Funding of merges and acquisitions-financing alternatives, Management buyouts, Leveraged buyouts, Post-merger management- accomplishment of objectives, Performance after merger, Mergers and accusations overseas by Indian corporates
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS032
5	Title of the subject	Corporate Tax Planning
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	After the completion of this course, students will be able to understand and apply corporate tax provisions to real life business problems efficiently using appropriate concepts of taxation laws for corporate tax planning.
9	Brief Contents	Concept of tax planning, Tax management, Tax evasion, Tax avoidance, Corporate tax in India, Types of companies, Residential status of companies and tax incidences, Tax liability and minimum alternative tax, Tax on distributed profits of companies, Tax planning with reference to setting up a new business, locational aspect, Nature of business, Form of business, Tax planning with reference to financial management decision-capital structure, Dividend including deemed dividend and bonus shares, Tax planning with reference to specific management decisions - Make or buy, Own or lease, Repair or replace, Tax planning with reference to employee remuneration, Tax Planning with reference to business restructuring- Amalgamation, Demerger, Slump sale, Transfer between holding and subsidiary companies, Tax deducted at source, Advance Tax, Double taxation relief, Goods and service tax planning, Transfer pricing and taxation.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective

4	Code of the subject	MS033
5	Title of the subject	Economic and Financial Modeling
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The students will be able to: Learn the skills for framing finance and economy modeling. Develop problem solving abilities in the context of both macroeconomics and microeconomics. Analyze the company / industry performance on relevant financial parameters using historical information on companies
9	Brief Contents	Economic Modelling: Classical model of national income; distribution of national income to the households; fiscal policy and the allocation of resources between consumption, investment and government purchases; modelling economic growth, Modelling inflation; net exports; capital flows and exchange rates in the long run; Mundell Fleming model of business cycle; Edgeworth-Bowley box and the production possibility curve, Financial Modelling: Introduction to financial modeling; basic excel for financial modeling (formatting of excel sheets; use of formula functions; data filter and sort; charts and graphs; table formula and scenario building; vlookup; pivot tables), Introduction to financial statement analysis; financial reporting mechanics; income statement; balance sheet; cash flow statement; financial analysis techniques; inventories; long lived assets; non-current liabilities; financial statement application, Financial ratio analysis for financial statement interpretation; time value of money; long term financing; cash flow waterfall & resolve circular reference problem in interest during construction.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS034
5	Title of the subject	Entrepreneurial Finance
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Students will be able to Understand the importance of financial management and managing a new venture. Learn analyzing the various sources of investment and also know the support provided by the state and central government for entrepreneurship. Determine the various financial support schemes provided different institutions to the entrepreneurs.
9	Brief Contents	Financing and managing new venture: Importance of financial management as an integral part of entrepreneurship; conducting

		a feasibility analysis; what lenders and investors look for in a business plan, Sources of Finance: Various sources of investment; basics of venture capital and angel investment; start-up culture; various measures of encouragement and support being provided by the state and central government for strengthening the entrepreneurial culture, Institutional Financial Support: Schemes and functions of rate of Industries; District Industries Centres (DICs); Industrial development corporation (IDC); State financial corporation (SFCs); Small scale industries development corporations (SSIDCs); Khadi and village industries commission (KVIC); Technical consultancy organisation (TCO); Small industries service institute (SISI); National small industries corporation (NSIC); Small industries development bank of India (SIDBI). Evaluating new venture: Project evaluation; Real options and risk assessment, Financial assessment of new venture: Measuring and evaluating financial performance; financial strategy and capital structure
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS035
5	Title of the subject	Management of Financial Services
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Students will be able to Enable participants, understand the financial services industry, regulatory environment, financial analysis, and risk management. Learn investment management, banking operations, financial planning, and financial technology, and ethics and professionalism. Determine the financial markets, financial intermediation and different financial services.
9	Brief Contents	Introduction to Financial Services: Financial services; Financial services sector in India: overview of financial services in India; nature scope and types of financial services: fund based and non-fund based financial services; venture capital: concept and types; regulatory framework; private equity; strategic secrets of private equity, investment strategies, hedge funds; new venture financing; risk & return in venture capital, Mutual Funds and Pensions Funds: Mutual funds and pensions funds; insurance services; bank assurances; reinsurances; securitization; Indian banking and financial crisis; asset reconstruction companies; depositaries; credit cards; micro/macro finance; financial inclusion, Plastic Money - Concept and different forms of plastic money - credit and

		debit cards, pros and cons. Credit process followed by credit card organizations. Factors affecting utilization of plastic money in India, Financial Depository: Depository – introduction, concept, depository participants; functioning of depository systems; process of switching over to depository systems; benefits; depository system in India; dematerialization and rematerialization role; objectives and functions of SEBI and its guidelines relating to depository system, Credit Rating & Merchant Banking: Credit Rating: the concept and objective of credit rating, various credit rating agencies in India, credit rating agencies – importance, issue, difference in credit rating, rating methodology and benchmarks, are Indian credit rating credible? International credit rating agencies – crisis of confidence?, Merchant Banking: origin and development of merchant banking in India scope, organizational aspects and importance of merchant bankers. latest guidelines of SEBI w.r.t. merchant bankers. Debt Securitization & Risk Management in Banks: Debt Securitization: meaning, features, scope and process of securitization. factoring: development of factoring types & importance, procedural aspects in factoring, financial aspects, prospects of factoring in India, Risk Management in Banks: credit risk management, operational risk management, market risk management, corporate treasury management, liquidity risk management, governance risk and compliance.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS036
5	Title of the subject	Financial Risk Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Understand the concept of financial risk and a comprehensive understanding of the various types of financial risks that organizations face. Developing the skills to identify and measure financial risk using various quantitative and qualitative techniques. Understanding to develop and implement the strategies to manage financial risk. Understanding the regulatory environment surrounding financial risk.
9	Brief Contents	Overview of financial risks, Risk, expectations, and asset prices, Volatility behavior and forecasting, Market risk measurement, Value-at-Risk and its implementation, Credit and counterparty risk, Leverage and leverage risk, Liquidity risk, Extreme events and market risk measurement, Assessing the

		accuracy of Value-at-Risk, Incorporating extreme events into risk measurement, Credit risk measurement, Portfolio credit risk measurement, Structured credit risk, Financial crises, Overview of regulatory policy, Regulatory capital and liquidity standards, Financial stability regulation
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS037
5	Title of the subject	Personal Wealth Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	After completion of the course, students will be able to understand personal financial planning as an approach for investment, insurance, taxation, and retirement and can identify the best combination of different financial products in view of different time horizons and propositions of risk return trade-off.
9	Brief Contents	Introduction and importance of personal wealth management, Concept of personal financial planning, Objective of personal financial planning, Steps involved in personal financial planning process, Emergence of personal financial planning in India, Financial institutions and products, Concept of risk, Types of risk, Measuring risk, Understanding return, Concept of compounding, Real and nominal rate of return, Tax adjusted return, Risk adjusted returns, Asset classes, Portfolio construction, Practical asset allocation and rebalancing strategies, Portfolio monitoring and re-balancing, Need for insurance, Requirement of an insurable risk, Role of insurance in personal finance, Steps involved in insurance planning, Insurance products, Products and functions of life and non-life insurance business, Need of life insurance, Retirement planning process, Estimation of retirement corpus, Determination of retirement corpus, Retirement products, Understand income tax principles, Tax aspects of investment products, Personal tax planning, Estate planning.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS038
5	Title of the subject	International Finance
6	Any prerequisite	Financial Engineering and Management
7	L-T-P	3-0-0

8	Learning Objectives of the subject	Students will be able to understand the significance of financial management in the global context particularly for MNCs, importance of foreign exchange market and international financial institutions, and applications of financial instruments of the international financial markets for the working capital and financing decisions.
9	Brief Contents	Concept and comparison of international trade, International business, International finance, International trade theories, Balance of payments and capital account convertibility, Development of international monetary system, Nominal, real and effective exchange rates, Determination of exchange rates, Factors influencing exchange rates, Theories of exchange rate behaviour; International financial institutions, Major participants in foreign exchange market, Spot market and forward market, Markets for currency futures and options, Foreign exchange rates, Techniques of exchange rate forecasting, Nature and Measurement of Foreign Exchange Exposure, Management of Foreign Exchange Exposure, Theories of Foreign direct investment, International capital budgeting- Evaluation criteria, Computation of cash flows, Cost of capital, Adjusted present value approach, Evaluation and management of political risk, International Portfolio Investment-concept of optimal portfolio, modes of international portfolio investment, An overview of international financial markets, Channels for international flow of funds, Multilateral development banks, International banking, International financial instruments, Financial swaps, Management of interest rate risk, Working capital policy, Management of current assets, Financing current assets, Foreign trade documentation, Modes of payments in international trade, Methods of trade financing.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS039
5	Title of the subject	Project Appraisal and Finance
6	Any prerequisite	Elementary Financial Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The course aims at providing an understanding of project identification, feasibility study of the project and project report preparations. It facilitates the knowledge about different sources of financing and financial appraisal technique. It provides an acquaintance about social cost benefit analysis with understanding for different types of project risk and also post assessment of the project.

9	Brief Contents	An introduction to project appraisal, Project appraisal and evaluation , Project life cycle, Project cycle management , Cost benefit analysis of Private and public sector projects; Identification of investment opportunities – industry analysis review of project profiles, – feasibility study , Project identification and formulation , Generation of project ideas, Basic principles of project analysis entrepreneurship concept, Theory and perspective, Market feasibility analysis of a project, Need for market analysis, Demand and supply analysis, Collection analysis, primary /secondary data, Forecasting of market growth; Market forecasting techniques, Technical appraisal of a project, Technology tie ups and diffusion; Management of technology and business, Financial feasibility analysis: Estimation of cost of project & means of financing, Arrangement of funds, Traditional sources of financing: Equity shares, preference shares, Debentures / bonds, loan from financial institutions, Alternative sources of financing: FDI & FII, private equity, securitization, venture capital, Different business/project support government schemes, Government funding for projects, Startup schemes of government, Projected cash flows of project, Appraisal criteria, NPV,IRR, PI, PBP, ARR, Economic analysis of a project : Social cost benefit analysis – rationale of SCBA, direct and indirect cost and benefits, shadow price efficiency and equity in project appraisal, UNIDO approach, Little Mirrlees approach, Environment impact assessment of a project and social impact assessment of a project, Risk and sensitivity Analysis, taxonomy of risks, break even analysis, Sensitivity analysis, Risk analysis using simulation models and decision trees, Monitoring and evaluation of a project – PERT / CPM, Monitoring mechanism, valuation and lessons, project audit, Preparation of project report, Case analysis.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS040
5	Title of the subject	Security Analysis and Portfolio Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The objective of this course is to help students gain an understanding of the evolving domestic and international investment landscape in general, and the Indian capital market with special emphasis on the availability of different financial products and stock exchange operations. It aims to provide a thorough understanding of portfolio management theory and practice. With the goal of assisting the participants in making wise investment choices in the context of portfolio investment, significant theories,

		techniques, laws, and advancements in investment theory will be covered.
9	Brief Contents	Investment Alternatives and Objectives, Organization and Mechanics of Securities Markets, Types of Security Markets and their Functions, Stock Exchanges, Depository, Stock Indices, Role of Regulatory Authorities, and various participants in markets, Market Microstructure, Risk and Return dynamics, Utility Theory, Portfolio Theory, CAPM Capital Asset Pricing Model (CAPM), Arbitrage Pricing Model (APT), Multi-factor Models, Sharpe's Single Index Model, Lagrange Multiplier Theory, Basics of futures and options, Fundamental Analysis: Macroeconomic activities and security markets, The Cyclical indicator approach, Monetary variables, Business cycles and industry sectors, Evaluating Industry life cycle, Analysis of industry competition and industry rate of returns, Company analysis, Analysis of Financial statement and Stock valuation, Technical analysis: Assumption, Advantages, Challenges, Types of Charts, Technical Trading Rules, and Indicators, Introduction to Efficient Market Hypothesis, Random Walk Model, Forms of EMH, Empirical Evidence, Bond Fundamentals, Valuation and Bond Yield, Term structure, Bond Theorems, Bond Portfolio Management Strategies, Passive and Active Management, Portfolio Management, Portfolio Objectives, Evaluation of Portfolio Performances, Application of Portfolio performance measures
10	Contents for lab	No

1	Program	MBA/IPG MBA
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS041
5	Title of the subject	Consumer Behavior
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Explaining the basic concepts of Consumer Behavior and its linkages to marketing. Examine how markets are segmented, and brands are positioned. Analyse the phenomenon of consumer learning about a brand and forming perceptions about it. Compare how the theoretical aspects of Consumer Behaviour are practiced in real scenarios by marketers and brands.
9	Brief Contents	Consumers, Marketers, and Technology, Consumer Behavior and Technology, Market Segmentation and Real-Time Bidding, The Consumer as an Individual, Consumer Motivation and Personality, Consumer Perception and Positioning, Consumer Learning, Consumer Attitude Formation and Change, Communication and Consumer Behavior, Persuading Consumers, From Print and Broadcast to Social Media and Mobile Advertising, Reference Groups and Communities, Opinion Leaders, and Word-of-Mouth, Social and Cultural Settings, The Family and Its Social Standing,

		Cultural Values and Consumer Behavior, Cross-Cultural Consumer Behavior: An International Perspective, Consumer Decision-Making, Marketing Ethics, and Consumer Research, Consumer Decision-Making and Diffusion of Innovations, Marketers' Ethics and Social Responsibility, Consumer Research.
10	Contents for lab	Case study exercises

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS042
5	Title of the subject	Advertisement and Sales Promotion Management
6	Any prerequisite	Marketing Management
7	L-T-P	3-0-1
8	Learning Objectives of the subject	To understand the key concepts of advertising and sales promotion. To explore an organisation's numerous copy and media decisions. To understand the link between advertising and sales promotion for enhancing brand equity
9	Brief Contents	Role of integrated marketing communication, Role of IMC in marketing process, Marketing and promotions process, Organizing for advertising and promotion: the role of Ad agencies and other marketing communication organizations, Perspectives on consumer behavior, The communication process, Source, message and channel factors, Establishing objectives and budgeting for the promotional program, Creative strategy: planning and development, Media planning and strategy, Media decisions, Evaluation of broadcast media, The internet and interactive media, International advertising and promotion, Advertisement effectiveness, Sales promotion, Linkage between advertising and sales promotion, Brand equity, Regulation of advertising and promotion, Evaluating the social, ethical, & economic aspects of advertising & promotion.
10	Contents for lab	Case study exercises Class projects and exercises Field projects and company visits

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS043
5	Title of the subject	Product and Brand Management
6	Any prerequisite	Marketing Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	After completion of this course students will be able to understand the concept of product and brand management, branding as marketing strategy; brand equity and its measurement, and operational aspects of brand management.

9	Brief Contents	Introduction and concept of product management, Management of new product development process, Understanding and managing product life cycle, Introduction to brand management, Brand management process, Brand choice decisions and models, Brand identity, Brand communication, Brand positioning, Brand image and personality, Brand valuation, Brand tracking and monitoring, Building brands in Indian market, Launching a new brand, Revitalizing brands, Brand extension strategies, Brand portfolio management, Managing brands across geographical borders, Managing brand experience, Digital branding, Employment branding, Co-branding.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS044
5	Title of the subject	E-Marketing
6	Any prerequisite	Marketing Management
7	L-T-P	3-0-1
8	Learning Objectives of the subject	To explore frameworks for the successful planning and execution of e-campaign strategies. To understand ROI enhancement, customer lifetime value and firm profitability aligned with business goals through e-marketing. To plan and implement search engine and social media campaigns in simulated environments. To understand leveraging digital marketing funnel for better customer engagement. To understand reach, engagement and conversions with paid and unpaid e-campaigns. To measure and optimize the e-campaigns through different matrices. Strategic application of digital marketing best practice.
9	Brief Contents	Marketing in the digital world, Exploring customer behaviour and customer journey in digital world, Crafting and executing digital strategy, Aligning business strategy, Reaching and engaging the customer, Strategies for paid and unpaid e-campaigns, Display, social media and e-mail campaigns, User experience and transformation, True personalization, Customer service, Content strategy, Matrices for strategy evaluation, Digital analytics, Emerging technologies
10	Contents for lab	Case study exercises Class projects and exercises Field projects and company visits

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS045
5	Title of the subject	Retail Management
6	Any prerequisite	No
7	L-T-P	3-0-0

8	Learning Objectives of the subject	Upon successful completion of the course, students should be able to: Demonstrate an understanding of how retailers develop a retail mix to build a sustainable competitive advantage. Explain how retailers use marketing communications to build a brand image and customer loyalty. Understand the integration of merchandise management and supply chain strategies leading to excellent customer service. Understand the financial implication of strategic retail decisions. Demonstrate an understanding of decisions retailers make to satisfy customer needs in a rapidly changing and competitive environment.
9	Brief Contents	Introduction to the world of Retailing : A. History of retail, B. Retail overview and present scenario C. Concept and Functions performed by retailers D. Emerging Trends and career opportunities in retailing, Types of Retailers: A. Retailer characteristics B. Retail Formats - Store based, Non-store based, Web based C. Various format within store based retailing e.g. specialty store, hyper market, supermarket, buying decision process : A. The buying process - need recognition, information search, evaluation of alternatives. B. Social factors influencing the buying process family, reference groups and culture retail market strategy: A. Definition of retail and market strategy B. Target market C. Building a sustainable competitive advantage like - customer's loyalty, location, human resource management, distribution and information system, vendor relations. D. Growth strategies - Market penetration, market expansion, retail format development diversification, integration, E. Global retail strategies F. Strategic retail planning process, Choosing retail location: A. Types of locations - Unplanned locations free standing sites B. Evaluation of area for location C. Evaluating specific area for locations, HRM In Retailing : A. Human resource planning, Recruitment and selection, training and development of retail employees. B. Motivation of retail employees, C. team building in retailing D. Employee Rewards and Incentives, Store Planning: Design & Layout, Retail Image Mix, effective retail space management, floor space management, Retail Supply Chain Management: A. Introduction to supply chain management B. The distribution across centres 24 C. Collaboration between retailer and vendor in SCM D. Inventory Management E. Warehousing F. Transportation G. Use of IT in SCM 8. Customer Relationship Management - The CRM process 9. Retail Information System Instructural Strate, Merchandise Pricing: Concept of Merchandise Pricing, Pricing Objectives, External factors affecting a retail price strategy, Pricing Strategies, Types of Pricing.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS046
5	Title of the subject	International Marketing
6	Any prerequisite	No
7	L-T-P	3-0-0

8	Learning Objectives of the subject	The course aims at providing knowledge to students to the global business activities, marketing in international business and global forces transforming the international business today. Participants will learn to plan effectively for the marketing of consumer and business needs and wants on an international level. Special emphasis will be placed on cultural and environmental aspects of international trade, and integration of culture and marketing functions.
9	Brief Contents	An Overview of International Marketing: The Scope and Challenge of International Marketing, The Dynamic Environment of International Trade, The Cultural Environment of Global Markets: History and Geography: The Foundations of Culture, Cultural dynamics in assessing Global markets, Culture, Management style, and Business systems, The Political environment: A Critical concern, The International legal environment: Playing by the rules , Assessing Global Market Opportunities: Developing a Global Vision through Marketing Research, Economic Development and the Americas, Europe, Africa, and the Middle East, The Asia Pacific Region, Developing Global Marketing Strategies: Global marketing management: Planning and Organization, Products and services for consumers, Products and services for businesses, International marketing channels, Integrated marketing communications and International advertising, Personal selling and Sales management, Pricing for international markets, Implementing Global Marketing Strategies: Inventive Negotiations with International Customers, Partners, and Regulators
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS047
5	Title of the subject	Sales and Distribution
6	Any prerequisite	Marketing Management
7	L-T-P	3-0-1
8	Learning Objectives of the subject	To understand the key concepts of sales and distribution. To explore an organisation's numerous distribution and sales channels. To broadly look at the role of sales and distribution as a key element within marketing strategy. To equip with basic skills required in sales and distribution management.

9	Brief Contents	Sales management and the business enterprise, Sales management, personal selling, and salesmanship, Setting personal-selling objectives, Determining sales-related marketing policies, Formulating personal-selling strategy, The effective sales executive, The sales organization, Sales department relations, Sales personnel management, Recruitment and selection, Sales training, motivation and compensation, Evaluation and supervision, Sales budget, Territories, control and cost analysis, Marketing channels, Managing channel partners, Channel information system, Logistics and supply chain management, International sales and channel management
10	Contents for lab	Case study exercises Class projects and exercises Field projects and company visits

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS048
5	Title of the subject	Marketing Research
6	Any prerequisite	Basic knowledge of statistics and research methodology
7	L-T-P	3-0-0
8	Learning Objectives of the subject	To understand the formulation of marketing problem into a feasible research question. To design and execute a basic survey research project. To understand the research tools and techniques for executing a marketing project and decision making.
9	Brief Contents	Introduction to Marketing Research: Marketing research an introduction, marketing research process design, Research design formulation: Measurement and scaling, questionnaire designing, sampling and sampling distributions, Sources and collection of data: Secondary data sources, Data collection: survey and observation, experimentation, fieldwork and data preparation, Descriptive statistics and data analysis: Measures of central tendency, measures of dispersion, hypothesis testing for single population and two populations, ANOVA and Experimental designs, hypothesis testing for categorical data (chi-square test), correlation and simple linear regression analysis, Multivariate analyses (multiple regression analysis, discriminant analysis, conjoint analysis, factor analysis, cluster analysis, multidimensional scaling and correspondence analysis, Result presentation: Presentation of results, report writing, Applications of marketing research: Marketing mix research: Product, price, place and promotion research
10	Contents for lab	Descriptive statistics and data analysis: Measures of central tendency, measures of dispersion, hypothesis testing for single population and two populations, ANOVA and Experimental designs, hypothesis testing for categorical data (chi-square test), Correlation and simple linear regression analysis, Multivariate analyses (multiple regression analysis, Discriminant analysis,

		conjoint analysis, factor analysis, Cluster analysis, Multidimensional scaling and correspondence analysis
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1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS049
5	Title of the subject	Service Marketing
6	Any prerequisite	Basic knowledge of Marketing Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	To provide an in-depth appreciation and understanding of the unique challenges inherent in managing and delivering quality services. To develop an understanding of the 'state of the art' of service management thinking. To understand the marketing concepts in the perspectives of services.
9	Brief Contents	Service Marketing Introduction : Meaning and nature of services, classifications of services, Introduction to service marketing, Evolution of service marketing, Service marketing mix and Gaps model: 7Ps of service marketing, service gaps framework, perceived service quality, model of service marketing, Service design and service delivery: Introduction to service design and service delivery, service delivery process, service encounters and moments of truth, employee role in service delivery, role of service provider, intermediaries involved in service process and delivery, managing demand and supply of service, STP strategy for Services: Need for segmentation of services, bases of service segmentation, segmentation strategies in service marketing, need for targeting and positioning strategies for services, Consumer behaviour in service marketing: Customer expectations in services, Service costs experienced by consumer, the role of consumer in service delivery, customer responses in services, customer delight, service failure and recovery, Emerging issues in Service marketing: Strategic approach in service marketing, Service marketing in e-commerce and e-marketing, Telemarketing services
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS050
5	Title of the subject	Strategic Marketing
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	On completion of this course, the student will be able to: Understand and critically discuss the marketing activities that impinge on our daily lives as business managers and citizens. Critically evaluate key marketing theory, concepts, research and current practice. Discuss critically decision-making processes and frameworks for selecting marketing objectives, target markets and marketing mixes.

		Discuss critically how marketing practice is influenced by contemporary challenges in the operating environment. Apply theoretical frameworks to real-world marketing innovation challenges: identifying their key features and implications, setting appropriate marketing objectives and evaluating alternative marketing strategies.
9	Brief Contents	Fundamentals of Marketing Strategies, Marketing management for a turbulent era, The marketing fit with corporate and business strategies, Capturing key Marketing environmental insights, Customer insights and customer connections , Capturing marketing insights for demand measurement, Market segmentation and target marketing, Conducting Marketing audits, Branding and positioning, Marketing strategies for competitive and market scenarios, The integrated marketing mix, Marketing Metrics and Analytics, Organising, planning, delivering and measuring market performance, Innovation and Marketing Strategy, Marketing Channels and Pricing, Marketing Communications, Digital and Social media marketing, Marketing strategy to the bottom of the pyramid, Frugal & Grass root marketing
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	
5	Title of the subject	Customer Relationship Management
6	Any prerequisite	Marketing Management
7	L-T-P	3-0-1
8	Learning Objectives of the subject	To understand the meaning and application of CRM. To explore the benefits of CRM to companies and consumers. To explore CRM best practices implementation in organizations. To understand the importance of bonding and building loyalty with customers. To explore the ways of building long-term customer relationships.
9	Brief Contents	Introduction to CRM, Market segments, buyer personas, and voice, Understanding and building customer relationships, Managing the customer journey, Strategic CRM, Operational CRM, Analytical CRM, Economies of CRM, CRM applications, CRM in business markets, Building effective internal structure, and choosing the right CRM solution, CRM Implementation, Streamlining processes, automating where possible, and employing analytics, Futuristic developments
10	Contents for lab	Case study exercises Class projects and exercises Field projects and company visits

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective

4	Code of the subject	MS051
5	Title of the subject	Public Policy and Processes
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Describe formulation and implementation of policies. Employ role of various institutions and interest groups in policy formulation and implementation process. Assess role of various stakeholders in influencing policy processes and associated outcomes.
9	Brief Contents	Concepts and Theories of Public Policy and Processes: Understanding public policy, Policy types, Approaches to policy making- various models of policy making and their relevance, Institutions and its role in Public Policy: Policy making institutions in India: Judiciary, executive and legislature, How policy making is accomplished in India, Constitutional/statutory bodies and its role in policy process, Political institutions, Changing role of institutions: new public management, New governance model, Role of networks in shaping public policy, Policy Process: Formulation of policies: Principal phases of policy process: issue identification/agenda setting, Stakeholder consultation and review, Transparency in policy formulation, Identifying the main actors/stakeholders in the policy process, Idea of political power and influence, Regional versus national interest, Policy Process: implementation of policies: policy implementation, Identifying implementation gaps, Feedback on policies, Policy implementation as a political process: political economy, Service Delivery, Accountability and people's participation: role of decentralization and local governance, Policy Change: Identifying role of domestic and international actors in determining policy choices, Endowments and Constraints on their power to determine policy choices civil Society/pressure groups/networks and its role in influencing policy decisions, Market (private sector/business) as an agent in influencing policy decisions, Media and its role in public policy
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS052
5	Title of the subject	Public Private Partnerships
6	Any prerequisite	
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Understand the role of cooperation between public and private sectors in delivering public services; to develop understanding of PPP models and their contextual suitability; and employ various types of partnerships and assess their consequences.

9	Brief Contents	<p>PPP Concept, Benefits and Limitations- Public service delivery and roles of government, recent trend of reforms on public service delivery, basic theories of public private partnership (PPP)</p> <p>PPPs Models- Concept and practices of outsourcing, Competition between private and public sectors, such as competitive sourcing and market testing, concept and practices of various types of private finance initiative (PFI), recent issues in PFI practices, theories and practices of deregulation, involvement of citizens, non-profit organization (NPOs) and social enterprises in public service delivery, Basic theories and practices of executive agencies and public corporations, theories and practices of privatization, recent practices to bring outsourced public services back in-house</p> <p>Government Role for Creating an Enabling PPP Environment- Conventional and innovative approaches for improving government procurement, practical models of shared services in public sector, advantages and disadvantages of PPP, strategies, steps, monitoring, evaluation of PPP, skills and resources required for managing PPP</p> <p>Risk Identification and Allocation- Risk assessment, value for money (VfM) and commercial feasibility exercises, risk identification, political risks, market risks, challenges for public service delivery and possible (desirable) future directions</p> <p>PPP Structure and Financing- Financing options, profitability assessment, funding cost, project attractiveness.</p>
10	Contents for lab	N/A

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS053
5	Title of the subject	Sustainable Development
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	<p>To enhance students understanding of the SDGs to create a better-informed citizenry, which will lead to a more sustainable action by all and for all. To understand the basic concept of Sustainable Development (SD), the environmental, social and economic dimensions. To know the history of the SD idea. To Be able to discuss the conflicts which are involved in the SD concept on the national as well as on the global scale. To be familiar with potential strategic options for SD (efficiency, sufficiency). To be able to discuss the (dis-advantages) of instruments for SD. To understand the SD challenge for companies, their responsibility and their potentials for action.</p>
9	Brief Contents	<p>Sustainability, sustainable development, and the sustainable development goals; SDGs overview, goals, and targets, Instruments for sustainable development, SDG Goal part-1 : Poverty, Hunger, Good health and Well-being, SDG Goal part-2 : Gender equality, Reduced inequalities, SDG Goal part-3 : Clean water and sanitation, Affordable and clean energy, SDG Goal part-4: Quality education, Decent work and Economic growth, SDG Goal part-5 Industry, Innovation, and Infrastructure; SDG goal part- 6: Sustainable cities and communities, Responsible Consumption and</p>

		Production, SDG Goal part-7 Climate action, Life below water, Life on land; SDG Goal part-8 Peace, Justice, and Strong institutions, #17 Partnerships for goals, Implementing the SDGs, Monitoring, Evaluation, Reporting, Beyond sustainability to radical transformation, Company perspectives
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS054
5	Title of the subject	Management of Rural and Social Sector
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Course is designed to inculcate students with realistic understanding of rural segment and society for the application of managerial and technological learning.
9	Brief Contents	Indian rural and social sectors, Rural and sector economic development, Different rural and social sector reform programmes of Asia; Local, National and International focuses and policies for economic reforms of rural and social sectors.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS055
5	Title of the subject	Information Technology Enabled Services
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Understand the business strategy and business implications for strategic IT planning. Equip students to understanding the concepts of IT infrastructure library and services
9	Brief Contents	Business Strategy: Challenges- opportunities, Interconnection establish principles before practice, IT strategy, Application strategy, Technology strategy for IT, IT management strategy, Developing IT strategy for competitive advantage, Stages of IT strategy development and implementation, Challenges of IT and business strategy alignment, Inhibitors of business and IT strategy alignment, Three-D framework for Business and IT strategy alignment, Business implications for IT strategy and planning, Strategic IT planning, Motivations, SITP Process: Prevalent planning approaches difficulties, Best practices for achieving good SITP, SITP approaches: Prevalent researches, Defining EITA, Contents of a typical enterprise IT architecture, Standard for enterprise IT architecture, Technology Management strategy

		framework, Information Technology Infrastructure Library (ITIL), ITIL overview- ITIL Service- support processes, Incident management, Problem management, Service delivery, Service level management- Financial management, Capacity management, IT Service continuity management (ITSCM), Availability management, Imperatives for outsourcing, IT management layers- Variants of outsourcing, Business process outsourcing, Insourcing.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS056
5	Title of the subject	Management of Non-Formal Organization
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The Non-Formal sector is the backbone of the Indian Economy. The understanding of the issues related to the informal sector is necessary to have a better understanding of the Indian economy. This course would try to educate the researcher on different issues related to the informal sector in India and across the developing countries. This paper would enable the management student and potential researcher to conduct some in-depth research work in the unorganized sector.
9	Brief Contents	Introduction: Why the Informal Economy Matters to Management, Concept, Features and Types of Non formal sector, Difference between formal and informal organisation, Function of Non formal sector ,Formalizing informal sector, Challenges of the informal economy for the field of Management, Theoretical Foundations: A General Equilibrium approach, Communication, Visibility, and the Informal Economy, Technology in Non formal sector – Application and challenges, Management of The ICT in Non informal sector, Small Business in the informal Economy, Informal Financial Services: A Proposed Research Agenda, The hidden enterprise culture: Entrepreneurship in the Non informal sector, Organization and Contract in the Informal Economy, Comparative Economic Organization Revisited: Hybrid Governance in the Informal Economy, Factors Influencing the Registration Decision in the Informal Economy, Informal Firms in India What Do We Know and Where Does the Research Go, Healthcare in the Informal economy, Subsistence Entrepreneurs and Formal Institutions: Semi-formal Governance among Indian Entrepreneurs, Learning From India's Aadhaar Project, Lesson form Akshyapatra',Lesson from 'Arvind Eye care'
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective

4	Code of the subject	MS057
5	Title of the subject	Healthcare System Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Delve into the components and functions of health care provider organizations and assess the unique challenges involved in managing complex health care organizations. Appraise the motivations and interests of key internal and external stakeholders and managing expectations and communicating with these stakeholders. Weigh common problems and decisions faced by health care managers, and explore the implications of various alternative strategic solutions
9	Brief Contents	Issues in health management: leadership, management and motivation, Organizational behavior and management thinking, Strategic planning, Information systems, Complexity and purpose of health care organizations, For profit and non-profit organizations, Management responsibilities and health care operations, Management code of ethics and ethical decision-making, Care and cure processes, Operations management, Impact of the pandemic on providers and caregivers, Physician practice management, The post-pandemic health care system, Strategic planning, Industry consolidation
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS058
5	Title of the subject	Emerging Areas in Management of Social Sector
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Apply social work skills, values and ethical responsibilities to leadership, management and supervision practices. Describe and critique selected theories, research and practice approaches relevant to effective and socially just leadership and management in human service organizations. Create a plan for strategic change using concepts, processes and skills related to leadership, management, and organization development.
9	Brief Contents	Corporate governance, Project management, Social entrepreneurship for sustainable development, Strategic planning for social sector organizations, Essentials of managing a social organization, Understanding financial statements, Measuring project results, Systems and tools for impact measurement, Social impact marketing and sales management, Scaling a social

		enterprise, Attracting & raising capital, Market regulation and compliance.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS059
5	Title of the subject	Infrastructure Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Understanding the importance of infrastructure in supporting economic development, quality of life, and public safety. Understanding the roles and responsibilities of different stakeholders involved in infrastructure management, including government agencies, private sector organizations, and community groups. Developing skills in infrastructure asset management, including maintenance, repair, and replacement of infrastructure assets. Understanding the principles of sustainable infrastructure development and management, including considerations of environmental and social impact. Developing an understanding of risk management, including identifying, assessing, and mitigating risks associated with infrastructure systems. Understanding the legal and regulatory frameworks governing infrastructure development and management. Developing an understanding of the financing and funding mechanisms for infrastructure projects, including public-private partnerships and other innovative financing approaches.
9	Brief Contents	Introduction to Infrastructure Management: Definition and scope of infrastructure, Importance of infrastructure management, Historical development of infrastructure management, Types of Infrastructure: Transport, Water and wastewater infrastructure, Energy infrastructure management, Telecommunication management, Asset Management: Asset inventory and condition assessment, life cycle costing, risk management, Funding and Financing of Infrastructure: Public sector funding, private sector funding, public-private partnership, Project Management: Project identification and selection, project planning and design, project procurement and contracting, construction management and supervision. Infrastructure Policy and Regulation: Government policy on infrastructure, regulatory framework for infrastructure management, environment regulations and considerations, Emerging trends in Infrastructure management: New technologies for infrastructure management, Sustainability and resilience considerations, Future challenges and opportunities in infrastructure management
10	Contents for lab	No