



**MANAV RACHNA
UNIVERSITY** 

FORMERLY MANAV RACHNA COLLEGE OF ENGINEERING
NAAC ACCREDITED 'A' GRADE INSTITUTION

Declared as State Private University under section 2f of the UGC act, 1956

Manav Rachna University

Faculty of Applied Sciences

Department of Mathematics

Scheme & Syllabus

B.Sc. (H) Mathematics (2021)



MAU01- Semester-I

SUBJECT CODES	SUBJECT NAME	**OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft/Workshop/NTCC)	COURSE TYPE (Core/Elective / University Compulsory)	L	T	P	O	NO. OF CONTACT HOURS PER WEEK	NO. OF CREDITS
MAH111B	STATISTICS – I	MA	HARD	CORE	3	1	0	0	4	4
MAH108B	CALCULUS-I	MA	HARD	CORE	3	1	0	0	4	4
CSH105 B-TC	PROGRAMMING FOR PROBLEM SOLVING USING C	CS	HARD	CORE	2	1	0	0	5	4
CSH105 B-P	PROGRAMMING FOR PROBLEM SOLVING USING C -LAB				0	0	2	0		
PHH106B T	ESSENTIALS OF PHYSICS	PH	HARD	CORE	3	1	0	0	6	5
PHH106B P	ESSENTIALS OF PHYSICS LAB				0	0	2	0		
MAH109 –B	MATHS LAB –I	MA	HARD	CORE	0	0	2	0	2	1
HLS102	COMMUNICATIVE ENGLISH	HL	SOFT	CORE	1	0	2	0	3	2
TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)					12	4	8	0	24	20

**DETAILED SYLLABUS
MAU01 – FIRST SEMESTER**

Course Title/ Code	STATISTICS – I /MAH- 111B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	To equip the students with the concepts of Measures of Central Tendency, Measures of Dispersion, Skewness, Moments & Kurtosis and Correlation & Regression Analysis.
Learning Outcomes	The students would be able to apply the concepts of Measures of Central Tendency, Measures of Dispersion, Skewness, Moments & Kurtosis and Correlation & Regression Analysis required for solving the mathematical problems and their applications.
Pre-requisites	NA

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

SECTION A

Measures of Central Tendency: Introduction, types of averages- Mean, Median, Mode, Geometric mean, Harmonic mean, Relationship among averages, Quartile, Percentile

SECTION B

Measures of Dispersion: Introduction, Significance of measuring variations, Range, Quartile deviation, Mean deviation, Standard deviation, Relation between them, Coefficient of variation, Relation between coefficient of variation and standard deviation

SECTION C

Skewness, Moments & Kurtosis: Introduction, Difference between dispersion and skewness, Measures of skewness, Karl Pearson's coefficient of skewness, Bowley's coefficient of skewness, Kelly's coefficient of skewness, Moments, Moments about arbitrary origin, about zero, about mean, Measures of Kurtosis.

SECTION D

Correlation & Regression Analysis: Introduction, Types of correlation, Karl Pearson's coefficient of correlation, Probable error, Rank correlation, Spearman's correlation coefficient, Concurrent deviation method, Introduction to regression analysis, Difference between correlation and regression analysis, Regression lines and Regression equations.

Recommended books:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
4. S. P. Gupta, Statistical Methods, Sultan Chand & Sons, Educational publishers, New Delhi
5. S.C. Gupta, Fundamentals of Statistics, Himalaya Publishing House.

Course Title/ Code	CALCULUS – I/MAH 108 B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	Students will be able to understand and apply the concepts of Continuity, Differentiability and its applications.
Learning Outcomes	Students would be able to find the limit , continuity and differentiability of the given function and learn consequences of various mathematical functions
Pre-requisites	N.A

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Limit & Continuity:

Limit, Continuity, Continuous functions: Properties and theorems Differentiability of a function of single variable. Indeterminate forms. Mean value theorems: Rolle's Theorem, Cauchy's theorem and Lagrange theorem.

Section B

Successive Differentiation & Curvature: Successive Differentiation, Leibnitz Theorem, Taylor's and Maclaurin's Series.

Curvature, Radius of curvature for Cartesian, parametric and Polar Curves, Radius of Curvature at the Origin, Evolutes.

Section C

Tracing of Curves : Asymptotes (Parallel and Oblique) of Cartesian, Polar and Parametric Curves, Intersection of Curve and its Asymptotes. Concavity & Convexity, Points of Inflexion, Multiple Points (Singular Points), Tracing of Curves in Cartesian, Parametric and Polar Form.

Section D

Functions of Several Variables : Limit, Continuity and Differentiability of a function of two variables, Partial Differentiation, Euler's theorem, Total Derivative, Maxima Minima of a function of two Variables, Jacobians, Taylor's theorem for a function of two variables, Differentiation under the Integral Sign .

Recommended Books:

1. Shanti Narayan , Differential Calculus, S.Chand & Co.
2. B.S.Grewal, Higher Engineering Mathematics Khanna Publica

Course Title/ Code	Programming for Problem Solving Using C (CSH105 B) T & P
Course Type	Core (Alliedl)
Course Nature	Hard
L-T-P-O Structure	(2-1-2-0)
Objectives	Students are able to construct a program of moderate complexity from a specification

Syllabus	Sections	Weightage
	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section-A

Programming and UNIX

Students will learn the basics of programming using Scratch, they will learn to use statements, expressions, conditions, selection, iteration, variables, functions, arrays, threads and events. In addition, they will be introduced to basic UNIX commands under Bash.

Introduction to Programming, test driven development, Scratch: Introduction, statements, expressions, conditions, selection, iteration, variables, functions, arrays. UNIX: Basic commands- pwd, ls, cd, rm, cat, less, mkdir, rmdir; permissions, root. C language: statements, expressions, conditions, selection iteration, variables, functions, arrays.

Section-B

Applying programming constructs

Students will learn how to write programs that satisfy unit tests. The instructor will build the unit tests, demonstrating how to break a problem down into smaller components. In the labs and homework, students will construct programs that satisfy the unit tests. Students become familiar with the constructs of the C programming language.

Moving to C: Data Types, constants, and variables, Statements, Expressions, Conditions, Selection, iteration, Functions and recursion

Decision making within a program, Conditions, Relational Operators, Logical Connectives, if statement, if-else statement, Loops: while loop, do while, for loop, Nested loops, Infinite loops, Switch statement, structured Programming

Arrays; One dimensional arrays: Array manipulation; Searching, Insertion, Deletion of an element from an array; Finding the largest/smallest element in an array; Null terminated strings as array of characters, Standard library string functions

Introduction to Top-down approach of problem solving, Modular programming and functions, Standard Library of C functions, Prototype of a function: Formal parameter list, Return Type, Function call, Block structure, Passing arguments to a Function: call by reference, call by value, Recursive Functions, arrays as function arguments .

Section-C

Practical programming:

During the third quarter of the class, students will begin building their own programs by decomposing problems into smaller tasks and writing unit tests that will check to see that the

program accurately accomplishes the task using Test Driven Development. They will then write the program that satisfies their own unit tests. Students will learn to apply the constructs of the C programming language to create programs.

Students will learn to apply these programming techniques: Structure variables, initialization, structure assignment, nested structure, structures and functions, structures and arrays: arrays of structures, structures containing arrays, unions, Break, Continue and Goto, Type Conversion; Enumerations; Macros. Students will be able to use these techniques to develop programs

Section-D

Memory Management and Abstraction

During the final quarter, students will be introduced to dynamic memory allocation and dynamic data structures including: dynamic arrays. They will consolidate their ability to use the C programming techniques they have learned in the earlier sections.

Address operators, pointer type declaration, pointer assignment, pointer initialization, pointer arithmetic, functions and pointers, Arrays and Pointers, pointer arrays, pointers and structures, dynamic memory allocation,

Software Configuration Management, Modules, CUnit, GIT, SCRUM, MAKE. Dynamic Memory Allocation.

LIST OF EXPERIMENTS:

1. Scratch : Covering Concepts of
 - I. Sequential Statements
 - II. Variables
 - III. Blocks
2. Unix Commands: pwd, mkdir, cd, ls, less, touch, cp,move, cat, rm, rmdir -r etc.
3. Moving to C Using nano and gcc.
4. Project on Calculator Using Agile Methodology, Nano, Cunit, Git, Scrum , Agile Methodology,

Nano, Gcc, Make. Covering Concepts :

- I. Statements
- II. Functions
- III. Arrays
- IV. Structures
- V. Pointers
- VI. File Handling.

Recommended Books

1. The C Programming Language, Brian Kernighan and Dennis Ritchie
2. The Unix Programming Environment
3. Pro Git

Help Pages

1. Eclipse C/C++ Development Guide

Wikipedia Pages

1. Test-driven development, http://en.wikipedia.org/wiki/Test-driven_development
2. Unit testing, http://en.wikipedia.org/wiki/Unit_testing

Tool Web Sites

1. Eclipse, <https://eclipse.org/users/>
2. Git, <http://git-scm.com/>
3. GCC, <https://gcc.gnu.org/onlinedocs/gcc-4.9.3/gcc/>
4. Make
5. Unix

Web tutorials

1. Harvard's CS50, <https://courses.edx.org/courses/HarvardX/CS50x3/2015/info>

Course Title/ Code	ESSENTIALS OF PHYSICS (PHH106B) T & P
Course Type:	Core (Departmental/Allied)
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Objectives	To apply the concepts of physics to 1) different optical phenomena 2) devices based on these phenomena, lasing in gases and solids 3) quantum mechanics and its applications 4) develop and analyze electromagnetic wave equations in different media
Learning Outcomes	Students will have the Ability to: 1) produce and Analyze the Interference Pattern Due to Division of Amplitude 2) produce required Quality Spectrum and analyze it Using Appropriate Diffraction Grating. 3) measure the Concentration/Purity of Optically Active Materials Using Optical Devices. 4) explain the Construction, Working and Applications of Lasers. 5) solve problem of one dimensional and three-dimensional problems using concepts of Quantum Mechanics. 6) to apply electromagnetic wave equations for different media and find out different parameters

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section-A

Physical Optics

Interference, Interference by Division Of Wave front and Amplitude, Interference in Thin Films (Uniform and Variable Thickness), Newton's Ring and its Applications, Michelson Interferometer and its Applications. Fraunhofer Diffraction at Single Slit, Plane Transmission Grating, Dispersive and Resolving Power of a Grating,

Section-B

Polarization and Laser

Polarized and Un-Polarized Light, Malus Law, Double Refraction, Nicol Prism, Quarter and Half Wave Plates, Laurent's Half Shade Polarimeter and its applications
Stimulated Absorption, Spontaneous and Stimulated Emission, Population Inversion, Conditions for Laser Action, Laser Properties and Laser Applications, Types of Laser: He-Ne Laser, Semiconductor Laser.

Section - C

Quantum Mechanics

Introduction to Quantum Mechanics, Planck's radiation law, Photoelectric Effect, Dual nature of matter, Schrodinger wave equations-time dependent and time independent, Physical significance of wave function, Particle in one dimensional box, Schrodinger Equation in Spherical Polar Coordinates, Hydrogen Atom, Vibrational and rotational spectra of molecules.

Section – D

Electromagnetic Theory

Electric Flux Density, Gauss's Law and its Applications to a Spherical Symmetry and Uniformly Charged Infinite Plane Sheet, Energy Per Unit Volume, Ampere's Law and its Modification for Non-Steady Currents, Maxwell's Equations, Wave Propagation in Free Space, Dielectrics and Conducting Medium, Poynting Theorem and its significance.

List of Experiments:

1. To determine the wavelength of sodium light by Newton's rings experiment. Describe the interference pattern using polychromatic source of light.
2. To determine the wavelength of sodium light by Fresnel's biprism experiment.
3. To determine the wavelength of various colors of white light with the help of a plane transmission diffraction grating.
4. Determination of dispersive power of the given grating.
5. To determine the refractive index and Cauchy's constants of a prism by using spectrometer.
6. To determine the wavelength of sodium light by Michelson interferometer.
7. To determine the resolving power of a telescope.
8. To determine the pitch of a screw using He-Ne laser
9. To determine the specific rotation of optically active solution by using Laurent's half shade polarimeter.
10. To determine the numerical aperture of an optical fiber using laser light.
11. To determine the value of Planck's constant by using a Photoelectric Cell.
12. To determine the value of Planck's constant by using LEDs.

Recommended Books:

1. Fundamentals of Engineering Physics , M S Khurana, MR Pub, Delhi (Text Book)
2. Modern Physics for Engineers I & II, S P Taneja; R Chand Publication (Text Book)
3. Engineering Physics, Satya Prakash, Pragati Prakashan.
4. Concepts of Modern Physics, A. Beiser
5. Optics, A. Ghatak
6. Fundamentals of Molecular Spectroscopy-C N Banwell & E M Mccash
7. Introduction to Molecular Spectra – H E White

Course Title/ Code	MATHEMATICS LAB –I /MAH109B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(0-0-2-0)
Objective	To introduce students with the mathematical software & its usage to solve mathematical problems. Computation of statistical parameters using software
Outcomes	The student would be able to To perform basic mathematical calculations, plotting the graphs and matrix operation using Mathematical software. To evaluate derivative and its application using mathematical software. To analyze the statistical data by plotting the graph, pi-chart etc. To analyze the statistical data in terms of measure of central tendency, dispersion , skewness , kurtosis and correlation regression.

LAB EXERCISE Using Software: OCTAVE/ MATLAB/ ALTAIR/Excel

1. Introduction to mathematical software and use of some simple e-commands.
2. Define matrices and compute matrix operations.
3. Introduction to graphics: Basic Two-Dimensional Graphs, Labels, Multiple plots on the same axes, Line styles, Markers and color, Axis limits and Subplots.
4. Limit & continuity of function of single variable.
5. Differentiability of function of single variable & Asymptotes of given curves.
6. Curvature of given cartesian curves, parametric and polar curves.
7. Maxima and minima of several variables.
8. Representation of data using graphs and charts.

9. Computation of Measures of Central Tendency – Mean, Median, Mode, quartiles, deciles.
10. Computation of Measures of Dispersion - range, quartile deviation, mean deviation, standard deviation and coefficient of variation. Comparison of various measures of dispersion.
11. Computation of Measures of Skewness, Moments & Kurtosis.
12. Computation of coefficient of correlation & regression and plotting lines of regression.

Recommended Books

1. MATLAB : An Introduction with Applications. Amos Gilat.

Course Title/ Code	COMMUNICATIVE ENGLISH /HLS102
Course Type:	Core (Allied)
Course Nature:	SOFT
L-T-P-O Structure	(1-0-2-0)
Objectives	<ol style="list-style-type: none"> 1. To equip the students with effective communication skills. 2. To deal extensively with the requirements of Industry. 3. To equip students with the nuances of technical writing. 4. To bridge the gap between college and work-place 5. To understand the genres of English Literature
Outcome	<p>After completion of course students would be able:</p> <ul style="list-style-type: none"> ● To learn about communication process and ways to make communication effective by giving attention to all elements involved. ● To understand the value of verbal communication as well as non- verbal aspects of communication in making inter personnel communication effective and intrapersonnel communication insightful. ● To gain confidence by enhancing their abilities to articulate their ideas. ● To able to scan, skim and revise documents for fruitful reading and comprehension. ● To acquire better writing skills in formal communication.

Section A

Lexis:

Homonyms, Homophones, Homographs, Words often confused, One word Substitutes, Synonyms and Antonyms, Foreign Words, Phrasal Verbs & Idioms and Phrases

Section B

Oral Communication:

Importance of Speech Sounds, Organs of Speech, Vowel Sounds, Consonant Sounds, IPA Symbols, Phonetic Transcription, Phoneme and Syllables, Intonation, Word Stress, Sentence Stress.

Section C

Presentation Skills:

Body Language and Paralanguage, Gestures and Postures, Kinesics, Proxemics, Importance of Body Language in Presentation, Etiquette of the Telephone Handling and Business Meetings, Professional Presentation, Hearing and Listening, Essentials of Effective Listening, Importance of Effective Listening, Visual Presentation – How to prepare slide presentation.

Section D

Technical Writing-II:

Business Letters, Job Application and Resume Writing, Developing Outlines, Circular, Memos, Blog Writing and Comments on Media.

Recommended Books:

1. A Practical Course for Developing Writing Skills in English. J K Gangal: PHI Learning Pvt.
2. A Textbook of English Phonetics for Indian Students. T.Bala Subhrmaniam: Macmillan
3. English Vocabulary in Use. MaCarthy: Foundation Books, OUP. Print.

4. English Grammar, Competition and Correspondenc. M.A. Pink and A.C. Thomas: S. Chand and Co. Print.
5. Reading Between the Line: Students Book. MacRae: Foundation Books. CUP, New Delhi.

MAU01- Semester-II

SUBJECT CODES	SUBJECT NAME	**OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft/Workshop/NTCC)	COURSE TYPE (Core/Elective / University Compulsory)	L	T	P	O	NO. OF CONTACT HOURS PER WEEK	NO. OF CREDITS
MAH115B	CALCULUS-II	MA	HARD	CORE	3	1	0	0	4	4
MAH107B	ALGEBRA	MA	HARD	CORE	3	1	0	0	4	4
STATISTICS - II	MAH205B	MA	HARD	CORE	3	1	0	0	4	4
MAH112B	ORDINARY DIFFERENTIAL EQUATIONS	MA	HARD	CORE	3	1	0	0	4	4
MAH114B	MATH LAB – II	MA	HARD	CORE	0	0	2	0	2	1
CHH137	ENVIRONMENTAL SCIENCE	CH	HARD	UNIVERSITY COMPULSORY	2	0	0	2	2	4
TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)					14	4	2	2	20	21
MAO116B	VALUE ADDED SUMMER COURSE - POST 2nd SEMESTER									02

Course Title/ Code	ALGEBRA /MAH107B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	To equip the students with the concepts of set theory, congruences, theory of equations & matrices.
Learning Outcomes	The students would be able to apply the concepts of set theory, Congruence's, theory of equations & matrices for solving the mathematical problems and their applications.
Pre-requisites	N.A

	Section s	Weightag e
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Sets, Relations & Functions: Sets, Relations, Equivalence relations, Functions, [Direct & Inverse Circular and Hyperbolic Functions, unit-step function, Dirac-Delta function] Composition of functions, Bijective functions, Invertible functions, Principle of mathematical induction, Well-ordering property of positive integers, Division algorithm, Greatest Common Divisor and Least Common Multiple ,Statement of fundamental theorem of arithmetic.

Section B

Congruences: Congruences and their properties, Linear congruences and their solutions, Chinese Remainder Theorem, Fermat's Theorem and Wilson's Theorem ,Diophantine equation $ax+by=c$ (a,b,c are integers).

Section C

Algebraic Equations: Fundamental Theorem of Algebra, General properties of equations,

Descartes rule of sign, Relation between coefficient and roots of the equation, Cube roots of unity.

Transformation of equations: Roots with sign changed, Roots multiplied with given quantities, Reciprocal roots, Increase or diminish the root by given quantity, Binomial coefficient,.

Section D

Matrices and its Applications: Elementary Transformations, Elementary Matrices, Inverse using Elementary Transformations, Rank of a matrix, Normal form of a matrix, Linear Dependence and Independence of vectors, Consistency of Linear System of Equations, Linear Transformation, Orthogonal Transformation, Eigen Values and Eigen Vectors, Properties of Eigen Values, Cayley Hamilton theorem, Diagonalization.

Recommended Books:-

1. Chandrika Prasad:-Text Book on Algebra and Theory of equation, Pothishala Pvt Ltd, 1978.
2. C. C. MacDuffee: Theory of Equations, John Wiley & Sons Inc., 1954
3. W.S. Burnside and A.W. Panton:The Theory of Equations, Dublin University Press, 1954.
4. K.Prakash,O.P Chug & P.Gupta: Algebra and Trigonometry, University Science press, 2009.

Course Title/ Code	CALCULUS – II /MAH 115 B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	To equip the students with the concepts of reduction formulae, application of single integrals , multiple integrals and vector calculus.
Learning Outcomes	<p>Students will be able to</p> <ul style="list-style-type: none"> ● integrate using reduction formulae. They would be also able to calculate length of an arc, area of a curve and volume and surface area of solid of revolution. ● to apply beta and gamma functions to evaluate integrals . They would also find centre of gravity and moment of inertia of different bodies . ● to explain physical meaning of gradient of a scalar field ,curl and divergence in terms of fluid flow. They would also be able to apply its concepts & demonstrate the problems related to mechanics, electrical engineering, fluid mechanics etc. ● to calculate work, circulation ,flux and verify path independence. They would also be able to evaluate line integrals ,surface integrals and volume integrals and relate Stokes, Divergence and Green’s Theorem in other branches of Mathematics.

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Applications of Single Integral

Reduction formulae: Derivations and illustrations of reduction formulae. Rectification: Length of arc of curves (cartesian, parametric and polar form). Quadrature: Area enclosed by curves (cartesian, parametric and polar form).

Solids of Revolution: Volume and surface area of solids of revolution

Section B

Multiple Integrals

Double and Triple Integral, Evaluation of Double Integral over the region, Evaluation of Double Integral by Changing the Order of Integration, Evaluation of Double & Triple Integral by Changing the Variable. Beta and Gamma Functions, Dirichlet Integral.

Section C

Vector Differentiation

Limit & Continuity of vector functions, differentiation of vector functions, tangent and

normal components of vector functions, vector fields and scalar fields, gradient of a scalar field and directional derivative. Divergence and Curl of a vector field and their physical interpretations, Irrotational and Solenoidal fields. Laplacian operator

Section D

Vector Integration

Integration of vector functions Line integral, Integrals independent of path, Surfaces in space, Surface integral, Volume integral, Gauss Divergence theorem, Stoke's theorem and Green's theorem.

Recommended Books:

1. Shanti Narayan, P.K. Mittal, Integral Calculus, S. Chand.
2. Shanti Naryan, Vector Calculus, S. Chand.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publications.

Course Title/ Code	ORDINARY DIFFERENTIAL EQUATIONS / MAH112B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	To equip the students with the concepts of Ordinary differential equations and its applications.
Outcomes	The student will be able to: CO1: Describe the concepts of ordinary differential equations and different types ODEs. CO2: Effectively write mathematical derivation/ solutions of all types of ODEs in a clear and concise manner. CO3: Explain and apply various forms of Ordinary differential equations in the different areas of day to day life problems and solve them. CO4: Derive and apply the concept of method of variation of parameter, simultaneous linear differential equations in arising the physical problems. (Orthogonal trajectories, electric circuits, etc.)
Prerequisites	Basic Knowledge of Ordinary differential equations.

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Basic concepts and genesis of ordinary differential equations, Formulation, Order and degree of a differential equation, equations of first order and first degree, solutions of equations by separable of variables, homogeneous equations, Linear equations and Bernoulli equations, Exact differential equations, integrating factors, Differential equations of first order but not the first degree.

Section -B

Application of first order differential equations to orthogonal trajectories, simple electric circuits and Newton's law of cooling. Linear differential equations with constant coefficient, Particular integral by inverse operator method of the forms when $X = e^{ax}$, $\sin ax/\cos ax$, x^m , e^{ax} .V and X is any other function and their combination, Method of undetermined coefficients Method of variation of parameters, Euler-Cauchy equation.

Section-C

Liner Equations of second order with variable coefficients, Existence and uniqueness theorem for linear differential equations, Principle of superposition for a homogeneous linear differential equation, Linearly dependent and linearly independent solutions on an interval, Wronskian and its properties, Concept of a general solution of a linear differential equation, Legendre's linear equation, ordinary simultaneous differential equations.

Section-D

Introduction-Definition & Simple situations for Mathematical Modeling, Technique of Mathematical Modeling, Classification of Mathematical Models, Some characteristic of Mathematical Models, compartmental models. Mathematical modeling through ordinary differential equations (Lotka-Volterra pollution model, drug assimilation into the blood of a single cold pill, growth and decay model).

RECOMMENDED BOOKS:

1. Belinda Barnes and Glenn R. Fulford: Mathematical Modeling with Case Studies, A Differential Equation Approach Using Maple, Taylor and Francis, London and New York, 2002.
2. C. H. Edwards and D. E. Penny: Differential Equations and Boundary Value Problems: Computing and Modeling, Pearson Education, India, 2005.
3. S. L. Ross: Differential Equations, John Wiley and Sons, India, 2004.
4. M.D. Rai Singhania: Advanced differential equations.
5. J. N. Kapoor: Mathematical Modeling.

Course Title/ Code	STATISTICS – II /MAH205B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	To equip the students with the concepts of Random Variable, Probability Distributions & Mathematical Expectation, Theoretical Distributions, Tests of Hypothesis, Chi square Test F-test, Analysis of Variance.
Learning Outcomes	The students would be able to apply the concepts of Random Variable, Probability Distributions & Mathematical Expectation, Theoretical Distributions, Tests of Hypothesis, Chi square Test F-test, Analysis of Variance required for solving the mathematical problems and their applications.
Pre-requisites	STATISTICS – I /MAH111B

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Random Variable, Probability Distributions & Mathematical Expectation: Random variable, probability distribution of a discrete & continuous random variable, cumulative probability function, moments, Mathematical expectation, Theorems on mathematical expectation, variance of X in terms of expectation, covariance of X in terms of expectation, joint and marginal distributions.

Section B

Theoretical Distributions: Discrete distributions: Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions: Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

Section C

Tests of Hypothesis: Procedure of testing hypothesis, Two-tailed and one-tailed test of hypothesis, Test of significance for large samples- single proportions, difference of proportions, single mean, difference of mean, test of significance of small sampling, t-test of significance of-mean of a random sample and difference of means of two samples.

Section D

Chi-square Test, F-test, Analysis of Variance: Degree of freedom, Chi-square distribution, Constants of chi square distributions, Conditions for applying Chi square test, Uses of chi square test, F-test, Applications of F-test, Analysis of variance-assumptions & techniques.

Recommended books:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
4. S. P. Gupta, Statistical Methods, Sultan Chand & Sons, Educational publishers, New Delhi
5. S.C. Gupta, Fundamentals of Statistics, Himalaya Publishing House.

Course Title/ Code	MATHS LAB –II /MAH114B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(0-0-2-0)
Objective	To familiarize students with programming and computation of integral calculus problems using mathematical software.
Outcomes	The student would be able to Write programming codes using conditional statements for related mathematical problems. Write programming codes using iterative statements (for loop, while loop) for related mathematical problems. understand and apply the concept of integration to evaluate area and volume using Mathematical software. visualize and find the roots of quadratic, cubic & biquadratics equations and transformation of equations using mathematical software.
Prerequisites	MATHS LAB – I

LAB EXERCISE: Using Software OCTAVE/ MATLAB/ SCILAB/ALTAIR/Excel/R/SPSS

1. Introduction to programming.- Creating script file or m-files.
2. Introduction to Conditional statements –if and else using mathematical software.
3. Introduction to iteration based programming – for loop, while loop.
4. Introduction to switch and break statements.
5. Introduction to functions and function files.
6. Transformation of an equation.
7. Roots of cubic and bi-quadratic equations.
8. Application of integrals- Compute arc length of a given curve & area under a given curve.
9. Application of integrals- Compute Volume & Surface Area, solid of revolution.
10. Compute Multiple integrals & Special Integrals - Beta –Gamma Functions.
11. Plotting of 2D figures.
12. Plotting of 3D figures.

Recommended Books

1. MATLAB : An Introduction with Applications. Amos Gilat.

Course Title/ Code	Environmental Science /CHH 137
Course Type:	Allied Core
Course Nature:	Hard
L-T-P-O Structure	(2-0-0-2)
Objectives	<ol style="list-style-type: none"> 1. To make the student identify the areas of environmental degradation 2. To make the student identify the impact of environmental degradation on the surroundings 3. To enable student apply the concept of sustainable development in real life. 4. To help the student to correlate his/her field with various aspects of environment
Outcome	<p>Student will be able to</p> <ol style="list-style-type: none"> 1. understand the environmental degradation and its surroundings 2. apply the concept of sustainable development 3. correlate field of work with various aspects of environments
Pre-requisite	N.A

Section A

Multidisciplinary nature of environmental studies

Definition, scope and importance; Need for public awareness.

Renewable and non-renewable resources :

Natural resources and associated problems.

- a) Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
- b) Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
- c) Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
- d) Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
- e) Energy resources : Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
- f) Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
- g) Role of an individual in conservation of natural resources.
- h) Equitable use of resources for sustainable lifestyles.

Section B

Ecosystems

- Concept of an ecosystem
- Structure and function of an ecosystem
- Producers, consumers and decomposers
- Energy flow in the ecosystem
- Ecological succession
- Food chains, food webs and ecological pyramids
- Introduction, types, characteristic features, structure and function of the following

ecosystem:

- a. Forest ecosystem
- b. Grassland ecosystem
- c. Desert ecosystem
- d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation

- Introduction – Definition: genetic, species and ecosystem diversity.
- Biogeographical classification of India
- Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values
- Biodiversity at global, National and local levels
- India as a mega-diversity nation
- Hot-spots of biodiversity
- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.
- Endangered and endemic species of India
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Section C

Environmental Pollution

- Definition, Cause, effects and control measures of :-
 - a. Air pollution
 - b. Water pollution
 - c. Soil pollution
 - d. Marine pollution
 - e. Noise pollution
 - f. Thermal pollution
 - g. Nuclear hazards
- Solid waste Management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution.
- Pollution case studies.
- Disaster management: floods, earthquake, cyclone and landslides.

Social Issues and the Environment

- From Unsustainable to Sustainable development
- Urban problems related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rehabilitation of people; its problems and concerns. Case Studies
- Environmental ethics: Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies
- Wasteland reclamation
- Consumerism and waste products
- Environment Protection Act
- Air (Prevention and Control of Pollution) Act
- Water (Prevention and control of Pollution) Act
- Wildlife Protection Act
- Forest Conservation Act
- Issues involved in enforcement of environmental legislation
- Public awareness.

Section D

Human Population and the Environment

- Population growth, variation among nations.
- Population explosion – Family Welfare Programme
- Environment and human health
- Human Rights
- Value Education
- HIV/AIDS
- Women and Child Welfare
- Role of Information Technology in Environment and human health.
- Case Studies.

ENVIRONMENTAL SCIENCES–FIELD WORK

- Visit to a local area to document environmental assets- river/forest/grassland/hill/mountain
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
- Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hill slopes, etc. (Field work Equal to 5 lecture hours)

Recommended Books:

1. K.C. Agarwal, Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.
3. R.C. Brunner, Hazardous Waste Incineration, McGraw Hill Inc.1989.
4. R. S. Clark, Marine Pollution, Clanderson Press Oxford (TB)
5. W. P. Cunningham, T. H. Cooper, E. Gorhani, M. T. Hepworth, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 2001.
6. A. K. De, Environmental Chemistry, Wiley Eastern Ltd.
7. C. Baird and M. Cann, Environmental Chemistry, W.H. Freeman and Company, New York, 2012.
8. C.J-Gonzalez and D.J.C. Constable, Green Chemistry and engineering: A practical Design Approach A John Wiley & Sons, INC., publication, New Jersey, 2011
9. S. E. Manahan, Environmental Chemistry, CRC Press, 2005
10. Perspectives in Environmental Studies Kaushik & Kaushik New age international publishers Ltd.-New Delhi
11. John Grant, The Green marketing Manifesto, Wiley Publications

MAU01- Semester-III

SUBJECT CODES	SUBJECT NAME	**OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft/Workshop/NTCC)	COURSE TYPE (Core/Elective / University Compulsory)	L	T	P	O	NO. OF CONTACT HOURS PER WEEK	NO. OF CREDITS
MAH204B	REAL ANALYSIS	MA	HARD	CORE	3	1	0	0	4	4
MAH113B	GEOMETRY OF TWO AND THREE DIMENSIONS	MA	HARD	CORE	3	1	0	0	4	4
MAH206B	GROUP THEORY	MA	HARD	CORE	3	1	0	0	4	4
MAH207B	PARTIAL DIFFERENTIAL EQUATIONS	MA	HARD	CORE	3	1	0	0	4	4
MAH208B	MATH LAB - III	MA	HARD	CORE	0	0	2	0	2	1
EDS288/ EDS289/ EDS290/ MCS231/ MCS232/ CDO203/M AN209B	APPLIED PHILOSOPHY/ APPLIED PSYCHOLOGY/ APPLIED SOCIOLOGY/ BASICS OF ECONOMICS/ (ANY ONE) INTRODUCTION TO FINANCE/ QUANTITATIVE APTITUDE – I / MINI PROJECT -I	ED/MC/ CDC/MA	Soft/ NTCC	ELECTIVE (Any one)	1	0	2	0	0	2
FLS103	FRENCH - I	MRCFL	SOFT	UNIVERSITY COMPULSORY	1	1	0	0	2	2
FLS101	SPANISH - I									
FLS102	GERMAN -I									
TOTAL (L-T-P-O/ CONTACT HOURS/ CREDITS)					14	5	4	0	23	21

DETAILED SYLLABUS
MAU01 – THIRD SEMESTER

Course Title/ Code	REAL ANALYSIS / MAH204B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	To equip the students with the concepts of real numbers, sequences and series of real numbers.
Learning Outcomes	Students shall be able to apply the Characterization of Real numbers, concepts of Sequences and series of Real numbers and their convergence behavior in solving the mathematical problems.
Pre-requisites	N.A

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Real Number System:

Algebraic and order properties of \mathbb{R} , Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of \mathbb{R} , The completeness property of \mathbb{R} , Archimedean property, Density of rational numbers in \mathbb{R} , Definition and types of intervals, Nested intervals property; Neighborhood of a point in \mathbb{R} , Open, closed and perfect sets in \mathbb{R} , Connected subsets of \mathbb{R} , Cantor set and Cantor function.

Section B

Sequences of Real Numbers:

Sequences, bounded sequence, limit of a sequence, convergent sequences, limit theorems, monotone sequences, monotone convergence theorem, subsequences, convergence and divergence criteria, existence of monotonic subsequences (idea only), Bolzano-Weierstrass theorem for sequences and sets, definition of Cauchy sequence, Cauchy's convergence criterion, limit superior and limit inferior of a sequence.

Section C

Infinite series:

Definition of infinite series, sequence of partial sums, Convergence and divergence of infinite series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series; Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's n th root test, Integral test; Alternating series, Leibniz test, Absolute and conditional convergence.

Section D

Uniform Convergence:

Pointwise and uniform convergence of sequence and series of functions, Weierstrass's M-test,

Dirichlet test and Abel's test for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiability

RECOMMENDED BOOKS:

1. W. Rudin - Principles of Mathematical Analysis - Mc. Graw Hill IntEdition (3rd)
2. Robert G. Bartle and Donald R. Shebert- Introduction to Real Analysis - Wiley India, 3rd ed.
3. Sterling K. Berberian - A First course in Real Analysis -1994 , Springer Verlag, Ny .I nc.
4. S.C. Malik, Principle of Real Analysis, PHI .
5. P.K. Jain ,SK Kaushik, INTRODUCTION TO REAL ANALYSIS, S CHAND.

Course Title/ Code	GEOMETRY OF TWO AND THREE DIMENSIONS / MAH113B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	To familiarize students with the concept of second degree eqns, sphere, cone and cylinder.
Outcome	The students would be able to trace conics and apply the concepts of sphere, cones, cylinders and conicoids required for solving the mathematical problems.
Prerequisite	N.A

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

General equation of second degree: Introduction, Condition for a pair of straight line, Condition for general eqn of second degree to be a circle, parabola, hyperbola and ellipse.

Tracing of conics: Standard form of conics, Reduction of general equation of second degree into a conic, determination of the length, positive and direction of axis of the central conic, eccentricity of a central axis, asymptotes of the conics Tangent at any point to the conic, chord of contact, pole of line to the conic, director circle of conic.

Section B

Confocal conics: Introduction, equation of confocals to an Ellipse, properties of confocal conics

Polar equation of a conic: Polar equation of a straight line, polar equation of a circle, polar equation of conic, focal chord tangent and normal to the conic, pair of tangents. System of co-ordinates.

Section C

Sphere: Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, radical plane of two spheres. Co-axial system of spheres. Cones. Right circular cone, enveloping cone and reciprocal cone.

Section D

Cylinder: Right circular cylinder and enveloping cylinder.

Central Conicoids: Equation of tangent plane. Director sphere. Normal to the conicoids. Polar plane of a point. Enveloping cone of a conicoid. Enveloping cylinder of a conicoid, Paraboloids.

RECOMMENDED BOOKS:

1. P.K. Jain and Khalil Ahmad: A Text Book of Analytical Geometry of Three Dimensions, Wiley Estern Ltd. 1999.

2. S. L. Loney: The elements of coordinate geometry, by Michigan Historical Reprint Series.
3. P.R Vittal: Analytical Geometry:2D and 3D, Pearson

Course Title/ Code	GROUP THEORY/MAH206B
Course Type	Core (Departmental)
Course Nature	Hard
L-P-O Structure	(3-1-0-0)
Objective	To equip the students with the concepts of groups and their properties.
Learning Outcomes	The students would be able to i) Recognize the mathematical objects called groups. ii) Link the fundamental concepts of groups and symmetries of geometrical objects. iii) Explain the significance of the notions of cosets, normal subgroups, and factor groups. iv) Analyze consequences of Lagrange's theorem. v) Learn about structure preserving maps between groups and their consequences. vi) Understand the basic concepts of group actions and their applications.
Prerequisites	N.A

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section – A

Groups and its Elementary Properties: Symmetries of a square, Definition and examples of groups including dihedral, permutation and quaternion groups, Elementary properties of groups, Subgroups and examples of subgroups, Lagrange's theorem, Euler phi function, Euler's theorem, Fermat's little theorem.

Section – B

Cyclic & Normal Subgroups: Cyclic groups, Properties of cyclic groups, Properties of cosets, Normal subgroups, Simple groups, Factor groups, Cauchy's theorem for finite abelian groups; Centralizer, Normalizer, Center of a group, Product of two subgroups; Classification of subgroups of cyclic groups.

Section – C

Permutation Groups & Group Homomorphisms: Cycle notation for permutations, Properties of permutations, Even and odd permutations, alternating groups, Cayley's theorem and its applications.

Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Properties of isomorphisms; First, second and third isomorphism theorems for groups.

Section – D

Group Actions: Group actions, Orbits and stabilizers, Conjugacy classes, Orbit-stabilizer theorem, Normalizer of an element of a group, Center of a group, Class equation of a group, Inner and outer automorphisms of a group.

Recommended Books:

1. Michael Artin (2014). Algebra (2nd edition). Pearson.
2. John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.
3. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.
4. I. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.
5. Nathan Jacobson (2009). Basic Algebra I (2nd edition). Dover Publications.
6. Ramji Lal (2017). Algebra 1: Groups, Rings, Fields and Arithmetic. Springer.
7. I.S. Luthar & I.B.S. Passi (2013). Algebra: Volume 1: Groups. Narosa.

Course Title/ Code	PARTIAL DIFFERENTIAL EQUATIONS /MAH207B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	To equip the students with the concepts of partial differential equations and mathematical modeling.
Learning Outcomes	The course will enable to the students to understand the genesis of partial differential equations, various techniques to solve first and second order partial differential equations. The students would be able to apply the concepts of partial differential equations to model physical phenomena such as the heat and wave equations.
Prerequisites	ORDINARY DIFFERENTIAL EQUATIONS MAH112B

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section-A

First Order Partial Differential Equation: Introduction, classification, construction and geometrical interpretation of first order partial differential equations (PDE), Lagrange's method of solution of first order Linear PDE, Solution of Nonlinear First Order PDE : Charpit's Method, Standard Forms-I, II, III and IV.

Section-B

Boundary Value Problems: Introduction , Method of separation of variables for PDE, Vibrating string Problem -Wave Equation (one and two dimension), Existence and uniqueness of solution of Vibrating string Problem., Heat conduction problem(one and two dimension), existence and uniqueness of solution of heat conduction problem.

Section-C

Linear Partial Differential Equations with Constant Coefficients: Linear PDE with Constant Coefficients, Solution of Linear Homogeneous PDE with Constant Coefficients : Method of finding the Complementary Function (C.F.) and Particular Integral (P.I.)- Method -I ,II and general method . Solution of Non-Homogeneous Linear PDE with Constant Coefficients: Method of finding the Complementary Function (C.F.) and Particular Integral (P.I.). Equations Reducible to Linear PDE with Constant Coefficients.

Section-D

Second Order Partial Differential Equation with Variable Coefficients: Introduction, Type-I, Type-II, Type-III, and Type-IV. Reduction of PDE to Canonical form by using methods (Parabolic to Canonical, Hyperbolic to Canonical and Elliptic to Canonical form).

RECOMMENDED BOOKS:

1. TynMyint-U and LokenathDebnath, Linear Partial Differential Equation for Scientists and Engineers, Springer, Indian reprint, 2006.
2. Ioannis P Stavroulakis and Stepan A Tersian, Partial Differential Equations: An Introduction with Mathematica and MAPLE, World Scientific, Second Edition 2004.
3. M.D. RaiSinghanian : Advanced differential equations
4. N.M. Kapur, a Text book of Differential Equations, Pitambar Publishing Company.

Course Title/ Code	MATH LAB III / MAH208B
Course Type:	Core (Departmental)
Course Nature:	SOFT
L-T-P-O Structure	(0-0-2-0)
Objective	To equip the student with the skill to write scientific or academic document in LaTeX
Learning Outcome	The students would be able to apply the concepts of LaTeX to create a document of Scientific Writing.
Pre- Requisites	N.A

LAB EXERCISE:

1. Introduction and basics of LaTeX.
2. Document structure and text formatting in LaTeX.
3. Mechanics of error and warning, lengths, Counters and Boxes.
4. Fundamentals for creating Technical Texts.
5. To Create Special Pages: Indexing ,Glossary, Bibliography
6. To Create Special Documents: Letters, Presentations, Curriculum Vitae.
7. Creating Graphics in LaTeX.
8. Programming: Macros, Plain text, Creating Packages, Themes.
9. Miscellaneous : Modular Documents, Collaborative Writing of LaTeX Documents, Export to other Formats.
10. Math – Type in Microsoft Word.

Course Title/Code	Mini Project –I/ MAN209B
Course Type	Elective
Course Nature	SOFT
LTPO Structure	1-0-2 (Credit-02)
Objective	To develop the research acumen.
Learning Outcome	<ol style="list-style-type: none"> 1. The student shall be able to describe research and its impact. 2. The student shall be able to identify broad area of research, analyze, the processes and procedures to carry out research. 3. The student shall be able to use different tools for literature survey 4. The student is able choose specific area of research and supervisor/mentor is finalized 5. To understand and adopt the ethical practice that is to be followed in the research activities 6. To work in groups with guidance
Pre- Requisites	N.A

Unit 1: What is Research and its impact?

- 1.1 Capturing the current research trends
- 1.2 Insight about scientific research performed by renowned experts in the related field (case studies)
- 1.3 Do's and Don'ts pertaining to research

Unit 2: Identification of Broad Area of research

- 2.1 Identification of thrust area of research for deciding broad area
- 2.2 Framing the research questions and hypothesis
- 2.3 Identification of the research gap based on feasibility of problem
- 2.4 Exploration of in-house and commercially available facilities related to broad area

Unit 3: Understanding the tools for Literature Survey

- 3.1 Finding research papers related to a topic
- 3.2 Understanding the different aspects of Literature search
- 3.3 Usage of different sources like Google scholar, WoS, SCI/ SCIE, PubMed, Scopus.
- 3.4 Search for online journals relevant to research area
- 3.5 Indexing of Journals
- 3.5 Usage of scholarly networking sites like Research Gate, Mendeley, and Academia.edu etc.
- 3.6 Demo sessions on the usage of above mentioned sources

Unit 4: Review of research papers pertaining to broad area and specific area of research

- 4.1 Selection of relevant papers
- 4.2 Finding specific research problem from broad area of research
- 4.3 Literature survey and justification of specific research problem
- 4.4 Experimentation and data cleaning and verification
- 4.5 Understanding and selection of the research domain
- 4.6 Seeking information through published work w.r.t the problem
- 4.7 Reading & categorizing the downloaded/referred papers and structuring of the idea
- 4.8 Model design about framing the research questions

Unit 5: Report Writing and Presentation skill Development

- 5.1 Report making on the surveyed literature to cater the basic idea of the research papers
- 5.2 Compiling and analyzing the published results to justify and understand the proposed ideas
- 5.3 Usage of MS-PowerPoint and other technical resources for the presentation
- 5.4 Development of presentation skills and group addressing
- 5.5 Scientific/technical writing and ethical practice, project report

Stages	Time line	Weightage	Conditions
Stage 1	4 weeks (PT1)	25% (25 MARKS)	Students shall be required to provide: 1. Background information of project work. 2. Explanation of objectives. 3. Research plan and methodology.
Stage 2	8Weeks (PT2)	25% (25 MARKS)	Students shall be required to provide: 1. Initial results and further work required to complete the objectives.
Pre-Project report	12 Weeks	On satisfactory recommendation of concerned faculty members students will be allowed for final evaluation (stage 3)	
Stage 3	At the end of semester (PT3)	50% (50 MARKS)	Evaluation will be based on following components: 1. Submission of Project report 2. Viva- Examination (By External Examiner)

Course Title/ Code	FRENCH-I(FLS103)
Course Type:	Allied Elective
Course Nature:	Audit (University Compulsory)
L-T-P-O Structure	(1-1-0-0)
Prerequisite	Basic knowledge of grammatical structure, syntax, and vocabulary of English and/or Hindi.
Objectives	<p>At the end of the course, students will be able to</p> <ol style="list-style-type: none"> 1. Exchange greetings and do introductions using formal and informal expressions 2. Understand and use interrogative and answer simple questions 3. Learn Basic vocabulary that can be used to discuss everyday life and daily routines, using simple sentences and familiar vocabulary 4. Express their likes and dislikes. Also will have understanding of simple conversations about familiar topics (e.g., greetings, weather and daily activities,) with repetition when needed 5. Identify key details in a short, highly-contextualized audio text dealing with a familiar topic, relying on repetition and extra linguistic support when needed. 6. Describe themselves, other people, familiar places and objects in short discourse using simple sentences and basic vocabulary 7. Provide basic information about familiar situations and topics of interest 8. Express or/and justify opinions using equivalents of different verbs <p>Differentiate certain patterns of behavior in the cultures of the French-speaking world and the student's native culture</p>

Course Outcomes:

FLS103.1. Exchange greetings and do introductions using formal and informal expressions. Understand

and use interrogative and answer simple questions.

FLS103.2. Learn Basic vocabulary that can be used to discuss everyday life and daily routines, using

simple sentences and familiar vocabulary. Express their likes and dislikes. Also will have

understanding of simple conversations about familiar topics (e.g., greetings, weather and daily activities,) with repetition when needed.

FLS103.3. Identify key details in a short, highly-contextualized audio text dealing with a familiar topic,

relying on repetition and extra linguistic support when needed. Describe themselves, other

people, familiar places and objects in short discourse using simple sentences and basic vocabulary.

FLS103.4. Describe themselves, other people, familiar places and objects in short discourse using

simple sentences and basic vocabulary. Provide basic information about familiar situations and topics of interest.

FLS103.5. Express or/and justify opinions using equivalents of different verbs. Differentiate certain

patterns of behavior in the cultures of the French-speaking world and the student's native culture.

FLS103.6. Describe various places, location, themselves using simple sentences and vocabulary.

SECTION-A

Unit - Saluer et épeler l'alphabet

1.1 Les Salutations & forms of politeness

1.2 Alphabets

Unit 2- Usage de Vous et de Tu

2.1 Taking leave expressions

2.2 Les pronoms sujets

2.3 Basic Questions

SECTION-B

Unit 3- Présentez-vous

3.1 Les verbes ER

3.2 Self introduction

3.3 Décrivez votre ami(e)

SECTION-C

Unit 4- Identifier un nombre, compter

4.1 Les noms

4.2 Verbes Avoir, Etre, Aller & Faire

4.3 Les nombres

Unit 5- Demander/ donner l'explications

5.1 Les articles définie et indéfini

5.2 Les mois de l'année

5.3 Les jours de la semaine

SECTION-D

Unit 6- Parler des saisons et demander l'heure

6.1 Time

6.2 Weather

6.3 Unseen Passage

Text Books/Reference Books/ Suggested Readings:

1. Alter Ego Level One Textbook, Annie Berthet, Catherine Hugot, Hachette Publications
2. Apprenons Le Français II & III, Mahitha Ranjit, 2017, Saraswati Publications

Weblinks:

www.bonjourfrance.com

www.allabout.com

Course Title/ Code	GERMAN-I(FLS102)
Course Type:	Allied Elective
Course Nature:	Audit (University Compulsory)
L-T-P-O Structure	(1-1-0-0)
Prerequisite	Basic knowledge of grammatical structure, syntax, and vocabulary of English and/or Hindi.
Objectives	<p>At the end of the course, students will be able to</p> <ol style="list-style-type: none"> 1. Exchange greetings and do introductions using formal and informal expressions 2. Understand and use interrogative and answer simple questions 3. Learn Basic vocabulary that can be used to discuss everyday life and daily routines, using simple sentences and familiar vocabulary 4. Express their likes and dislikes. Also will have understanding of simple conversations about familiar topics (e.g., greetings, weather and daily activities,) with repetition when needed 5. Identify key details in a short, highly-contextualized audio text dealing with a familiar topic, relying on repetition and extra linguistic support when needed. 6. Describe themselves, other people, familiar places and objects in short discourse using simple sentences and basic vocabulary 7. Provide basic information about familiar situations and topics of interest 8. Express or/and justify opinions using equivalents of different verbs 9. Differentiate certain patterns of behavior in the cultures of the French-speaking world and the student's native culture

Course Outcomes:

FLS102.1. Students will be able to exchange greetings and introductions using formal and informal

expressions. They will be able to ask and answer simple questions.

FLS102.2. Students will be able to discuss everyday life and daily routines, using simple sentences

and familiar vocabulary.

FLS102.3. Students will be able to identify key details in short, highly-contextualized audio text

dealing with a familiar topic, relying on repetition and extra linguistic support when needed.

FLS102.4. Students will be able to discuss likes and dislikes, understand simple conversations about familiar topics (e.g., greetings, weather and daily activities,) with repetition when

needed

FLS102.5. Students will be able to differentiate certain patterns of behavior in the cultures of the

German- speaking world and the student's native culture.

FLS102.6. Students will be able to describe various places, location, themselves using simple sentences and vocabulary.

SECTION-A

Unit-1: Begrüßungen

1.1 Salutations/Greetings

1.2 Introduction

Unit-2: sich vorstellen und Zahlen

2.1 Introduction

2.2 Alphabets

2.3 Numbers 1-20

SECTION-B

Unit-3: Berufe/ Pronomen

3.1 Personal pronouns

3.2 Hobbies and professions

SECTION-C

Unit-4: Café

4.1 Café related vocabulary and dialogues

4.2 Revision personal pronouns

Unit-5: Café dialog

5.1 Café related vocabulary and dialogues

5.2 Common verbs and their conjugations

SECTION-D

Unit-6: Zeit und Monate

6.1 Time

6.2 Days

6.3 Months

Text Books/Reference Books:

1. Studio D A1, Hermann Funk, 2011, Cornelson Publication
2. Tangaram Aktuell A1, Kursbuch & Arbeitsbuch, 2011, Hueber
3. Netzwerk, Stefanie Dengler, Paul Rusch et. Al, 2011, Klett

Weblinks:

<http://www.nthuleen.com/>

Course Title/ Code	SPANISH-I(FLS101)
Course Type:	Allied Elective
Course Nature:	Audit (University Compulsory)
L-T-P-O Structure	(1-1-0-0)
Prerequisite	Basic knowledge of grammatical structure, syntax, and vocabulary of English and/or Hindi.
Objectives	<p>At the end of the course, students will be able to</p> <ol style="list-style-type: none"> 1. Exchange greetings and do introductions using formal and informal expressions 2. Understand and use interrogative and answer simple questions 3. Learn Basic vocabulary that can be used to discuss everyday life and daily routines, using simple sentences and familiar vocabulary 4. Express their likes and dislikes. Also will have understanding of simple conversations about familiar topics (e.g., greetings, weather and daily activities,) with repetition when needed 5. Identify key details in a short, highly-contextualized audio text dealing with a familiar topic, relying on repetition and extra linguistic support when needed. 6. Describe themselves, other people, familiar places and objects in short discourse using simple sentences and basic vocabulary 7. Provide basic information about familiar situations and topics of interest 8. Express or/and justify opinions using equivalents of different verbs 9. Differentiate certain patterns of behavior in the cultures of the French-speaking world and the student's native culture

Course Outcomes:

FLS101.1. Students will be able to exchange greetings and introductions using formal and informal expressions and students will be able to ask and answer simple questions.

FLS101.2. Students will be able to discuss everyday life and daily routines, using simple sentences

and familiar vocabulary and students will be able to discuss likes and dislikes understand

simple conversations about familiar topics.

FLS101.3. Students will be able to identify key details in a short, highly-contextualized audio text

dealing with a familiar topic, relying on repetition and extra linguistic support when needed and students will be able to offer basic descriptions of self, other people, familiar places and objects in short discourse using simple sentences and basic vocabulary.

FLS101.4. Students will be able to provide basic information about familiar situations and topics

of interest and students will be able to express or/and justify opinions using equivalents of different verbs.

FLS101.5. Spanish-speaking world and student's native culture.

FLS101.6. Students will be able to describe various places, location, themselves using simple sentences and vocabulary.

SECTION-A

Unit 1: Introduction to Spanish and SER

1.1 Presentation on Spanish language

1.2 Greetings and goodbyes

1.3 Spanish letters

1.4 Introduction of verbo SER

Unit 2: Verb Ser, Nationality, Profession and Counting

2.1 Uses of verbo SER

2.2 Adjectives related to verbo SER.

2.3 Introduction of Nationality

2.4 Professions and vocabulary related to professions.

2.5 Counting till number 20.

SECTION-B

Unit 3: Articles, Interrogative and Estar

3.1 Introduction of Articles and Indefinite articles

3.2 Interrogatives

3.3 Introduction of Verbo Estar

SECTION-C

Unit 4: Estar, Preposition, Tener and Self Introduction

4.1 Uses of Verbo ESTAR and adjectives related to it

4.2 Introduction of 'my house' vocabulary

4.3 Prepositions related to the positioning of an object

4.4 Self – introduction

SECTION-D

Unit 5 : Day, Month and Regular AR verb

5.1 Days

5.2 Months

5.3 Introduction to regular –AR verbs

Text Books/Reference Books:

1. ¡Ole!-Langers
2. ¡Uno, dos, tres.....

Weblinks:

<http://studyspanish.com/>

Course Title/Code	APPLIED PHILOSOPHY (EDS288)
Course Type	Elective (Allied)
Course Nature	Soft
L-T-P-O Structure	(1-0-2)
Objectives	<p>To enable students to</p> <ul style="list-style-type: none"> - confront the philosophical problems implicit in the experience of self, others and the society. - read critically the philosophy of influential philosophers with respect to society, Science and success in life - understand and apply concepts and theories of moral philosophy. - reflect philosophically and ethically on their own personal, professional and civic lives. - formulate for himself or herself a philosophy of life or world-view consistent with the objectives of liberal society.

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

SECTION A

INTRODUCTION TO PHILOSOPHY: Philosophy: Meaning, Nature and Scope, Practical uses of Philosophy, Branches of Philosophy.

SECTION B

THOUGHTS OF PHILOSOPHERS AND THEIR IMPLICATIONS: General Philosophy of John Dewey, Swami Vivekananda and Rabindra Nath Tagore, Philosophy of life and success: Steve Jobs, N.R. Narayana Murthi, Dr. A.P.J. Abdul Kalam and Muhammad Yunus, Philosophy of Science and technology- Francis Bacon and Martin Heidegger.

SECTION C

PHILOSOPHICAL PERSPECTIVES OF SOCIO-POLITICAL SCENARIO IN INDIA: Nature of Democracy and its implications, Meaning and requirements of National Integration, Universal Human Rights

SECTION D

PHILOSOPHICAL PERSPECTIVES OF RELIGIOUS SCENARIO IN INDIA: Secularism—its nature and implications, Moral Philosophy of religion with special reference to Hinduism, Jainism, Buddhism, Islam, Christianity, Sikhism. Religious pluralism and Religious tolerance.

Reference Books and Readings:

1. Bhatia, K. & Bhatia, B. (1974) The Philosophical and Sociological Foundations of Education. Delhi: Doaba House.
2. Brubacher, John. S. (1969). Modern Philosophies of Education, New Delhi: Tata McGraw-Hill
3. Dewey, J. (1966). Democracy in Education, New York: Macmillan.
4. Ferre, F.(1995). Philosophy of Technology. University of Georgia Press.
5. Gandhi, M. K. (1956). Basic Education. Ahmedabad, Navajivan.
6. Goel, A. & Goel S. L. (2005). Human values and Education. New Delhi: Deep and Deep Publications Pvt. Ltd.
7. Palmer, Joy A. et.al. (2001). Fifty major thinkers on education from confucious to Dewey. New Delhi: Rutledge.
8. Rajput, J.S. (2006). Human Values and Education. New Delhi: Paragon Publications.
9. Walia, J.S. (2011). Philosophical, Sociological and Economic Bases of Education.

LAB: (EDS288)

1. Prepare and present a report on ‘philosophy of life’ from the perspective of a young adult.
2. Quiz and interactive sessions on various philosophical perspectives of contemporary philosophers.
3. Organization of and participation in street plays /dramas/ declamation/ debates/ any other suitable activity on any theme of Philosophical perspectives of Socio-Political scenario in India.
4. Group discussions on any suitable topics concerning contemporary society like aggression among youth, Over-ambitiousness in young generation, misuse of democracy, implications of secularism etc. and to reflect upon different viewpoints.
5. Preparation of quotation boards to display quotes of great philosophers in the college premises.
6. Picture interpretation and philosophical reflection on social themes like juvenile crime, begging in India, Social networking etc.
7. Readings from the autobiographies and other publications of great philosophers e.g. ‘Wings of Fire’ followed by discussion session.
8. Showing Videos on Unique personalities: life and philosophies followed by reflection exercises.
9. Any other suitable activity.

Course Title/Code	Applied Psychology (EDS289)
Course Type	Elective
Course Nature	Soft
L-T-P-O Structure	(1-0-2-0)
Objectives	-To define psychology and its application across various fields. -To understand the conceptual framework of attitude and personality along with cherishing out their attitude and personality development. -To conceptualize psychology in social and organizational settings. -To maintain and reform group dynamics.

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

PSYCHOLOGY: ATTITUDE FORMATION

Psychology: Meaning, nature, and scope, Role of psychology across multi-disciplinary aspects, Introduction: Attitude, Stereotypes, Prejudice, and Discrimination, Formation of attitude and attitude change.

Section B

PERSONALITY AND PERSONALITY DEVELOPMENT

Definition of personality and personality development, State/ Trait approach to personality, Bandura's Social- Cognitive theory of personality

Section C

SOCIAL PSYCHOLOGY

Introduction to social identity, social cognition, and social influence, social conflicts and its resolutions, Group dynamics: Introduction, formation, types of groups, cooperation, competition, and conflict in groups

Section D

ORGANIZATIONAL PSYCHOLOGY

Organizational Psychology: Definition, fundamental concepts and importance, Introduction to job satisfaction, work motivation, and organizational commitment. Introduction to participation, empowerment, and team work

References Books and Readings:

1. Arrow, K. J. (1995). Barrier to Conflict Resolution. NY: W. W. Norton.
2. Bandura, A., & Walters, R. H. (1963). Social Learning and Personality Development. New York: Holt, Rinehart, & Winston.
3. Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice- Hall, Inc.

4. Baron, R. A., Byrne, D. (1997). *Social Psychology* (8th Ed.). Boston, MA: Allyn & Bacon.
5. Baron, R. A. (2001). *Psychology* (5th ed.). London: Pearson.
6. Cialdini, R. B. (2001). *Influence: Science and Practice* (4th Ed.). Boston, MA: Allyn & Bacon.
7. Feldman, R. S. (2008). *Essentials of Understanding Psychology*. New Delhi: Tata McGraw Hill.
8. Friedkin, N. (1998). *A structural theory of social influence*. Cambridge: Cambridge University Press.
9. Gage, N. L., & Berliner, D. C. (1992). *Educational Psychology* (5th Ed.). Boston, MA: Houghton Mifflin Co.
10. Hall, C. S., Lindzey, G. & Campbell, J. B. (2004). *Theories of Personality* (4th Ed.). New York: Wiley.
11. Hunt, R. R., & Ellis, H. C. (2006). *Fundamentals of Cognitive Psychology*. New Delhi: Tata McGraw Hill.
12. McDavid, J. M., & Harari, H. (1994). *Social Psychology: Individuals, Groups, and Societies*. New Delhi: CBS Publishers.
13. Millward, L. (2005). *Understanding Occupational and Organizational Psychology*. London: Sage Publications.
14. Morgan, C. T., King, R. A., Weisz, J. R., & Schopler, J. (1993). *Introduction to Psychology*. (7th Ed.). New Delhi: Tata McGraw Hill.
15. Woolfork, A. E. (2014). *Educational Psychology* (12th Ed.). Boston: Allyn & Bacon.

LAB: (EDS289)

1. Prepare a story using different pictures in order to understand the personality
2. Prepare a SWOT Chart to identify strength and weakness of oneself
3. Role of psychology be proved as an asset in professional development
4. Give a brief account of your personality before and after the transaction of course content.
5. Identify different stereotype present in our Society and present your views on it.
6. Collect any five articles on discrimination prevalent in Society
7. List out Company incentives provided to their employee for work motivation.
8. Prepare a street play on social issues to understand the group dynamics
9. Reflection activities to understand the emotions and personality
10. List out the Do's and Don'ts of the Interview
11. Role of body language in attitude formation.
12. Situational Activities: Suppose you are captain of your football team. Draw out inputs to motivate your team, and maintain the team- spirit.
13. Write a brief note on any one attitude you want to change in yourself and the strategies to accomplish it.
14. The psychometric tests to be conducted by learners:
15. Sociometry test
16. Personality testing (16PF)
17. Vineland Social Maturity Scale
18. Rorschach inkblot test
19. Thematic Appreciation Test
20. Color personality Test
21. Any other suitable activities.

Course Title/Code	APPLIED SOCIOLOGY (EDS290)
Course Type	Elective (Allied)
Course Nature	Soft
L-T-P-O Structure	(1-0-2)
Objectives	<ol style="list-style-type: none"> 1. To know and understand about the fundamental concepts of sociology and its applications. 2. To develop the analytical skills of students about ways in which social processes affect our everyday lives. 3. To understand the impact of various processes of social change and assess their impact on society. 4. To understand and analyze the social cultural dynamics that contribute to transformation of Indian reality 5. To study the various contemporary issues of society. 6. To develop basic research skills in area of sociology.

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Introduction and Applications of Sociology:

- Society, Community, Social Institutions, Social Groups, Introduction to Applied Sociology
- Sociology and Social Processes
- Sociology and Social Change
- Sociology and Social Problems
- Clinical Sociology

Section B

Sociological Processes:

- Social Stratification, Social Mobility and their impact on society
- Socialization, Agents of Socialization, Assessing the effects of Socialization
- Social Movements: Concept, Impact of Environmental Movements in India: Chipko Movement, Narmada Bachao Andolan

Section C

Processes and Issues of Social Change:

- Social Change: Westernization, Urbanization, Privatization, Globalization, Sustainable development

- Issues in urban development-Population, poverty, unplanned growth and ecological issues
- Conflict management:
 - Intergroup: Causes, Resolutions
 - Organizational Conflict, Conflict Management and Grievance Handling

Section D

Field Survey & Report Writing:

- Need, Meaning of Survey
- Types of Survey
- Steps in Conducting Survey
- Data Collection Methods
- Salient Features of Report Writing

LAB:

1. Showing Videos on the life and philosophies of Famous sociologists and to acquaint the students about their different theories
2. Preparation of quotation board with the help of displaying the pictures and quotes of famous sociologists
3. Choose a theme of your interest- for e.g., crime, technology environmental concerns or any other and look through the Sunday editorials of any national daily of the last 3 months to locate related articles.
4. Role Play: Gender issues in everyday life, students will form small groups and present skits to address this issue creatively; this will be followed by discussions.
5. Students may be given the assignment of taking pro-active role in initiating social change in a local field
6. Visit a shopping mall and observe the interaction between employees and customers/visitors. Identify themes based on your observation and prepare a questionnaire based on this experience.
7. Look at a set of published letters of Gandhi, Nehru, C.F. Andrews and Tagore etc. and identify key social issues that are discussed in the contents of the letters and prepare a report on it.
8. Students will be asked to write a short essay on the pressures they feel of the experience in performing masculinity or femininity, Presentations and discussions based around the essays.
9. Debate or discussion on “Is the family the site of love and care” or “Is the family democratic?”
10. Discuss the impact of modernization, industrialization and globalization on the day-today life.
11. Students may be asked to apply any applied research technique
12. Design a survey on factors effecting marriage choices of young people.
13. Any other suitable activity

References: Books and Readings

1. Andrew, W. (1997) Introduction to the Sociology of Development. New Jersey, Palgrave Macmillan.
2. Berg, L.B. (2001). Qualitative Research Methods for the Social Sciences (4th edition). Boston: Allyn and Bacon

3. Bhatia, H.(1970). Elements of Social Psychology. Bombay: Somaiyya Publications Pvt Ltd.
4. Bhattacharyya D.K (2009). *Organizational Behavior*, Oxford University Press, UK.
5. Dastupta Driskle(2007) : Discourse on Applied Sociology Volume-II, 2007
6. Desai, B Sonalde et al. (2010). Human Development in India: Challenges for a Society in Transition. OUP
7. Deshpande, S.(2003). Contemporary India: A Sociological View. New Delhi: Viking.
8. Hall R.H (2009). *Organizational Structures, Processes & outcomes, Asia*: Pearson Education Publications.
9. Hodegetts R M. (2009). *Organizational Behavior*, Macmillan.
10. Mc Michael.P. (1996). Development and Social change: A global perspective. California Thousand Oaks.
11. Merton, R and Nisbet, (1976) Contemporary Social Problems, New York: Harcourt, Brace and World.
12. Metha, S. (2009). Women and Social Change, Jaipur: Sage.
13. Michael Edwards (2011). Civil Society in India, edited The Oxford Handbook of Civil Society, Oxford, Oxford University Press
14. Mitra et.al. (2009). Democracy, Agency and Social Change in India, New Delhi: Sage
15. Pratt Henry Fairchild(2009) : Outline of Applied Sociology, 2009
16. Ranjithkumar : Research Methodology, Person Education, Delhi.
17. Schaefer, R.T (2004). Sociology a Brief Introduction, (5thed.) New York: McGraw-Hill Inc..
18. Sirclaus Moser & G. Kalton: Survey Methods in Social Investigation, Heinemann Educational Books, London.
19. Sanderson. (2010). Social Psychology, New York: John Wiley.
20. Tepperman, L. & Curtis, J. (Eds.) (2009). Principles of Sociology: Canadian perspectives. Don Mills, ON: Oxford University Press.
21. Young, K. (2001). Handbook of Social Psychology, London: Routledge and Kegal Paul Ltd.

Course Title/ Code	Basics of Economics (MCS231)
Course Type:	Elective (Allied)
Course Nature:	Soft
L-T-P-O Structure	(1-0-2-0)
Objective	

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

SECTION-A

Definition of Economics - various definitions, Nature of Economic problem, Production possibility curve, Concepts and measurement of utility, Law of Diminishing Marginal Utility, Law of equi-marginal utility - its practical application and importance.

SECTION-B

Meaning of Demand, Individual and Market demand schedule, Law of demand, shape of demand curve, Elasticity of demand, degrees of Price elasticity of demand, factors effecting elasticity of demand, practical importance & applications of the concept of elasticity of demand.

SECTION-C

Meaning of production and factors of production, laws of production, various concepts of cost - Fixed cost, variable cost, average cost, marginal cost, money cost, real cost and opportunity cost. Shape of short run cost curves.

SECTION-D

Meaning of Market, Types of Market -Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition (Main features of these markets). Supply and Law of Supply, Role of Demand & Supply in Price Determination and effect of changes in demand and supply on prices.

TEXT BOOKS:

1. Principles of Economics: P.N. Chopra (Kalyani Publishers).
2. Economics for Engineers- T R Jain & O P Khanna
3. Micro Economic Theory – M.L. Jhingan (S.Chand).
4. Micro Economic Theory - H.L. Ahuja (S.Chand).
5. Modern Micro Economics: S.K. Mishra (Pragati Publications).
6. Economic Theory - A.B.N. Kulkarni & A.B. Kalkundrikar (R.Chand & Co.).
7. Indian Economy: Rudar Dutt & K.P.M. Sundhram

Course Title/ Code	Introduction to Finance (MCS232)
Course Type:	Elective (Allied)
Course Nature:	Soft
L-T-P-O Structure	(1-0-2-0)

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

SECTION-A

Introduction to Finance ; Forms of Business Organization ; Overview to financial statements , Balance Sheet, Profit and Loss Account , Cash Flow Statement.

SECTION-B

Financial Analysis and Planning; Financial Ratios, Break Even Analysis Sources of Long term Finance – Equity Capital, Preference Capital, Terms Loans, Debentures; Raising Long term Finance.

SECTION-C

Time Value of Money, Capital Budgeting- Techniques of Capital Budgeting, Net Present Value and Payback Period; Capital Structure and Cost of Capital.

SECTION-D

Working Capital: Introduction, Components of Current Assets and Current Liabilities, Operating Cycle, Estimation of Working Capital; Operating Income , Earning Before Interest and Tax (EBIT).

Suggested Readings:

1. Pandey, I.M., Financial Management, Vikas Publishing House, New Delhi
2. Khan M.Y, and Jain P.K., Financial Management, Tata McGraw Hill, New Delhi
3. Keown, Arthur J., Martin, John D., Petty, J. William and Scott, David F, Financial Management, Pearson Education
4. Chandra, Prasanna, Financial Management, TMH, New Delhi
5. Van Horne, James C., Financial Management and Policy, Prentice Hall of India
6. Brigham & Houston, Fundamentals of Financial Management, Thomson Learning, Bombay.
7. Kishore, R., Financial Management, Taxman's Publishing House, New Delhi

Course Title/ Code	QUANTITATIVE APTITUDE - I /CDO203
Course Type:	Elective (Allied)
Course Nature:	Soft
L-T-P-O Structure	(1-0-2-0)

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Unit 1: Number System

1.1 Simplification

- 1.1.1 BODMAS rule
- 1.1.2 Fractions and recurring decimals
- 1.1.3 Surds and indices

1.2 Numbers

- 1.2.1 Types of numbers and number tree
- 1.2.2 Divisibility Rule
- 1.2.3 HCF & LCM

Unit 2: Arithmetic I

2.1 Percentages

2.2 Ratio & Proportion

- 2.2.1 Proportionality
- 2.2.2 Variations
- 2.2.3 Partnership

2.3 Profit & Loss

- 2.3.1 Basic terminology & Formulae
- 2.3.2 Error in Weights
- 2.3.3 Marked Price and Discounts

2.4 Average

2.5 Interest

- 2.5.1 Simple Interest
- 2.5.2 Compound Interest

2.5.3 Relation between SI & CI

Unit 3: Arithmetic II

3.1 Time & Work

- 3.1.1 Time and Work, Chain Rule
- 3.1.2 Work & Wages
- 3.1.3 Pipes & Cisterns

3.2 Time, Speed & Distance

- 3.2.1 Basics Formulas & Proportionality
- 3.2.2 Average & Relative Speed
- 3.2.3 Trains and Boats & Streams
- 3.2.4 Circular Motion and Clocks

3.3 Alligation & Mixtures

Unit 4: Reasoning Ability

- 4.1 Clocks
- 4.2 Coding Decoding
- 4.3 Arithmetic Reasoning
- 4.4 Blood Relation Test
- 4.5 Direction Sense Test

Text Books/Reference Books:

1. Quantitative Aptitude for Competitive Examinations: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2017
2. A Modern Approach to Verbal & Non Verbal Reasoning: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2018

Instructions for paper setting: Fifty MCQ will be set in total. All questions will be compulsory. Each question will be of 1 mark. There will be no negative marking. Calculator will not be allowed.

MAU-01- Semester IV

SUBJECT CODES	SUBJECT NAME	**OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft/Workshop/NTCC)	COURSE TYPE (Core/Elective / University Compulsory)	L	T	P	O	NO. OF CONTACT HOURS PER WEEK	NO. OF CREDITS
MAH210B	ADVANCED ANALYSIS	MA	HARD	CORE	3	1	0	0	4	4
MAH211B	ADVANCED ALGEBRA	MA	HARD	CORE	3	1	0	0	4	4
MAH212B	MECHANICS-I	MA	HARD	CORE	3	1	0	0	4	4
MAH213B	INTEGRAL TRANSFORMS & APPLICATION	MA	HARD	CORE	3	1	0	0	4	4
MAH214B	SET THEORY & NUMBER THEORY	MA	HARD	CORE	3	1	0	0	4	4
CSH210B-T	DATA STRUCTURES	CS			3	0	0	0	5	
CSH210B-P	DATA STRUCTURES LAB				0	0	2	0	4	
MAH215B	ACTUARIAL STATISTICS	MA			3	1	0	0	4	
MAH216B	SURVEY SAMPLING & INDIAN OFFICIAL STATS	MA			3	1	0	0	4	
CHS234/ ECS249/LWS 323 CDO204/ MAN218B	ESD/ E-WASTE/ CYBER CRIMES & LAWS/QUANTITATIVE APTITUDE II/ MINI PROJECT - II	CH/EC/ DC/LW/ MA			Soft	ELECTIVE (Any one)	1	0	2	
TOTAL (L-T-P-O/ CONTACT HOURS/ CREDITS)					15	4 OR 5	2 OR 4	0	23 OR 24	22

**DETAILED SYLLABUS
MAU01 – FOURTH SEMESTER**

Course Title/ Code	ADVANCED ANALYSIS /MAH210B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	To equip the students with the concepts of Riemann Integrals, Improper integrals and fundamentals of Complex Analysis.
Learning Outcomes	The students would be able to apply the concepts of theory of Riemann Integrals, Improper integrals and fundamentals of Complex Analysis required for solving the mathematical problems and their applications.
Prerequisites	Real Analysis/MAH204B

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Riemann Integral-I: The Upper and lower R-integrals, Integrable (R) functions, Properties of definite and indefinite integral Riemann condition of integrability, Riemann sum, Basic inequality of Riemann integral, algebraic and order properties of the Riemann integral. Riemann integrability for continuous functions, monotonic functions and functions with finite number of discontinuities.

Section B

Riemann Integral-II: The fundamental theorem of integral calculus, Mean Value Theorem (First and Second), Change of variable of R-integral.

Improper Integrals : Improper integrals, Convergence of improper integrals, tests of convergence for improper integrals, Abel's and Dirichlet's tests for improper integrals, Beta and Gamma functions.

Section C

Function of Complex Variable: Complex number system, function of Complex variable, Elementary functions, Transformations, Limit, Continuity, Differentiability, Analytic function, Cauchy-Riemann equations, Harmonic functions, Milne-Thomson method, L'Hospital's Rule Taylor's and Maclaurin's Series, Singular points.

Section D

L'Hospital's Rule Taylor's and Maclaurin's Series, Singular points. Line integral, Cauchy's theorem , Green's theorem, Morrrera's theorem Cauchy's integral formula, Poles and residue's, Cauchy's residue theorem, Evaluation of integrals using Residue theorem.

RECOMMENDED BOOKS:

1. W. Rudin- Principles of Mathematical Analysis - Mc. Graw Hill Int .Edition (3rd)
2. C. C. Pugh, Real Mathematical Analysis- Springer Verlag, Ny. Inc.
3. S.C. Malik and Savita Arora, Mathematical Analysis, New Age International (P).
4. J. W. Brown and R. V. Churchill, Complex variable and Application.

Course Title/ Code	ADVANCED ALGEBRA/MAH211B
Course Type	Core (Departmental)
Course Nature	Hard
L-P-O Structure	(3-1-0-0)
Objective	To equip the students with the concepts of groups and their properties.
Outcomes	The students would be able to (i) Recognize and use the Sylow theorems to characterize certain finite groups. ii) Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields. iii) Learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields.
Prerequisites	GROUP THEORY/ MAH206B

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Sylow Theorems: Cauchy's theorem for finite abelian groups, Finite simple groups, Sylow theorems and applications including nonsimplicity tests.

Section B

Rings: Definition, examples and elementary properties of rings, Commutative rings, Integral domain, Division rings and fields, Characteristic of a ring, Ideals and quotient rings. Prime, principal and maximal ideals, Relation between integral domain and field.

Section C

Ring Homomorphism & Polynomial Rings: Homomorphism of rings, Fundamental theorem on Homomorphism of rings. Euclidean rings and their properties, Wilson and Fermat's theorems. Polynomial rings over commutative ring and their basic properties, The division algorithm; Polynomial rings over rational field, Gauss lemma and Eisenstein's criterion.

Section D

Integral Domains & Fields: Euclidean domain, principal ideal domain, and unique factorization domain.

Fields, Extension of a field, Algebraic element of a field, Algebraic and transcendental numbers, Perfect field, Classification of finite fields.

Recommended Books:

1. Michael Artin (2014). Algebra (2nd edition). Pearson.
2. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003). Basic Abstract Algebra (2nd edition). Cambridge University Press.
3. David S. Dummit & Richard M. Foote (2008). Abstract Algebra (2nd edition). Wiley.
4. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.
5. I. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.
6. I. S. Luthar & I. B. S. Passi (2013). Algebra: Volume 1: Groups. Narosa.
7. I. S. Luthar & I. B. S. Passi (2012). Algebra: Volume 2: Rings. Narosa.

Course Title/ Code	MECHANICS-I/ MAH212B
Course Type	Core (Departmental)
Course Nature	Hard
L-P-O Structure	(3-1-0-0)
Objective	The students would be able to apply the concepts of Statics required for solving the mathematical problems and their applications.
Outcomes	Students will be able to solving the mathematical problems of Composition and resolution of forces, Virtual work and Friction.
Prerequisites	N.A

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section-A

Composition and resolution of forces. Parallel forces. Moments and Couples.

Section-B

Analytical conditions of equilibrium of coplanar forces. Friction. Centre of Mass and Centre of Gravity.

Section-C

Virtual work. Forces in three dimensions. Poinsots central axis

Section-D

Wrenches. Null lines and planes. Stable and unstable equilibrium.

Recommended Books:

1. S.L. Loney : Statics, Macmillan Company, London
2. R.S. Verma : A Text Book on Statics, Pothishala Pvt. Ltd., Allahabad

Course Title/ Code	INTEGRAL TRANSFORMS & APPLICATION/ MAH341 T& P
Course Type:	CORE(DEPARTMENTAL)
Course Nature:	HARD
L-T-P-O Structure	(3-1-2-0)
Objective	To equip the student with notion of Laplace transforms, Fourier transforms and Z-transforms and their applications.
Course Outcome	<p>The student will be able to:</p> <p>CO1. Recognize the different methods of finding Laplace transforms , Fourier Series, Fourier transforms and Z transforms of different functions.</p> <p>CO2. Apply the knowledge of L.T, F.S,F.T, and Z transforms in finding the solutions of differential equations, initial value problems and boundary value problems.</p> <p>CO3. Analyze the characteristics and properties of L.T, F.S,F.T, and Z transforms.</p> <p>CO4. Summarize / reorganize applications of L.T, F.S,F.T, and Z transforms.</p>
Prerequisite	N.A

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

SECTION A

Laplace Transforms and its Applications: Laplace transforms of elementary functions, Properties of Laplace transforms, Existence conditions, Transforms of derivatives, Transforms of integrals, Multiplication by t^n , Division by t . Evaluation of integrals by Laplace transforms. Laplace transform of unit step function, Unit impulse function and periodic function. Inverse transforms, Convolution theorem,

Section B

Application of Laplace Transforms: Application to linear differential equations and simultaneous linear differential equations with constant coefficients and Applications to integral equations.

Fourier Series: Euler's formulae, Conditions for a Fourier expansion, Change of interval, Fourier expansion of odd and even functions, Fourier expansion of square wave, Rectangular wave, Saw-toothed wave, Half and full rectified wave, Half range sine and cosine series.

Section C

Fourier Transforms : Fourier integrals, Fourier transforms, Shifting theorem (both on time and frequency axes), Fourier transforms of derivatives, Fourier transforms of integrals, Convolution theorem, Fourier transform of Dirac-delta function. Application of Fourier transforms in initial and boundary value problem.

Section D

Z-TRANSFORMS: Introduction, Basic Theory of Z-transforms, Z-transforms of various sequences, Existence of Z-transforms, Properties of Z-transforms, Inverse Z-transforms, Differentiation of Z - transforms, Convolution of sequences, Solution of difference equations using Z-transforms.

RECOMMENDED BOOKS:

1. Higher Engineering Mathematics: B. S. Grewal
2. Advanced Engineering Mathematics: Jain and Iyenger

INTEGRAL TRANSFORMS & APPLICATION LAB (MAH341-P):

Objective: Mini Project encourage students to explore and strengthen the understanding of subject through practical application of theoretical concepts. It also helps students to boost their skills and widen their horizon of thinking.

Students are required to identify the topics for project work related with applications of Integral Transforms and Applications. Students can work individually or in a group of 2 & 3. Some suggested topics for mini project are

1. Application of Laplace transforms
2. Application of Fourier Series
3. Application of Fourier transforms
4. Application of Z transforms...etc

Course Title/ Code	SET THEORY AND NUMBER THEORY /MAH214B
Course Type:	Elective(Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	To equip the student the concept of <ul style="list-style-type: none"> ● set, set operation, cartesian products of sets, cardinality of set, relation etc. ● the basic structure and properties of integers.
Learning Outcome	The students would be able to <ul style="list-style-type: none"> ● apply the concept of set and relation on pure and applied mathematics. ● prove results involving divisibility and greatest common divisors; ● find integral solutions to specified linear Diophantine Equations; ● apply Euler-Fermat's Theorem to prove relations involving prime numbers;
Prerequisite	N.A

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section-A

Cartesian products of sets, equivalence relations and partition, fundamental theorem of equivalence relation, equivalent set, countable sets and uncountable sets, cantor's theorem Cardinal numbers, power of continuum, cardinal arithmetic, inequalities in cardinals, Schoeder-Bernstein theorem, partially and totally ordered sets.

Section-B

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruencies, complete set of residues, Algebraic congruencies Chinese Remainder theorem, Fermat's Little theorem, Lagrange theorem, Wilson's theorem.

Section-D

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

Section-D

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruencies with composite moduli. Fibonacci Numbers, sequences and Fibonacci Identities, Pell number.

Recommended Book:

- David M. Burton: Elementary Number Theory, 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.

Course Title/ Code	ACTUARIAL STATISTICS /MAH215B
Course Type:	Elective(Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	To equip students with theoretical and practical knowledge, develop and apply techniques of mathematics, statistics, probability and finance to solving real business problems.
Learning Outcomes	The student would be able to 1. understand the role of statistical principles and their application in actuarial science; 2. Demonstrate the necessary analytical skills for interpreting and analyzing actuarial and statistical information; 3. Justify and communicate the necessary management skills for dealing with organizations, teams and policy issues, so as to be able to work independently and collaboratively to collect, process, interpret and communicate the outcomes of actuarial and statistical problems; and, 4. Demonstrate the skills necessary to critically engage with and evaluate actuarial and statistical problems.
Pre-requisites	Statistics I/ MAH111B

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section - A

Distribution and order statistics: Chebyshev's inequality, W.L.L.N, S.L.L.N and their applications, De-Moivre Laplace theorem, Central Limit Theorem for i.i.d variates – statement and application, Distribution of rth order statistics, Joint distribution of rth and sth order statistics, distribution of sample median and sample range.

Section - B

Data analysis: Exploratory data analysis, Principal Components Analysis, Random sampling and sampling distributions.

Section - C

Estimation: Concepts of estimation, estimators, efficiency, bias and mean square error of estimators, asymptotic distribution, Confidence intervals, Hypothesis testing and goodness of fit.

Section – D

Regression theory and applications: Linear regression, Generalized linear models, Bayesian statistics, multiple linear regression models, Pearson's chi-square test and likelihood ratio test.

Recommended Book :-

1. D.S Borowiak: Financial and Actuarial Statistics, CRC Press Taylor and Francis Group.

Course Title/ Code	SURVEY SAMPLING AND INDIAN OFFICIAL STATISTICS MAH216B
Course Type:	Departmental Elective
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	To familiarize students with survey sampling theory, techniques and present official statistical system in India.
Learning Outcomes	The students would be able to (i) understand the concept of population and sample and estimate statistical attributes of both like mean, variances etc. (ii) apply Stratified random sampling technique (iii) apply Ratio and regression methods of estimation (iv) understand the methods of collection of official statistics and data handling.
Pre-requisites	STATISTICS – I/MAH105B & STATISTICS – II/ MAH202B

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Concept of population and sample, complete enumeration versus sampling, sampling and nonsampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey, simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of: population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination.

Section B

Stratified random sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision, post stratification and its performance. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates ($N=n \times k$). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.

Section C

Introduction to Ratio and regression methods of estimation, first approximation to the population mean and total (for SRS of large size), variances of these estimates and estimates of these variances, variances in terms of correlation coefficient for regression method of estimation and their comparison with SRS. Cluster sampling (equal clusters only) estimation of population mean and its variance, comparison (with and without randomly formed clusters). Relative efficiency of cluster sampling with SRS in terms of intra class correlation. Concept of sub sampling

Section D

Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of India's Principal publications containing data on the topics such as population, industry and finance.

Recommended Books:

1. Cochran W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.
2. Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. Asok, C. (1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics
3. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
4. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.
5. Goon A.M., Gupta M.K. and Dasgupta B. (2001): Fundamentals of Statistics (Vol.2), World Press.
6. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.
7. <http://mospi.nic.in/>

Course Title/ Code	Data Structures (CSH210 B) T & P
Course Type:	Allied Core
Course Nature:	Hard
L-T-P-O Structure	(3-0-2-0)
Objectives	The course should assess how the choice of data structures and algorithm design methods impacts the performance of programs and choose the appropriate data structure and algorithm design method for a specified application.

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section-A

Data structures and Algorithms: Introduction to Data structure: Concept of data structure, choice of right data structures, types of data structures, Introduction to algorithms, how to design and develop an algorithm: stepwise refinement, algorithm analysis, complexity of algorithms
 Arrays: Introduction, One Dimensional Arrays, two dimensional array, address calculation of a location in arrays operations defined: traversal, selection, searching, insertion, deletion, Searching: linear search, binary search, Sorting: selection sort, bubble sort, insertion sort

Section-B

Pointers: Introduction to pointers, Pointer variables, Pointer and arrays, array of pointers, pointers and structures, Dynamic allocation. Linked Lists: Concept of a linked list, operations on Singly linked lists: traversal, selection, searching, insertion, deletion, and sorting, overview of circular and doubly linked list. Applications of linked lists.

Section-C

Stacks: Introduction to Stacks, array representation of stack, operations on stack: PUSH, POP, Evaluation of Expression: Concept of precedence and associativity in expressions, Resolving precedence of operators and association of operands, postfix & prefix expressions, conversion of expression from one form to other form using stack (with & without parenthesis), Recursion, Linked list representation of stack, Applications of stacks. Queues: Queues, array representation of Queues, operations on queue: insertion and deletion, Linked list representation of queue, Overview of priority queue, circular and dequeue. Applications of Queues.

Section-D

Non-Linear Structures: Trees definition, characteristics concept of child, sibling, parent child relationship etc, binary tree: different types of binary trees based on distribution of nodes, operation on binary tree: insertion, deletion, searching and traversal, traversing: Preorder, Postorder and Inorder,

Introduction to binary search tree, operations on BST: insertion, deletion, searching, Application of trees.

Graphs: Definition, Relation between tree & graph, directed and undirected graph, connected and disconnected graph, Depth first and breadth first traversal of graphs, Applications of Graph.

List of Experiments:

1. Programs on C language
2. Write a program on Linear search and Binary search Using C
3. Write a program to implement bubble sort, insertion sort, selection sort
4. Programs on Link list
5. Programs on stack
6. Programs on queues
7. Programs on binary trees
 - Traversal
 - Insertion
 - Deletion

Text Books:

1. Data Structures with C by Seymour Lipschutz ,McGraw Hill Education(India) Private Limited.
2. Data Structures using C by A. K. Sharma, Pearson Publication.
3. Data Structures using C-YashwantKanetkar Publication.

Reference Books:

1. Data Structures using C by A. M. Tenenbaum, Langsam, Moshe J. Augentem, PHI Pub.
2. Data Structures and Algorithms by A.V. Aho, J.E. Hopcroft and T.D. Ullman Publisher.

Course Title/ Code	QUANTITATIVE APTITUDE-II /CDO204
Course Type:	Allied Elective
Course Nature:	Soft
L-T-P-O Structure	(1 – 0 – 2 - 0)
Objectives	To prepare students with the concepts of quantitative techniques required in aptitude test of various competitive exams & placements.
Learning Outcomes	The students would be able to solve problems related to HCF, LCM, Ratio and Proportions, , Permutation Combination, Probability & data analytics
Pre-requisites	QUANTITATIVE APTITUDE-I /CDO203

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Unit 1: Number System

- 1.1 Factors and Multiples
- 1.2 Unit Digits & Cyclicity
- 1.3 Remainders
- 1.4 Factorials
- 1.5 Logarithm

Unit 2: Modern Mathematics

2.1 Permutation and Combination

- 2.1.1 Principal of counting and Basic formulas
- 2.1.2 Arrangements, Selection and Selection + Arrangement.
- 2.1.3 Linear/Circular arrangements, Digits and Alphabetic Problems and Applications.

2.2 Probability

- 2.2.1 Events and Sample Space, Basic Formulas.
- 2.2.2 Problems on Coins, Cards and Dices.
- 2.2.3 Conditional Probability, Bayes' Theorem and their Applications.

Unit 3: Data Analytics

3.1 Data Interpretation

- 3.1.1 Table and Bar graph
- 3.1.2 Line and Pie Charts
- 3.1.1 Mixed Charts and Caselets

3.2 Data Sufficiency

Unit 4: Area & Volume

4.1 Mensuration I- Areas

- 4.1.1 Different types of Triangles and their area and perimeter.
- 4.1.2 Different types of Quadrilateral and their area and perimeter.
- 4.1.3 Circumference and Area of Circle, Area of Sector and length of Sector.
- 4.1.4 Mixed Figures and their Applications.

4.2 Mensuration II- Surface Areas and Volumes

- 4.2.1 Problems on Cubes & Cuboids, Cone, Cylinder and Sphere.
- 4.2.2 Prism and Pyramid.
- 4.2.3 Mixed Figures and their Applications.

Unit 5: Logical Reasoning

- 5.1 Seating Arrangement
- 5.2 Ranking
- 5.3 Syllogism
- 5.4 Calendar
- 5.5 Ages & Numbers

Text Books/Reference Books:

3. Quantitative Aptitude for Competitive Examinations: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2017
4. A Modern Approach to Verbal & Non Verbal Reasoning: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2018

Instructions for paper setting: Fifty MCQ will be set in total. All questions will be compulsory. Each question will be of 1 mark. There will be no negative marking. Calculator will not be allowed.

Course Title/ Code	Mini Project –II/ MAN218B
Course Type	Elective(Departmental)
Course Nature	NTCC
L-T-P-O Structure	1-0-2
Objectives	
Learning Outcomes	<ol style="list-style-type: none"> 1. The students will be able to critically evaluate the work done by various researchers relevant to the research topic 2. To integrate the relevant theory and practices followed in a logical way and draw appropriate conclusions 3. To understand the research methodologies/approaches/techniques used in the literature 4. To structure and organize the collected information or findings through an appropriate abstract, headings, reference citations and smooth transitions between sections
Pre-requisites	

Unit-1 Literature Survey (LS)/Design of Experiment

- 1.1 Collection of research papers related to previously identified gap/problem (15 papers or more)
- 1.2 Comprehend and arrange the literature based on the idea framed
- 1.3 Presenting the collected data and inferring it with the further scope of expansion and Designing the experiment wherever applicable.

Unit-2 Structuring of Review Paper and setting up of experimental facility

- 2.1 Analysis of different approach/methodology adopted by various researchers
- 2.2 Listing out the components of the paper/ setting up experimental facility w.r.t the problem
- 2.3 Identification of suitable Journal or Conference
- 2.4 Formatting/Styling the paper according to the respective template

Unit-3 Planning of experiments

- 3.1 Formulate experimental procedures with Modification of the experimental set-up, if required
- 3.2 Procurement of materials

Unit-4 Execution of experiments/simulations

- 4.1 Conduct experiments/ build prototype
- 4.2 Tabulating and recording data
- 4.3 Analysis and interpretation of the data
- 4.4 Comparison of the results with other reported experiments
- 4.5 Interpretation of observations
- 4.6 Integration of relevant theory, findings in a structured way and draw appropriate conclusions

Unit-5 Departmental Presentation

- 5.1 Structuring and preparation of PPT
- 5.2 Mock presentation
- 5.3 Review on presentation skills and content delivered both
- 5.4 Incorporating the review comments in the slides

Course Title/ Code	CYBER CRIMES & LAWS/ LWS 323
Course Type:	Allied Elective
Course Nature:	Hard
L-T-P-O Structure	(1-1-0-0)
Objectives	<p>This objectives of this paper are:</p> <ol style="list-style-type: none"> 1. To make students understand the concept of Cyber Crimes & Cyber Law and various aspects relating to it. 2. To enhance their understanding of problems arising out of online transactions and stimulate them to find solutions. 3. To clarify the Intellectual Property issues in the cyber space and the growth and development of the law in this regard. 4. To help them understand Information Technology Act, 2000.and Information Technology Amendment Act 2008.

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Unit 1: Cyber Crimes: Meaning, Categories & Kinds

- A. Cyber Crime: Meaning & Categories
- B. Nature of Cyber Crime, Cyber Crimes v. Conventional Crimes
- C. Kinds of Cyber Crime- hacking, spamming, phishing, cyber stalking, cyber pornography, malware etc.

Section B

Unit 2: Privacy Issues &

Access Rights

- A. Freedom of speech and expression in Cyberspace.
- B. Right to Privacy and Right to Data Protection.
- C. Access Rights

Section C

Unit 3: Cyber Space & Legal framework

- A. Cyber Security
- B. Cyber Space , Concept of Property in Cyber Space
- C. Jurisdiction in Cyber Space

Section D

Unit 4: Information and Technology Act 2000 & IT Amendment Act 2008 (Contact Hours - 3)

- A. Need of Cyber Law in India
- B. Enactment & Scheme of the IT Act
- C. Objectives of the IT Act 2000, Amendments to the Act
- D. Justice Dispensation System for Cyber Crimes under IT Act

Tutorial activities 1

Hr/Week

Reference Books:

1. *Cyber Law - Pavan Duggal*
2. Cyber Crimes & Laws-Sushma Arora & Raman Arora-Taxmann's

Course Title/ Code	ENVIRONMENTAL ETHICS & SUSTAINABLE DEVELOPMENT(CHS234)
Course Type:	Elective (Allied)
Course Nature:	Soft
L-T-P-O Structure	(1-0-2)
Objectives	<p>The students would be able to describe, explain and analyses the sustainable development concerns and challenges. At the end of the course, the students would be able to</p> <ul style="list-style-type: none"> • develop an inter-disciplinary understanding of sustainable development concerns; • recognise the challenges of sustainable development; the opportunities and limits in meeting these challenges; and • defend or criticise the sustainability initiatives adopted by different enterprises.

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Introduction to Sustainable Development

Definition of Sustainable Development; Triple Bottom Line, Components of TBL, Changing Perspective & Debates in Sustainable Development - Need for Sustainable Development, Evolution of the concept of Sustainable Development: Stockholm Conference, The Brundtland Commission, Earth Summit, Agenda 21; Millennium Development Goals

Section B

Challenges to Sustainable Development and Sustainable Development Goals (SDGs)

Challenges to Sustainable Development - Agriculture, Population & Food Security, Public Health and Nutrition, Education, Natural Resources (Forests, Energy, Water), Climate Change Sustainable Development Goals (SDGs) - Introduction, Challenges to SDGs, Indian Scenario.

Section C

Sustainability Strategies & Reporting

Sustainability Strategies & Reporting - Introduction, Rationale and Mechanisms, Key Principles, Sustainability Strategies Adopted by Different Enterprises – Case Studies

Section D

Sustainable Development and Contemporary Issues

Tools: Video lecture; research papers or articles, survey, presentations, white board

LAB EXPERIMENTS/ACTIVITIES

1. Survey - Business and non-business students' perception towards TBL (based on the readings listed above); inferences on the basis of survey; <http://www.aabri.com/manuscripts/121249.pdf>
2. Workshop based - Sustainable agriculture- Mushroom farming
3. Workshop based - Back to nature - DIY composting bin
4. Review - Sustainable Consumption in India: Challenges and Opportunities; Divesh Kumar, Praveen Goyal, Zillur Rahman, Ishwar Kumar; IJMBS Vol. 1, Issue 3, September 2011; <http://www.ijmbs.com/13/devesh.pdf>
5. Calculate Carbon Footprint/Ecological footprint
6. Stimulus Activity (Piece of writing) - Sustainable Consumption
7. CSR - Workshop for Village school children
8. Simulation Activity - Challenges to Sustainable Development
9. Case Studies - Sustainability initiatives @ TATA Motors, CAIRN INDIA, Mahindra & Mahindra, Subaru Isuzu, Disney, Novo Nordisk, etc.

VIDEO LECTURES:

1. Triple Bottom Line (TBL) - <https://www.youtube.com/watch?v=2f5m-jBf81Q>
2. How Humans Made Malaria So Deadly - <https://www.youtube.com/watch?v=64pvlCtH-O>
3. Ocean Confetti! - https://www.youtube.com/watch?v=qVoFeELi_vQ&spfreload=5
4. Sustainability explained through animation - <https://www.youtube.com/watch?v=B5NiTN0chj0>
5. SDGs - <https://www.youtube.com/watch?v=uHEfRAooih8>
6. Micro-plastics - <https://www.youtube.com/watch?v=UpGt5L3GC7o>
7. Sustainable Consumption - <http://www.ijmbs.com/13/devesh.pdf>.

BOOKS/READING MATERIAL

1. Environmental Management for Sustainable Development; C.J. Barrow; Routledge Publishers
2. Roberts, J.T., and Hite, A., 2000, From Modernization to Globalization - Perspectives on Development and Social Change, Blackwell Publishing
3. Sachs, J., 2004, Stages of Development, Speech at the Chinese Academy of Arts and Sciences
4. Giddings, B., Hopwood, B., and Geoff O'Brien, 2002, Environment, Economy and Society: Fitting Them Together into Sustainable Development, Published online in Wiley Inter Science (www.interscience.wiley.com). DOI: 10.1002/sd.199
5. IPCC, Adaptation to Climate Change in the context of Sustainable Development and Equity, www.ipcc.ch/ipccreports/tar/wg2/pdf/wg2TARchap18.pdf
6. Brundtland Commission, 1987, "Our Common Future", Oxford University Press
7. Food Insecurity Atlas of Rural India (2001) MS Swaminathan Research Foundation and World Food Programme. <http://home.wfp.org/stellent/groups/public/documents/ena/wfp076968.pdf>.
8. Maternal and Child Undernutrition 1 Maternal and child undernutrition: global and regional exposures and health consequences http://www.who.int/nutrition/topics/Lancetseries_Undernutrition1.pdf.

Course Title/Code	E-Waste: Environmental Problems and Management (ECS249)
Course Type:	Domain Elective (Allied)
Course Nature:	Hard
L-T-P-O Structure	1-0-2-0
Course Objectives	<ol style="list-style-type: none"> 1. Gain a better understanding and appreciation for the challenges related to waste management. 2. Create awareness about environmental impacts of e-waste. 3. Identify various components of e-waste

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

INTRODUCTION: E-Waste, Indian and global scenario of e-Waste, Growth of Electrical and Electronics industry in India, E-waste generation in India, Composition of e-waste, Possible hazardous substances present in e-waste, Environmental and Health implications.

Section B

E-WASTE LEGISLATION: Regulatory regime for e-waste in India, The hazardous waste (Management and Handling) rules 2003, E-waste management rules 2015, Regulatory compliance including roles and responsibility of different stakeholders – producer, manufacturer, consumer etc., Proposed reduction in the use of hazardous substances (RoHS) & REACH, Extended producer responsibility (EPR).

Section C

END OF LIFE MANAGEMENT OF E-WASTE: Historic methods of waste disposal – dumping, burning, landfill; Recycling and recovery technologies – sorting, crushing, separation; Life cycle assessment of a product – introduction; Case study – optimal planning for electronic waste.

Section D

ENVIRONMENTALLY SOUND E-WASTE MANAGEMENT: Emerging recycling and recovery technologies, Guidelines for environmentally sound management of e-waste, environmentally sound treatment technology for e-waste, Guidelines for establishment of integrated e-waste recycling and treatment facility, Case studies and unique initiatives from around the world.

LAB EXPERIMENTS:

1. Identify the hazardous materials present in printed circuit boards.
2. Extraction of copper of printed circuit boards in etching solution.
3. Demo of recycling process through videos.
4. Extraction of precious metal from e Waste.
5. Invited guest lecture.
6. Field visit to a waste management initiative in NCR.
7. Activity based learning: survey of the household practice of e-waste disposal and awareness.
8. Case study – presentation and group discussion.

REFERENCE BOOKS:

1. Electronic Waste Management, R E Hester, R M Harrison, RSC publishing.
2. E Waste: Implications, Regulations and Management in India and current global practices, Rakesh Johri, TERI PRESS.

MAU-01- Semester V

SUBJECT CODES	SUBJECT NAME	**OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft / Workshop/ NTCC)	COURSE TYPE (Core/Elective / University Compulsory)	L	T	P	O	NO. OF CONTACT HOURS PER WEEK	NO. OF CREDITS
MAH301B	NUMERICAL ANALYSIS	MA	HARD	CORE	3	1	0	0	4	4
MAH302B	LINEAR ALGEBRA				3	1	0	0	4	4
MAH303B	METRIC SPACES				3	1	0	0	4	4
MAH304B	INFORMATION THEORY AND CODING	MA		3	1	0	0	4	4	
CSH321B-T	INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS	CS		ELECTIVE (ANY ONE)	3	0	0	0	5	4
CSH321B-P	INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS LAB				0	0	2	0		
MAH305B	MATHEMATICS OF FINANCE	MA			CORE	3	1	0	0	4
MAH306B	STATISTICAL INFERENCES			3		1	0	0	4	4
MAS307B	MATH LAB-IV			0		0	2	0	2	1
MAN308B	MINOR PROJECT			NTCC	1	0	2	0	3	2
TOTAL (L-T-P-O/ CONTACT HOURS/ CREDITS)					13	3/4	4/6	0	21/22	19

DETAILED SYLLABUS
MAU01 – 5th SEMESTER

Course Title/ Code	NUMERICAL ANALYSIS/MAH301B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Objective	<p>This course will enable the students to:</p> <ul style="list-style-type: none"> i) Obtain numerical solutions of algebraic and transcendental equations. ii) Find numerical solutions of system of linear equations and check the accuracy of the solutions. iii) Learn about various interpolating and extrapolating methods. iv) Solve initial and boundary value problems in differential equations using numerical methods. v) Apply various numerical methods in real life problems.
Learning Outcomes	<p>Students will be able to</p> <ol style="list-style-type: none"> 1. Distinguish between types of errors in numerical computation and computing them. 2. Identify and compute the interpolating polynomial for equispaced and nequispaced intervals. 3. Differentiate and integrate numerical data. 4. Find roots of algebraic and transcendental equation. 5. Solve system of linear equation by using direct and iterative methods. 6. Compute Eigen values and Eigen vectors for symmetric and non symmetric matrices. 7. Solutions of Initial value problems of differential equations by single and multiple steps methods. 8. Compute solution of heat wave, Laplace and Poisson equations 9. Solutions of the problems through MATLAB.

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Errors & Interpolation: Errors in numerical calculations introduction, Numbers and their accuracy, Absolute, Relative and Percentage errors and their analysis, General error formula.

Introduction to interpolation, Newton's formula for equispaced points. Lagrange approximation, Newton's divided difference formula, Hermite interpolation.

Curve fitting by a straight line and a second degree curve and laws reducible to linear law.

Section B

Solution of nonlinear equations Bracketing methods for locating a root, Initial approximations and convergence criteria, Bisection method, RegulaFalsi, Newton- Raphson and Secant method. Numerical differentiation and integration: Approximating the derivatives, Numerical differentiation formulas (forward, backward and central-Gauss Forward, GaussBackward, Stirling's), introduction to numerical quadrature, Newton- cotes formula, Gaussian quadrature - Gauss Legendre & Gauss Chebyshev's.

Section C

Solution of linear systems: Direct methods, Gaussian elimination, Gauss Jordan, Matrix inversion, UV factorization, Iterative methods for linear systems (Gauss Seidel & Gauss Jacobi), LU decomposition. Eigen value problems: Jacobi and Given's methods for symmetric matrices, Power and inverse power methods.

Section D

Solution of differential equations: Introduction to differential equations, Initial value problems, Picard's method, Taylor series method, Euler's methods, classical method of Runge-Kutta method of order IV, Predictor-Corrector methods (Milne's & Adam's Bashforth). Partial differential equations: Solution of hyperbolic, parabolic (Bender Schmidt and Crank Nicolson Method) and elliptic equations.

Recommended Books:

1. "Numerical Methods in Engineering. & Science : B.S. Grewal.
2. Numerical Methods for Scientific and Engineering. Computations : M.K. Jain, S.R.K. Iyenger and R.K. Jain-Wiley Eastern Ltd.

Course Title/ Code	LINEAR ALGEBRA /MAH302B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	The students would be able to apply the concepts of Vector Space, Linear Transformation and inner product Space required for solving the mathematical problems and their applications.
Outcome	<p>This course will enable the students to:</p> <ul style="list-style-type: none"> ● understand the concepts of vector spaces, subspaces, bases, dimension and their properties. ● relate matrices and linear transformations, compute eigen values and eigen vectors of linear transformations. ● learn properties of inner product spaces and determine orthogonality in inner product spaces. ● realise importance of adjoint of a linear transformation and its canonical form.
Prerequisites	N.A

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Vector spaces, Subspaces, Sum and Direct sum of subspaces, Linear span, Linearly Independent and dependent subsets of a vector space. Finitely generated vector space, Existence theorem for basis of a finitely generated vector space, Finite dimensional vector spaces, Invariance of the number of elements of bases sets, Dimensions, Quotient space and its dimension.

Section B

Homomorphism and isomorphism of vector spaces, Linear transformations and linear forms on vector spaces, Null Space, Range space of a linear transformation, Rank and Nullity Theorem, Algebra of Linear Transformation, Minimal Polynomial of a linear transformation, Singular and non-singular linear transformations Vector space of all the linear transformations Dual Spaces, Bi dual spaces, Annihilator of subspaces of finite dimensional vector spaces, Matrix of a linear Transformation, Change of basis.

Section C

Eigen values and Eigen vectors of linear transformations, Eigen space, Similar matrices, Diagonalisation, Bilinear and quadratic forms.

Section D

Inner product spaces, Cauchy-Schwarz inequality, Orthogonal vectors, Orthogonal complements, Orthogonal sets and Basis, Bessel's inequality for finite dimensional vector spaces, Gram-Schmidt, Orthogonalization process, Adjoint operator of a linear transformation and its properties.

Recommended Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra(4th Edition), Narosa Publishing House
2. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence, Linear Algebra (4th Edition),Prentice- Hall of India Pvt. Ltd, New Delhi
3. Hoffman & Kunze : Linear Algebra

Course Title/ Code	METRIC SPACES /MAH303B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	To equip the students with the concept of metric spaces, completeness, compactness and connectedness
Outcome	The students would be able to apply the concepts of Metric Spaces and their properties required for solving the mathematical problems and their applications
Prerequisites	Real Analysis

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section-A

Metric Space-Basic Concepts: Definition and examples of metric spaces, Semi metric space, Bounded and unbounded metric space, Sphere or ball, Interior, Neighborhood, open set, limit point, isolated point, Derived set, closed set, Exterior, Frontier

Sequences in a metric space, Convergence in a metric space, Cauchy sequence, Complete metric space, Cantor's intersection theorem.

Section-B

Completeness: First Category space, Second category space, Baire's category theorem, Contraction on a metric space Continuity in a metric space: Continuous functions, Uniform continuity, Isometry, Homeomorphism, Extension theorem

Section-C

Compactness: Covers, Compact spaces and sets, Sequentially compactness, The Heine- Borel theorem, Countably compact, Continuity and compactness.

Section-D

Connectedness: Connected set, Connected subsets, Intermediate Value Theorem, connected component, Totally disconnected set, Path wise connectedness.

Recommended books:

1. E. T. Copson, Metric Spaces- Cambridge University Press
2. Mícheál O'Searcoid, Metric Space-Springer Verlag, Ny . Inc.
3. P. K. Jain, Khalil Ahmad, Metric Space, Alpha Science International, New Delhi.

Course Title/ Code	INFORMATION THEORY AND CODING/ MAH304B
Course Type:	Elective(Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	<p>Students would be able to:</p> <ul style="list-style-type: none"> ▪ To equip students with the basic understanding of the fundamental concept of entropy and information as they are used in communications. ▪ To enhance knowledge of probabilities, entropy, measures of information. ▪ To guide the student through the implications and consequences of fundamental theories and laws of information theory and coding theory with reference to the application in modern communication and computer systems
Outcomes	<p>This course will enable the students to:</p> <ul style="list-style-type: none"> ▪ Study simple ideal statistical communication models. ▪ Understand the development of codes for transmission and detection of information. ▪ Learn about the input and output of a signal via transmission channel. ▪ Study detection and correction of errors during transmission. ▪ Represent a linear code by matrices - encoding and decoding
Pre-requisites	N.A

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Concepts of Information Theory : Communication processes, A model of communication system, A quantitative measure of information, Binary unit of information, A measure of uncertainty, H function as a measure of uncertainty, Sources and binary sources, Measure of information for two-dimensional discrete finite probability schemes.

Section B

Entropy Function : A sketch of communication network, Entropy, Basic relationship among different entropies, A measure of mutual information, Interpretation of Shannon's fundamental inequalities; Redundancy, efficiency, and channel capacity; Binary symmetric channel, Binary erasure channel, Uniqueness of the entropy function, Joint entropy and conditional entropy, Relative entropy and mutual information, Chain rules for entropy, Conditional relative entropy and conditional mutual information, Jensen's inequality and its characterizations, The log sum inequality and its applications.

Section C

Concepts of Coding: Block codes, hamming distance, Maximum likelihood decoding, Levels of error handling, Error correction, Error detection, Erasure correction, Construction of finite fields, Linear codes, Matrix representation of linear codes, Hamming codes.

Section D

Bounds of Codes: Orthogonality relation, Encoding and decoding of linear codes, the singleton bound and maximum distance separable codes, The sphere-packing bound and perfect codes, The Gilbert-Varshamov bound, MacWilliams' identities.

Cyclic Codes : Definition and examples of cyclic codes, Generator polynomial and check polynomial, Generator matrix and check matrix, Bose-Chaudhuri-Hocquenghem (BCH) code as a cyclic code.

Recommended Books:

1. Robert B. Ash, (2014). Information Theory. Dover Publications.
2. Thomas M. Cover & Joy A. Thomas (2013). Elements of Information Theory (2nd edition). Wiley India Pvt. Ltd.
3. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition), Cengage.
4. Fazlollah M. Reza, (2003). An Introduction to Information Theory. Dover Publications.
5. Ron M. Roth (2007). Introduction to Coding Theory. Cambridge University Press.
6. Claude E. Shannon & Warren Weaver (1969). The Mathematical Theory of Communication. The University of Illinois Press.

Course Title/ Code	INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS/ CSH321B
Course Type:	Elective (Allied)
Course Nature:	Hard
L-T-P-O Structure	(3-0-2-0)
Objectives	To introduce the basic concepts related to DBMS, Relational Database Design and Data Mining

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section-A

Data Base Concepts: Data base vs. file oriented approach, Data Independence, Data Base Models, General Architecture of a Data Base Management Software Components of a DBMS, Advantages and Disadvantages of DBMS, Introduction to SQL(Insertion of Data, Updating in the data, Alteration in the Schema, Data Fetching, Functions)

Section-B

Relational model – Mathematical formulation, Relation and its properties, domain compatibility, Relational algebra – set operations (union, intersect, difference, cross product), relational operations (select, project, division, joins-cross, inner/outer, theta, natural), Tuple calculus, Relational Calculus, SQL (Set Operations, group by, order by, Joins)

Section-C

Relational Database design: Relational Database Design and ER Model (Entity, Relationship, Strong Entity, Weak Entity, Type of Attributes and their representation), Functional dependencies, Finding keys; 1st to 3rd NFs, BCNF, Lossless Join and Dependency preserving decomposition.

Section-D

Introduction to Data Mining: Data mining definition & task, KDD versus data mining, Data Mining Applications, Data preprocessing, Data mining techniques: Market Basket Analysis, Frequent Itemsets, Closed Itemsets, and Association Rules(Apriori Algorithm), Mining Multilevel Association Rules, Mining Multidimensional Association Rules, Correlation Analysis.

LIST OF EXPERIMENTS:

Note: MyAccess/MySQL may be used.

1. DDL statement
 - Create table, alter table, drop table
2. DML Statement
 - Select , update, delete, insert statements

- Condition specification using Boolean and comparison operators (and, or, not, =, <>, >, <, >=, <=)
- Arithmetic operators and aggregate function (Count, sum, avg, Min, Max)
- Multiple table queries
- Nested select statements
- Set manipulation using (any, in, contains, all, not in, not contains, exists, not exists, union, intersect, minus, etc.)
- Categorization using group by.....having
- Arranging using order by

3. Introduction to Data mining Tool : Weka

Recommended Books:

1. R. Elmasri, S.B. Navathe, Fundamentals of Database Systems (5th Ed.), Pearson Education. 2010
2. A. Silberschatz, H.F. Korth, S. Sudarshan, Database System Concepts (5th Ed.), McGraw Hill. , 2013.
3. Data Mining- Concepts & Techniques; Jiawei Han & Micheline Kamber- 2001, Morgan Kaufmann.

Reference Book:

1. R. Ramakrishanan, J. Gehrke, Database Management Systems (3rd Ed.), McGraw-Hill. 2002
2. Modern Database Management by Feffray A. lioffcr, Mary B. Prcscotl, Fred R Mefadden, 6th edition. Pearson Education.

Course Title/ Code	MATHEMATICS OF FINANCE / MAH305B
Course Type:	Elective(Departmental)
Course Nature:	Hard
L-T-P-O Structure	3-1-0-0
Objective	To equip the students with the concept of risk evaluation, stocks, price modeling
Learning Outcomes	The student would be able to understand and apply the knowledge of stock market evaluation, pricing model ,risk factor required in real world .
Pre-requisites	NA

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields, Macaulay and modified duration,

Section B

Term structure of interest rates: Spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, puttable and callable bonds.

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints),

Section C

Two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index. Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index.

Forwards and futures, marking to market, value of a forward/futures contract, replicating portfolios, futures on assets with known income or dividend yield, currency futures,

Section D

Hedging (short, long, cross, rolling), optimal hedge ratio, hedging with stock index futures, interest rate futures, swaps. Lognormal distribution, Lognormal model / Geometric Brownian Motion for stock prices, Binomial Tree model for stock prices, parameter estimation, comparison of the models. Options, Types of options: put / call, European / American, pay off of an option, factors affecting option prices, put call parity.

Recommended Books:

1. David G. Luenberger, Investment Science, Oxford University Press, Delhi, 1998.
2. John C. Hull, Options, Futures and Other Derivatives (6th Edition), Prentice-Hall India, Indian reprint, 2006.
4. Sheldon Ross, An Elementary Introduction to Mathematical Finance (2nd Edition), Cambridge University Press, USA, 2003

Course Title/ Code	STATISTICAL INFERENCE /MAH306B
Course Type:	Elective (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	To equip the students with the various Statistical Inference Techniques, applications & analysis.
Learning Outcomes	The students would be able to (i) test hypothesis for the parameters of normal distribution (ii) apply various test for categorical data. (iii) apply tests for the significance of correlation coefficient (iv) do analysis of variance & design experiments.
Pre-requisites	STATISTICS – I (105B) & STATISTICS – II (MAH202B)

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Fisher-Neymann Criterion (Statement and applications), Factorization theorem, Complete statistic, Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems and their applications, Cramer-Rao inequality, MVB estimators and their applications.

Section B

Method of moments, method of maximum likelihood estimation, method of minimum chi-square, tests of association using Chi-square, Yates' correction.

Section C

Tests for the significance of correlation coefficient. Sign test for median, Sign test for symmetry, Wilcoxon two-sample test.

Section D

Analysis of variance, one-way and two-way classification. Brief exposure of three basic principles of design of experiments, treatment, plot and block. Analysis of completely randomized design, randomized complete block design.

Recommended Books:

1. Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences. John Wiley (2005).
2. Goon, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I & II (2005).
3. Dass, M. N. &Giri, N. C.: Design and analysis of experiments. John Wiley.
4. Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences .(1964, 1977) by John Wiley.
5. Bancroft, Holdon Introduction to Bio-Statistics (1962) P.B. Hoebar New York.

Course Title/ Code	MATH LAB IV/ MAH307B
Course Type:	Core (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(0-0-2-0)
Objective	This course will enable the students to generate code for various Numerical Techniques using software.
Learning Outcomes	<p>Students will be able to;</p> <ul style="list-style-type: none"> ● Obtain numerical solutions of algebraic and transcendental equations. ● Find numerical solutions of system of linear equations and check the accuracy of the solutions. ● Learn about various interpolating and extrapolating methods. ● Solve initial and boundary value problems in differential equations using numerical methods. ● Apply various numerical methods in real life problems.

LAB EXERCISES

- 1: Interpolation: To find the value of a dependent variable for a given value of an independent variable using Newton divided difference interpolation for a given set of data.
- 2: Interpolation: To find the value of a dependent variable for a given value of an independent variable using Newton divided difference interpolation for a given set of data.
- 3: To find roots of algebraic and transcendental equations using Bisection method.
- 4: To find roots of algebraic and transcendental equations using Regula Falsi method.
- 5: To find roots of algebraic and transcendental equations using Newton Raphson method.
- 6: Numerical Integration: To find the value of a definite integral using Trapezoidal rule of integration.
- 7: Numerical Integration: To find the value of a definite integral using Simpson's 1/3 rule of integration.
- 8: Numerical Integration: To find the value of a definite integral using Simpson's 3/8 rule of integration.
- 9: To find the solution of an ordinary differential equation of first order by Euler's method.
- 10: To find the solution of an ordinary differential equation of first order by R-K method.

MAU-01 Semester-VI

SUBJECT CODES	SUBJECT NAME	**OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft / Workshop/ NTCC)	COURSE TYPE (Core/Elective / University Compulsory)	L	T	P	O	NO. OF CONTACT HOURS PER WEEK	NO. OF CREDITS			
MAH309B	LINEAR PROGRAMMING & GAME THEORY	MA	HARD	ELECTIVE (ANY TWO)	3	1	0	0	4	8			
MAH310B	MECHANICS-II				3	1	0	0	4				
MAH311B	DISCRETE MATHEMATICS				3	1	0	0	4				
MAH312B	MATHEMATICAL MODELING				3	1	0	0	4				
MAH313B	APPLICATIONS OF ALGEBRA				3	1	0	0	4				
MAH314B	INDUSTRIAL MATHEMATICS				3	1	0	0	4				
MAH315B	BIO MATHS				3	1	0	0	4				
MAH316B	CRYPTOGRAPHY				3	1	0	0	4				
CSE322B-T	FUNDAMENTALS OF MACHINE LEARNING	CS		HARD	ELECTIVE (ANY ONE)	3	0	0	0	5	4		
CSE322B-P	FUNDAMENTALS OF MACHINE LEARNING LAB					0	0	2	0				
MCH393	MANAGEMENT OF BANKING & INSURANCE	MC			3	1	0	0	4				
MAH317B	ECONOMETRICS	MA			3	1	0	0	4				
MCH109	ENTREPRENEURSHIP THEORY & PRACTICE	MC			3	1	0	0	4				
MAN318B	PROJECT	MA			NTCC	CORE	0	0	0	6		2	6
TOTAL (L-T-P-O/ CONTACT HOURS/ CREDITS)					9	2/3	0/2	6	14/15	18			

**DETAILED SYLLABUS
MAU01 – 6th SEMESTER**

Course Title/ Code	LINEAR PROGRAMMING & GAME THEORY/MAH309B
Course Type:	Elective (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	The students would be able to apply the concepts of Linear Programming, Transportation problems and Game theory required for solving the mathematical problems and their applications.

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	Total	100%

Section-A

Introduction to linear programming problem, Formulation, Solution by graphical, Theory of simplex method, Optimality and unbounded-ness, The simplex algorithm, Simplex method in tableau format. Introduction to artificial variables, Two-phase method, Big M method and their comparison. Duality, Formulation of the dual problem, Primal-dual relationships, Dual Simplex, Economic interpretation of the dual.

Section-B

Transportation problem and its mathematical formulation, North-west corner method least cost method and Vogel approximation method for determination of starting basic solution, Algorithm for solving transportation problem, Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem, Travelling salesman problem.

Section-C

Game theory: Formulation of two person zero sum games, Solving two person zero sum games, games with mixed strategies, Graphical solution procedure, Linear programming solution of games.

Section-D

Sequencing: Sequencing problems: Introduction, assumptions, processing of n - jobs through 2 machines, Processing of n - jobs through 3 machines. Processing of n-jobs through m-machines.

Recommended books:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows (2nd edition), John Wiley and Sons, India, 2004.
2. F. S. Hillier and G. J. Lieberman, Introduction to Operations Research (9th Edition), Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, Operations Research, An Introduction (8th edition), Prentice - Hall India, 2006.

4. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.

Course Title/ Code	MECHANICS-II /MAH310B
Course Type:	Elective (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	The students would be able to apply the concepts of Dynamics required for solving the mathematical problems and their applications.
Learning Outcomes	The students would be able to solve the mathematical problems and their applications of Velocity and acceleration, Momentum and Force, Projectile motion and Moment of Inertia .
Pre requisites	MECHANICS I/ (MAH212B)

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Velocity and acceleration along radial, transverse, tangential and normal directions. Relative velocity and acceleration. Mass, Momentum and Force. Newton's laws of motion. Work, Power and Energy. Conservative forces and Impulsive forces.

Section B

Collision of smooth spheres: Direct Impact of two elastic spheres, oblique impact of two elastic spheres in a plane, Central Orbits: Motion of a particle under a central force, The differential equation of a central orbit-Reciprocal polar form, The differential equation of a central orbit-Pedal form, Energy equation, some standard central orbit ,Central orbits under various laws.

Section C

Motion on smooth and rough plane curves. Projectile motion of a particle in a plane. Vector angular velocity. Simple harmonic motion. Elastic strings.

Section D

Moment of Inertia: Moment of Inertia-some simple cases, Method of composition and Decomposition, Parallel Axes Theorem, Moment of Inertia about any axis through the origin, Motion of a Rigid Body parallel to a fixed plane.

Recommended Books::

1. F. Chorlton : Dynamics, CBS Publishers, New Delhi
2. A.S. Ramsey: Dynamics Part-1&2, CBS Publisher & Distributors.

Course Title/ Code	DISCRETE MATHEMATICS /MAH311B
Course Type:	Elective (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	To equip the students with the concepts of counting, permutation and combination, Recurrence relations and graph theory required for solving the mathematical problems and their applications
Learning Outcomes	The student would be able to: CO1: Demonstrate concepts of partial order relation and lattices. CO2: Apply basic counting techniques to solve combinatorial problems CO3: Simplify Boolean functions by using the basic Boolean algebraic properties and K-map. CO4: Express mathematical properties formally via the formal language of propositional logic and predicate logic CO5: Apply algorithms and theorems that are treated in the course for solving graph theoretical problems..

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

SECTION A

Ordered Sets: Relations, Definitions, Examples and basic properties of ordered sets, Order isomorphism, Hasse diagrams, Dual of an ordered set, Duality principle, Maximal and minimal elements.

Lattice: Lattices as ordered sets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, Examples, and properties of modular and distributive lattices, Complemented lattice.

SECTION B

Boolean algebra: Introduction to Boolean algebra and Boolean functions, Different representations of Boolean functions, Application of Boolean functions to synthesis of circuits. Karnaugh maps. Karnaugh diagrams, switching circuits and applications of switching circuits.

Counting Techniques: Pigeonhole principle, Basic counting principles, Binomial and multinomial theorems, Combinatorial identities, Inclusion and Exclusion principle. Recurrence relations, generating functions, solution of recurrence relations using difference equations and generating functions.

SECTION C

Propositional Logic: Syntax, Semantics, Validity and Satisfiability, Basic Connectives and Truth Tables, Logical Equivalence: The Laws of Logic, Logical Implication, Rules of Inference, The use of Quantifiers.

SECTION D

Graph Theory: Definitions, Examples and Basic Properties of Graph, Types of Graph, Matrix Representation of Graph, Isomorphic Graph, Path and Cycles, Eulerian and Hamiltonian paths and cycles, Weighted Graph, Travelling Salesman Problem, Shortest Path, Dijkstra's Algorithm.

Tree, Planar Graph & Coloring: Digraphs, Planer graphs, Euler formula, Graph Colouring, Chromatic numbers. Tree, Properties of Trees, Spanning Trees, Algorithm for Constructing Spanning Trees (BFS and DFS), Minimal Spanning Tree, Algorithms for Constructing Minimal Spanning Tree (Kruskal's and Prim's).

RECOMMENDED BOOKS:

Text books:

1. Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata McGraw – Hill
2. Susanna S. Epp, Discrete Mathematics with Applications, 4th edition, Wadsworth Publishing Co. Inc.
3. C L Liu and D P Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, 3rd Edition by, Tata McGraw – Hill.
4. M.K. Sen (Author), D.S. Malik (Author), Discrete Mathematics: Theory and Applications, Cengage.

Reference books:

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structure and Its Application to Computer Science”, TMG Edition, Tata McGraw-Hill
2. Norman L. Biggs, Discrete Mathematics, 2nd Edition, Oxford University Press. Schum's Outlines Series, Seymour Lipchitz, Marc Lipson,
3. Discrete Mathematics, Tata McGraw - Hill

Course Title/ Code	MATHEMATICAL MODELING-/MAH312B
Course Type:	Elective (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	To equip the students with the concepts of Mathematical Modeling in different physical areas and use of different mathematical tools in mathematical modeling.
Outcomes	The course will enable to the students to understand the basic and different tools of the modeling. The students would be able to apply the concepts of mathematics in the arising the different types of physical problems and can find the best solutions.
Prerequisites	Basic Knowledge of ode, pde & different topics of the mathematic subject.

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Introduction and the technique of mathematical modeling, Classification and characteristics of mathematical models. Mathematical modeling through algebra, finding the radius of the earth, Motion of planets, Motions of satellites. Linear and Non-linear growth and decay models, Population growth models. Effects of Immigration and Emigration on Population size, Decrease of temperature, Diffusion, Change of price of a commodity, Logistic law of population growth. A simple compartment model. Diffusion of glucose or a Medicine in the bloodstream.

Section B

Mathematical modeling of epidemics, A simple epidemics model, A susceptible–infected-susceptible (SIS) model, SIS model with constant number of carriers, Simple epidemic model with carriers, Model with removal, Model with removal and immigration. Mathematical modeling in economics, Domar macro model, Domar first debt model, Domar second debt model, Samuelson investment model, Stability of market equilibrium. Mathematical modeling in medicine, Arms race and battles: A model for diabetes mellitus, Richardson model for arms race, Lamechester combat model.

Section C

Mathematical modeling through partial differential equations: Mass-balance Equations, Momentum-balance Equations, Variation principles, Probability generating function, modeling for traffic on a highway.

Section D

Stochastic models of population growth Need for stochastic models, Linear birth-death-immigration-emigration processes, linear birth-death process, Linear birth-death-immigration process, linear birth-death-emigration process, Non-linear birth-death process.

Recommended Books:

1. J.N. Kapur, Mathematical Modeling, New Age International Limited.
2. J.N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East-West Press (P) Ltd.
5. Mathematical Models in the Social, Management and Life Sciences, D.N. Burghes and A.D. Wood, John Wiley & Sons.
6. Mathematical Modeling, J.G. Andrews & R.R Mclone, Butterworths (Pub.) Inc.

Course Title/ Code	APPLICATIONS OF ALGEBRA/MAH313B
Course Type:	Elective (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	To familiarize students with the applications of Algebra.
Learning Outcomes	The students would be able to (i) construct Balanced incomplete block designs (BIBD) using various methods (ii) understand basics coding theory & applications (iii) apply concepts of group theory on problems related to symmetry & colour patterns (iv) know about different types of matrices and their applications in image processing & statistics (v) understand the applications of linear transformations in various areas and apply the same (vi) apply linear algorithms for matrix factorization.
Pre-requisites	Linear Algebra(MAH302B)

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section –A

Balanced incomplete block designs (BIBD): definitions and results, incidence matrix of a BIBD, construction of BIBD from difference sets, construction of BIBD using quadratic residues, difference set families, construction of BIBD from finite fields.

Section - B

Coding Theory: introduction to error correcting codes, linear codes, generator and parity check matrices, minimum distance, Hamming Codes, decoding and cyclic codes.

Symmetry groups and color patterns: review of permutation groups, groups of symmetry and action of a group on a set; colouring and colouring patterns, Polya theorem and pattern inventory, generating functions for non-isomorphic graphs.

Section – C

Special types of matrices: idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Frobenius-König theorem, Birkhoff theorem. Positive Semi-definite matrices: positive semi-definite matrices, square root of a positive semi-definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonalization. Symmetric matrices and quadratic forms: diagonalization of symmetric matrices, quadratic forms, constrained optimization, singular value decomposition, and applications to image processing and statistics.

Section – D

Applications of linear transformations: Fibonacci numbers, incidence models, and differential equations. Least squares methods: Approximate solutions of system of linear equations, approximate inverse of an $m \times n$ matrix, solving a matrix equation using its normal equation, finding functions that approximate data. Linear algorithms: LDU factorization, the row reduction algorithm and its inverse, backward and forward substitution, approximate inverse and projection algorithms.

Recommended Books:

1. I. N. Herstein and D. J. Winter: Primer on Linear Algebra, Macmillan Publishing Company, New York, 1990.
2. S. R. Nagpaul and S. K. Jain: Topics in Applied Abstract Algebra, Thomson Brooks and Cole, Belmont, 2005.
3. Richard E. Klima, Neil Sigmon, Ernest Stitzinger: Applications of Abstract Algebra with Maple, CRC Press LLC, Boca Raton, 2000.
4. David C. Lay: Linear Algebra and its Applications. 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
5. Fuzhen Zhang: Matrix theory, Springer-Verlag New York, Inc., New York, 1999.

Course Title/ Code	INDUSTRIAL MATHEMATICS / MAH314B
Course Type:	Elective (Departmental)
Course Nature:	Hard
L-P-O Structure	(3-1-0)
Objective	To familiarize students with the basics of X-ray, CT-scan, Tomography etc using mathematics
Outcome	The student would be able to analyze medical imaging , inverse problems, CT scan through mathematics.
Prerequisites	N.A

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Medical Imaging and Inverse Problems: The content is based on Mathematics and X-ray and CT scan based on knowledge of calculus differential equations, complex numbers and matrices.

Section B

Introduction to Inverse Problems: Why should we teach inverse problems? Illustration of inverse problems through pre-calculus, calculus, Matrices and differential equations. Geological anomalies in Earth interior from measurements and its surface (Inverse problems for Natural disaster) and Tomography.

Section C

X-ray introduction, X ray behaviour and Beers Law (The fundamental question and image construction) Lines in the plane. Random Transform: Definition and examples, Linearity, Phantom (Shepp-Logan Phantom-Mathematical phantoms) Back Projection: Definition, Properties and examples.

Section D

CT Scan: Revision of properties of Fourier and inverse Fourier transforms and applications of their properties in image reconstruction. Algorithms of CT scan machine. Algebraic reconstruction techniques abbreviated as ART with application to CT scan.

Recommended Books:

1. Timothy G. Feeman: The Mathematics for Medical Imaging: A beginner's guide, Springer Under graduate Text in Mathematics and Technology, Springer 2010.
2. C.W. Groetsch: Inverse problems. Activities for undergraduates, the Mathematical Association of America, 1999.
3. Andreas Kirsch: An Introduction to the Mathematical Theory of Inverse Problems, 2nd Edn. Springer, 2011.

Course Title/ Code	BIO-MATHS/MAH315B
Course Type:	Elective (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0)
Objective	<ul style="list-style-type: none"> ▪ Scientific study of normal functions in living systems. ▪ Exposure to nonlinear differential equations with examples such as heartbeat, chemical reactions and nerve impulse transmission. ▪ Apply basic concepts of the probability to understand molecular evolution and genetics
Learning Outcomes	<p>At the end of the course, students should:</p> <ul style="list-style-type: none"> ▪ Learn the development, analysis and interpretation of bio mathematical models. ▪ Reinforce the skills in mathematical modeling. ▪ Appreciate the theory of bifurcation and chaos. ▪ Learn to apply the basic concepts of probability to molecular evolution and genetics.
Pre-requisites	

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Modeling Biological Phenomenon

Population growth, Administration of drugs, Cell division, Systems of linear ordinary differential equations, Heartbeat, Nerve impulse transmission, Chemical reactions, Predatorprey models..

Section B

Mathematics of Heart Physiology and Nerve Impulse Transmission

Stability and oscillations: Epidemics, The phase plane and the Jacobian matrix, Local stability, Stability, Limit cycles, Forced oscillations; Mathematics of Heart Physiology: The local model, The Threshold effect, The phase plane analysis and the heartbeat model, A model of the cardiac pacemaker; Mathematics of Nerve Impulse Transmission: Excitability and repetitive firing, Travelling waves.

Section C

Bifurcation and Chaos

Bifurcation, Bifurcation of a limit cycle, Discrete bifurcation and period-doubling, Chaos, Stability of limit cycles, The Poincaré plane.

Section D

Modeling Molecular Evolution and Genetics

Modeling Molecular Evolution: Matrix models of base substitutions for DNA sequences, The Jukes-Cantor model, The Kimura models, Phylogenetic distances; Constructing Phylogenetic Trees: Phylogenetic trees, Unweighted pair-group method with arithmetic means (UPGMA), Neighbor joining method; Genetics: Mendelian genetics, Probability distributions in genetics

Recommended Books:

1. Allman, Elizabeth S., & Rhodes, John A. (2004). *Mathematical Models in Biology: An Introduction*. Cambridge University Press.
2. Jones, D. S., Plank, M. J., & Sleeman, B. D. (2009). *Differential Equations and Mathematical Biology* (2nd ed.). CRC Press, Taylor & Francis Group, LLC. Department of Mathematics, University of Delhi 72
3. Murray, J. D. (2002). *An Introduction to Mathematical Biology* (3rd ed.). Springer. 2. Myint-U, Tyn (1977). *Ordinary Differential Equation*. Elsevier North-Holland, Inc.
4. Simmons, George F., & Krantz, Steven G. (2015). *Differential Equations*. McGrawHill Education. Indian Reprint.
5. Strogatz, Steven H. (2009). *Nonlinear Dynamics and Chaos* (2nd ed.). Perseus Book Publishing. LLC. Sarat Publication, Kolkata, India.

Course Title/ Code	CRYPTOGRAPHY / MAH316B
Course Type:	Elective (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objective	<p>Students would be able to:</p> <ul style="list-style-type: none"> ▪ Understand the concepts of classical encryption techniques and concepts of finite fields and number theory. ▪ Explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms ▪ Explore the design issues and working principles of various authentication protocols, PKI standards. ▪ Explore various secure communication standards including Kerberos, IPsec, and SSL/TLS and email. ▪ Understand concepts of cryptographic utilities and authentication mechanisms to design secure applications
Learning Outcomes	<p>This course will enable the students to:</p> <ul style="list-style-type: none"> ▪ Understand the difference between classical and modern cryptography. ▪ Learn the fundamentals of cryptography, including Data and Advanced Encryption Standards (DES & AES) and RSA. ▪ Encrypt and decrypt messages using block ciphers, sign and verify messages using well-known signature generation and verification algorithms. ▪ Know about the aspects of number theory which are relevant to cryptography.
Pre-requisites	Set Theory & Number Theory /MAH214B

	Secti ons	Weightage
Sylla bus	A	25%
	B	25%
	C	25%
	D	25%
	TOT AL	100%

Section A

Introduction to Cryptography and Classical Cryptography : Cryptosystems and basic cryptographic tools: Secret-key cryptosystems, Public-key cryptosystems, Block and stream ciphers, Hybrid cryptography, Message integrity: Message authentication codes, Signature schemes, Nonrepudiation, Certificates, Hash functions, Cryptographic protocols, Security; Hybrid cryptography: Message integrity, Cryptographic protocols, Security, Some simple cryptosystems,

Shift cipher, Substitution cipher, Affine cipher, Vigenère cipher, Hill cipher, Permutation cipher, Stream ciphers, Cryptanalysis of affine, substitution, Vigenère, Hill and LFSR stream ciphers.

Section B

Cryptographic Security, Pseudo Randomness and Symmetric Key Ciphers: Shannon's theory, Perfect secrecy, Entropy, Spurious keys and unicity distance; Bit generators, Security of pseudorandom bit generators. Substitution-permutation networks, Data encryption standard (DES), Description and analysis of DES; Advanced encryption standard (AES), Description and analysis of AES; Stream ciphers, Trivium.

Section C

Basics of Number Theory and Public-Key Cryptography: Basics of number theory; Introduction to public-key cryptography, RSA cryptosystem, Implementing RSA; Primality testing, Legendre and Jacobi symbols, Solovay-Strassen algorithm, Miller-Rabin algorithm; Square roots modulo n , Factoring algorithms, Pollard $p - 1$ algorithm, Pollard rho algorithm, Dixon's random squares algorithm, Factoring algorithms in practice; Rabin cryptosystem and its security.

Section D

More on Public-Key Cryptography: Basics of finite fields; ElGamal cryptosystem, Algorithms for the discrete logarithm problem, Shanks' algorithm, Pollard rho discrete logarithm algorithm, Pohlig-Hellman of ElGamal systems, Bit security of discrete logarithms.

Hash Functions and Signature Schemes: Hash functions and data integrity, SHA-3; RSA signature scheme, Security requirements for signature schemes, Signatures and Hash functions, ElGamal signature scheme, Security of ElGamal signature scheme, Certificates.

Recommended Books:

1. Jeffrey Hoffstein, Jill Pipher & Joseph H. Silverman (2014). An Introduction to Mathematical Cryptography (2nd edition). Springer.
2. Neal Koblitz (1994). A Course in Number Theory and Cryptography (2nd edition). Springer-Verlag.
3. Christof Paar & Jan Pelzl (2014). Understanding Cryptography. Springer.
4. Simon Rubinfeld-Salzedo (2018). Cryptography. Springer.
5. Douglas R. Stinson & Maura B. Paterson (2019). Cryptography Theory and Practice (4th edition). Chapman & Hall/CRC Press, Taylor & Francis.

Course Title/ Code	FUNDAMENTALS OF MACHINE LEARNING / CSH322B
Course Type:	Elective (Allied)
Course Nature:	Hard
L-T-P-O Structure	(3-0-2-0)
Prerequisite	
Objectives	<p>At the end of the course the students should be able to</p> <ul style="list-style-type: none"> • To design and implement machine learning solutions to classification, regression and clustering problems • To evaluate and interpret the results of the algorithm

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section-A

Introduction: Introduction to Machine Learning, Supervised/unsupervised/semi-supervised, Regression, classification, Bias Variance Trade off, Training and Testing, Evaluation measures

Section-B

Supervised Learning: Linear Regression, single and Multiple, Gradient Descent, Linear Classification, Logistic Regression, Support Vector Machines, Decision Trees, Loss functions,

Section-C

Neural Networks – Biological Neuron prototype, Multilayer Perceptron, Feed forward and Feedback networks, Back propagation, Applications, Instance based learning, Dimensionality Reduction

Section-D

Bootstrapping and Bagging, Random Forest, Unsupervised Learning: Partitional Clustering, Hierarchical Clustering,

LIST OF EXPERIMENTS:

1. Introduction to machine learning libraries in Python/Matlab/R:
2. Linear Regression
3. Logistic regression
4. Support Vector Machines
5. Decision Trees
6. Neural networks
7. k-nearest neighbor classification
8. K-means clustering

Text Books:

1. Tom. M. Mitcheli. Machine Learning, McGraw-Hill Publishing Company Ltd.
2. Ethern Alpaydin. Introduction to Machine Learning, The MIT Press.

Reference Book:

1. Pattern Recognition and Machine Learning, Christopher Bishop, Springer, 2009.

Course Title/Code	MANAGEMENT OF BANKING & INSURANCE-MCH393
Course Type:	Elective (Allied)
Course Nature:	Hard
L-T-P-O Structure	3-1-0-0
Prerequisites	Nil
Course Objectives	To acquaint the students with the understanding of banking Innovations & technology as per the current scenario. To give through knowledge of RBI and its functioning. To enlighten the students regarding the new concepts introduced in the banking system. To make the students familiar with risk, Insurance and its different types and to make them understand the working of the Insurance sector

Section A

Banking and Innovations in Banking Technology: Bank Computerization, Core Banking, Online Banking, Mobile Banking, Internet-Banking, ATMs, Organization of a Bank Branch, Banking Structure in India & Abroad, Bank Branch Set up, Strong Room, Front Office, Back Office, Security Arrangements in Bank and Clearing Houses, Ancillary Services of Banks- Safe custody of valuables, Lockers, Remittances – RTGS/NEFT/Drafts, Fee based services- Issuing Guarantees and letters of credit, Selling Third Party Products- Insurance and Mutual fund units, Credit Cards, Debit Cards, Brokerage and Demit Services.

Section B

Reserve Bank of India Regulations on Banks: Cash Reserve Ratio, Statutory Liquidity Ratio, Bank Rate, Repo Rate, Reverse Repo Rate, Base Rate, Performa of Final Accounts of Banking Companies- Profit & Loss Account and Balance Sheet, Basics of Business Mathematics- Calculation of simple interest and Compound Interest, Calculations of interest on fixed rate and Floating rate, Calculation of EMIs, Calculations of interest on Savings Accounts, Calculations of date of maturity of bills of exchange,

Section C

Insurance – Life Insurance and its principles. Key players in Life Insurance Meaning and importance of General Insurance, different types of General Insurance, (i) Fire Insurance, (ii) Marine Insurance, (iii) Motor Vehicle Insurance, (iv) Medi-Claim Insurance, (v) Accident Insurance, (vi) Burglary and Theft Insurance, Present Organizational set up of General Insurance companies in India - GIC - its subsidiaries, Private Companies, Principles of General Insurance - Insurable Interest, Indemnity, subrogation, good faith, Regulator of Insurance Sector- IRDA and various provisions and regulations, Fire Insurance- Types of Fire insurance Policies - Their main features and clauses, Meaning & Significance of Average Clause, Procedure for taking Fire Insurance Policies and settlement of claims.

Section D

Kinds of General Insurance(contd.) Marine Insurance,Three types of Marine insurance - Cargo Insurance, Hull Insurance and Freight Insurance, Types of Policies,Clauses of a Marine Insurance Policy, Marine losses,Motor Vehicle Insurance-Types of Polices and Risks Covered therein,Procedure for obtaining motor Insurance Policy, Settlement of claims,Medi-Claim and Accident Insurance-Important conditions of such Polices and Benefits available therein, Procedure for claims,Burglary and Theft Insurance-Need for such Insurance, Information to be furnished and procedure to be follow,Recovering the claims.

Recommended Books

1. Practice & Law of banking – G.S. Gill
2. Banking: Law & practice – P.N. Varshney
3. Banking: Theory & Practice – E. Gordon, K. Talraj
4. Banking: Law & practice – in India- Tannan
5. Banking: Law & practice –in India – Maheshwari
6. Fundamentals of banking- Dr. G.V. Kayandepatil, Prof. B.R. Sangle Dr. G.T. Sangle, Prof. N.C. Pawar
7. Mishra M.N., “ Principles and Practices of Insurance”,S. Chand and Co; 2004
8. Panda G.S., “Principles and Practices of Insurance” Kalyani Publications, 2004
9. Reference Books: 1.Jeevanandam C., “Risk Management,” Sultan Chand and Sons; 2005
10. Arthur C. and C. William Jr., “Risk Management

Course Title/ Code	ECONOMETRICS /MAH317B
Course Type:	Elective (Departmental)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	To equip the students with the concepts of econometric models,
Learning Outcomes	The students would be able to (i) conceptualize econometric model, structure & estimation. (ii) do detection of multicollinearity (iii) apply Aitken estimators (iv) do tests & find solutions of heteroscedastic disturbances
Pre-requisites	STATISTICS – I (105B) & STATISTICS – II (MAH202B)

	Sections	Weightage
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	100%

Section A

Introduction: Objective behind building econometric models, nature of econometrics, model building, role of econometrics, structural and reduced forms. General linear model (GLM). Estimation under linear restrictions.

Section B

Multicollinearity: Introduction and concepts, detection of multicollinearity, consequences, tests and solutions of multicollinearity, specification error.

Section C

Generalized least squares estimation, Aitken estimators. Autocorrelation: concept, consequences of autocorrelated disturbances, detection and solution of autocorrelation.

Section D

Heteroscedastic disturbances: Concepts and efficiency of Aitken estimator with OLS estimator under heteroscedasticity. Consequences of heteroscedasticity. Tests and solutions of heteroscedasticity. Autoregressive and Lag models, Dummy variables, Qualitative data.

Recommended Books:

1. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4th Edition, McGraw Hill Companies.
3. Johnston, J. (1972): Econometric Methods, 2nd Edition, McGraw Hill International.
4. Koutsoyiannis, A. (2004): Theory of Econometrics, 2nd Limited, Edition, Palgrave Macmillan Limited
- Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th edition, John Wiley & Sons.

Course Title/Code	ENTREPRENEURIAL THEORY AND PRACTICES / MCH109
Course Type:	Elective (Allied)
Course Nature:	Hard
L-T-P-O Structure	3-1-0-0
Prerequisites	Nil
Course Objectives	Recognize the entrepreneurial potential within yourself and in your environment; Appreciate the role of entrepreneurship within society, at the level of the organization, and in your own personal life; Understand the process, nature of entrepreneurship, and ways to manage the process; this course will introduce to the basic knowledge of various aspects of Entrepreneurship.

SECTION A

Defining Entrepreneurship; what is an Entrepreneurial Mindset? The Entrepreneurial Process; An Integrative Model of Entrepreneurship. “Who” is the Entrepreneur? Sociological and Psychological Characteristics; The Different Types of Entrepreneurs; Nature versus Nurture, Why Entrepreneurs are not Born

SECTION B

Understanding The Nature of Opportunity & Defining Opportunity; An Opportunity is Different from a Business Concept; Sources and Types of Opportunity; Discovery versus Search; Where are the Emerging Opportunities; Evaluating Opportunity; Factors that Undermine an Opportunity; Windows of Opportunity; Understanding the Market and the Customer Needs. Entrepreneurial Skills such as Communication, Design Thinking, Personal Selling, and Risk and Resilience

SECTION C

Developing a Great Business Concept and Business Model From Product to Business Concept (the Value Proposition), From Business Model to Business Plan; The Nature of Successful Business Concepts; Sources of Concepts; What Makes for a Good Concept; Components of a Complete Business Model; A Look at Successful and Failed Business Models

SECTION D

Expectations about Size, Growth, Returns, and Risk, What About the Investment Model (Income, Growth, or Speculative)?; Ways of Extracting Returns from the Venture; Types of Ventures; What it Takes to Actually Start a Venture; Four Ways to Enter a Market; The Concept of Risk; Types of Risk; Assessing in a New Venture; Risk and Return.

Recommended Books:

1. Rajeev Roy , “Entrepreneurship”, 2nd ed, Oxford Higher Education, 2011
2. Bruce R. Barringer and R. Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd Edition, Pearson Prentice Hall (2009).
3. Nandini Vaidyanathan. Entrepedia, A Step-by –step Guide to Becoming An Entrepreneur In India, 2nd ed, Publisher: Embassy Books Publishers & Distributors, 2011.

