Mathematical Statistics (19M21MA211)

Course Description

Course Code	**19M21MA211**	**Semester Odd**	**Semester III Session 2021-22** **Month from** Aug 2021- Dec 2021
Course Name	Mathematical Statistics		
Credits	4	**Contact Hours**	3-1-0
Faculty (Names)	**Coordinator(s)**	Dr. Himanshu Agarwal	
	Teacher(s) (Alphabetically)	Dr. Himanshu Agarwal	

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
CO1	explain random variables and some standard distributions.	Understanding Level (C2)
CO2	apply the concepts of random sampling, parametric point and interval estimation.	Applying Level (C3)
CO3	apply hypothesis testing for goodness of fit and large sample tests.	Applying Level (C3)
CO4	analyze the sample data using ANOVA and regression analysis.	Analyzing Level (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Random variables and its properties	Discrete and continuous random variables, univariate and bivariate random variables, joint, marginal and conditional distributions, expectation of a random variable, moment generating function (MGF) and characteristic function of a random variable, correlation.	**9**
2.	Probability distributions	Binomial, Poisson, uniform, normal distributions.	**7**
3.	Theory of sampling	Sampling theory, random sampling, distribution of sample mean, variance.	**4**
4.	Point and interval estimation	General concept of estimation, unbiasedness, consistency, efficiency and sufficiency, factorization theorem, completeness, Rao-Blackwell theorem, Cramer-Rao inequality, method of moments, confidence interval.	**9**
5.	Hypothesis testing	Null and alternative hypothesis, type I and type –II error, analysis of discrete data and Chi-square test of goodness of fit, large sample tests.	**5**
6.	Analysis of variance	One way of analysis with equal and unequal sample size, tests for the homogeneity of variances.	**4**

7.	Regression	Simple and multiple linear regression, elementary regression, regression curve and scedastic curves	**4**
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Project based learning: Students in small groups will collect sample data set and make simple/multiple linear regression models. They will validate and analyze the model by hypothesis testing and ANOVA. By this students will be able to make simple/multiple linear regression models.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**A. M. Mood, F. A. Graybill and D. C. Boes,** Introduction to the theory of statistics, 3rd Indian Ed., Mc Graw Hill, 2001.
2.	**R. V. Hogg and A. T. Craig,** Introduction to mathematical Statistics, Mc-Millan, 1995.
3.	**V. K. Rohatgi,** An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern, 1984.
4.	**S. M. Ross,** A First Course in Probability, 6th edition, Pearson Education Asia, 2002.
5.	**S. Palaniammal,** Probability and Random Processes, PHI Learning Private Limited, 2012.
6.	**P. L. Mayer,** Introductory Probability and Statistical Applications, Addison-Wesley, Second Edition, 1972.
7.	**R. E. Walpole, R H. Myers, S. L. Myers, and K. Ye,** Probability & Statistics for Engineers & Scientists, 9th edition, Pearson Education Limited, 2016.
8.	**I. Miller and M. Miller, John E. Freund's** Mathematical Statistics with Applications, 8th Edition, Pearson Education Limited 2014.

Numerical Analysis (19M21MA212)

Course Description

Course Code	**19M21MA212**	**Semester Odd**	**Semester III Session 2021-22** **Month from** Aug 2021- Dec 2021
Course Name	Numerical Analysis		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**	Dr. Anuj Bhardwaj	
	Teacher(s) (Alphabetically)	Dr. Anuj Bhardwaj	

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
CO1	explain concepts of errors and find the roots of algebraic and transcendental equations.	Understanding Level (C2)
CO2	solve the system of linear equations using direct & iterative methods and to find eigenvalues and eigenvectors of matrices.	Applying Level (C3)
CO3	explain the concept of interpolation.	Understanding Level (C2)
CO4	apply numerical methods to find differentiation and integration of a function.	Applying Level (C3)
CO5	apply numerical methods to solve ordinary differential equations.	Applying Level (C3)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Concept of Errors**	Fixed-point and floating-point numbers, truncation, round-off and maximum absolute errors, relative error, accuracy of the numbers.	**2**
2.	**Algebraic and transcendental equations**	Iterative method, Newton-Raphson's method. successive iteration method, rate of convergence, roots of a polynomial: Horner's method, Birge Vita method, Lin's method, Bairstow and Muller's method, Roots of a system of nonlinear equations.	**10**
3.	**System of linear algebraic equations**	Gauss elimination method, Gauss-Jordon method, LU-decomposition method, inverse of matrices, Jacobi and Gauss-Seidal iterative methods, convergence of iteration methods.	**6**
4.	**Eigen values and eigen vectors**	Power's method to find dominant eigen value and eigen vector, Rayleigh method, eigen values and	**6**

		eigen vectors of a symmetric matrix by Jacobi's, Given's and Householder's method.	
5.	**Interpolation**	Newton's divided difference, Gauss forward and backward interpolation, Lagrange's interpolation, spline interpolation.	**3**
6.	**Numerical differentiation and integration**	Approximation of derivatives, Newton-Cotes Formulae-Trapezoidal, Simpson's, Boole's and Weddle' rules of integration with errors, Romberg integration, Gaussian two and three point quadrature rules, double integration by Trapezoidal and Simpson's rules.	**6**
7.	**Differential equations**	Picard's method, Euler's and modified Euler methods, Taylor's series method, Runge-Kutta 2nd and fourth order methods, multistep methods, solution of simultaneous and higher order equations, boundary value problems: finite difference and shooting methods.	**9**
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Project based learning: A group of 2 to 3 students will be formed. Each group will have a group leader to develop coordination among the group members. A problem of differential equation will be given to each group to find its solution. The group leader will submit a report of findings for the same.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**M. K. Jain, S. R. K. Iyengar and R. K. Jain,** Numerical Methods for Scientific and Engineering Computation, 6th Ed., New Age International, New Delhi, 2014.
2.	**C. F. Gerald and P. O. Wheatley,** Applied Numerical Analysis, 7th Ed., Pearson Education, 2004.
3.	**R. S. Gupta,** Elements of Numerical Analysis, 2nd Ed., Cambridge University Press, 2015.
4.	**S. D. Conte and C. deBoor,** Elementary Numerical Analysis, An Algorithmic Approach, 3rd Ed., McGraw-Hill, New York, 1980.
5.	**S. C. Chapra** and **R. P. Canale**, Numerical Methods for Engineers, 5th Ed., McGraw Hill, 2006.

Operations Research (19M21MA213)

Course Description

Course Code	**19M21MA213**	**Semester Odd**	**Semester III Session 2021-22** **Month from** Aug 2021- Dec 2021
Course Name	Operations Research		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**	Dr. Pato Kumari	
	Teacher(s) (Alphabetically)	Dr. Pato Kumari	

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
CO1	construct mathematical models for optimization problems and solve linear programming problems (LPP) using graphical, simplex method and its variants.	Applying Level (C3)
CO2	utilize duality to analyse the sensitivity of optimal solution of linear programming problems.	Applying Level (C3)
CO3	solve transportation, assignment and travelling salesman problems.	Applying Level (C3)
CO4	classify and solve the problems on queuing and inventory models.	Analyzing Level (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Linear Programming Problems (LPP)**	Introduction, definition of operations research, its scope and Application in different areas, Convex sets, formulation of LPP, graphical solutions, Simplex method, big-M method, two phase method, special cases in simplex method.	**10**
2.	**Duality and Sensitivity Analysis**	Primal-Dual relationship, duality, dual simplex method, sensitivity analysis.	**7**
3.	**Transportation Problems**	Mathematical formulation of transportation problem, basic feasible solution-north west corner rule, least cost method, Vogel's approximation method, degeneracy, resolution on degeneracy, optimal solution, maximization case in transportation problem, unbalanced transportation problem.	**7**

4.	**Assignment Problems**	Mathematical formulation of assignment problem, optimality condition, Hungarian method, maximization case in assignment problem, unbalanced assignment problem, travelling salesman problem.	**4**
5	**Elementary Queuing Models**	Markov process, steady-state solutions of Markovian queuing models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space, M/G/1 model.	**7**
6	**Elementary Inventory Models**	Inventory control models: economic order quantity (EOQ), deterministic inventory problems with and without shortage.	**7**
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Project based learning: Each student in a group of 2-3 will collect literature on queueing and inventory models to solve some applicational problem. To make the subject application based, the students analyze the optimized way to deal with aforementioned topics.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**H. A. Taha,** Operations Research- An Introduction, 10th Edition, New York Macmillan, 2017.
2.	**G. Hadley,** Linear Programming, Massachusetts, Addition Wesley, 1962.
3.	**F. S. Hiller and G. J. Lieberman,** An Introduction to Operations Research, 10th Edition, San Francisco Holden Day, 2017.
4.	**H. M. Wagner,** Principles of Operations Research with Applications to Managerial Decisions, Prentice Hall of India Pvt. Ltd., 1975.
5.	**N. D. Vohra,** Quantitative Techniques in Management, 5th Edition, TMH, 2017.

Numerical Analysis Lab (19M25MA211)

Course Description

Course Code	**19M25MA211**	**Semester Odd**	**Semester III Session 2021-22** **Month from** Aug 2021 - Dec 2021
Course Name	Numerical Analysis Lab		
Credits	01	**Contact Hours**	0-0-2
Faculty (Names)	**Coordinator(s)**	Dr. Anuj Bhardwaj	
	Teacher(s) (Alphabetically)	Dr. Anuj Bhardwaj	

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
CO1	understand the basics of MATLAB to find real roots of algebraic/ transcendental equations.	Applying Level (C3)
CO2	develop the program to solve system of linear algebraic equations using MATLAB.	Applying Level (C3)
CO3	solve interpolation problems using MATLAB.	Applying Level (C3)
CO4	develop the program for derivatives and integrals using MATLAB.	Applying Level (C3)
CO5	construct the program for solutions of ordinary differential equations in MATLAB.	Applying Level (C3)

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	Algebraic/ transcendental equations	1. To find a real root of an algebraic/ transcendental equation by using Newton-Raphson method. 2. To find a real root of an algebraic/ transcendental equation by using Successive iteration method. 3. To find a root of an equation by using Muller's method.	CO1
2.	System of linear algebraic equations	4. Implementation of Gauss-Elimination method to solve a system of linear algebraic equations. 5. Implementation of Gauss-Jordon method to solve a system of linear algebraic equations. 6. Implementation of Gauss-Seidel method to solve a system of linear algebraic equations.	CO2
3.	Interpolation	7. Implementation of Lagrange's formula for interpolation.	CO3

		8. Implementation of Newton's divided difference formula for interpolation.	
	Numerical differentiation and integration	9. To find differential coefficients of 1st and 2nd orders using interpolation formulae. 10. To evaluate integrals by using Trapezoidal rule. 11. To evaluate integrals by using Simpson method.	CO4
4.	Differential equations	12. To compute the solution of ordinary differential equations by using Euler's method. 13. To compute the solutions of ordinary differential equations by using Runge-Kutta methods. 14. To solve two point boundary value problem by shooting and finite difference method.	CO5

Evaluation Criteria

Components	**Maximum Marks**
Lab Test 1	20
Lab Test 2	20
TA	60 (Quiz, Assignments, Tests, Viva)
Total	**100**

Project based learning: A group of 2 to 3 students will be formed. Each group will have a group leader to develop coordination among the group members. A problem of differential equation will be given to each group to find its solution with the help of MATLAB. The group leader will submit a report of findings with output for the same.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**R. Pratap,** Getting started with MATLAB: A quick introduction for scientists and engineers, Oxford university press, 2016.
2.	**B. S. Grewal**, Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB, 11th Ed., Khanna, 2014.
3.	**S. Nomura**, C Programming and Numerical Analysis: An Introduction, 1st Ed, Morgan & Claypool Publishers, 2018.
4.	**S. S. Otto**, Introduction to Programming and Numerical Methods in MATLAB, 1st Ed. Springer, 2005.
5.	**D. Vaughan Griffiths and I. M. Smith,** Numerical Methods for Engineers, 2nd Ed., CRC Press, 2006.
6.	**S. C. Chapra**, Applied Numerical Methods with Matlab for Engineers and Scientists, 2nd Ed. Tata McGraw Hill, New Delhi, 2008.

Operations Research Lab (19M25MA212)

Course Description

Course Code	**19M25MA212**	**Semester Odd**	**Semester III Session 2021-22** **Month from** Aug 2021- Dec 2021
Course Name	Operations Research Lab		
Credits	01	**Contact Hours**	0-0-2
Faculty (Names)	**Coordinator(s)**	Dr. Pato Kumari	
	Teacher(s) (Alphabetically)	Dr. Pato Kumari	

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
CO1	understand the basics of MATLAB to solve linear programming problems.	Applying Level (C3)
CO2	solve dual problem using MATLAB and perform sensitivity analysis of optimal solution of LPP.	Applying Level (C3)
CO3	solve transportation problems with the help of MATLAB.	Applying Level (C3)
CO4	solve assignment problems with the help of MATLAB.	Applying Level (C3)
CO5	solve travelling salesman using MATLAB.	Applying Level (C3)

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	Linear programming problems	1. Construct code to solve linear programming problem (LPP) using Graphical method. 2. Construct code to solve linear programming problem (LPP) using Simplex method. 3. Construct code to solve LPP using Big-M method. 4. Construct code to solve LPP using two phase method.	CO1
2.	Duality and sensitivity analysis	5. Construct code to write the dual of a primal problem. 6. Construct code to solve LPP using dual simplex method. 7. Construct code to analyze the sensitivity of optimal solution if cost coefficients are changed.	CO2

		8. Construct code to analyze the sensitivity of optimal solution if resource vector components are changed. 9. Construct code to analyze the sensitivity of optimal solution if a constraint is added.	
3.	Transportation problem	10. Construct code to solve transportation problem as a LPP.	CO3
4.	Assignment problem	11. Construct code to solve an assignment problem as a LPP.	CO4
5.	Travelling salesman problem	12. Construct code to solve travelling salesman problem.	CO5

Evaluation Criteria

Components	**Maximum Marks**
Lab Test 1	20
Lab Test 2	20
TA	60 (Quiz, Assignments, Tests, Viva)
Total	**100**

Project based learning: Each student in a group of 2-3 will collect literature on travelling salesman problem to develop algorithm and can generate code on the same.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**R. Pratap,** Getting started with MATLAB: A quick introduction for scientists and engineers, Oxford university press, 2016.
2.	**H. A. Taha,** Operations Research - An Introduction, Tenth Edition, Pearson Education, 2017.
3.	**N. Ploskas and N. Samaras,** Linear programming using MATLAB, Springer Optimization and Its Applications 127, Springer, 2017.
4.	**S. K. Mishra and B. Ram,** Introduction to linear programming with MATLAB, CRC Press, 2018.
5.	**R. H. Kwon,** Introduction to linear optimization and extensions with MATLAB, CRC Press, 2014.
6.	**P. Venkataraman,** Applied Optimization with MATLAB programming, John Wiley & Sons, 2002

Advanced Matrix Theory (20M22MA211)

Course Description

Course Code	20M22MA211	**Semester Odd**	**Semester III Session 2021-22** **Month from** Aug 2021- Dec 2021
Course Name	Advanced Matrix Theory		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**	Prof. R.C. Mittal	
	Teacher(s) (Alphabetically)	Prof. R.C. Mittal	

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
CO1	solve the system of linear equations using direct and iterative methods.	Applying Level (C3)
CO2	explain matrix norms, orthogonal complement and apply the revised Gram-Schmidt process in constructing orthonormal basis and Q-R decomposition.	Applying Level (C3)
CO3	construct Gershgorin's circles, quadratic and canonical forms and solve smallest and largest eigenvalue problems, eigen system of Hermitian matrix and singular value decomposition.	Applying Level (C3)
CO4	analyze systems of differential and difference equations arising in dynamical systems using matrix calculus.	Analyzing Level (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Linear System of equations**	Existence and uniqueness of solution for a system of linear equations, LU- decomposition methods, Crout's and DooLittle's methods, Cholesky method, conjugate gradient method.	**7**
2.	**Normed and Inner Product Spaces**	*p*-norms of a vector, norms of a matrix, condition number, Orthogonal matrices, QR factorization, expansion in terms of orthonormal basis–Fourier series, orthogonal complement, Pythagoras theorem.	**10**
3.	**Eigen value Problems**	Eigen values and Eigenvectors, spectral radius, Greshgorin's theorem, Power and Inverse power methods eigen system of a Hermitian matrix, Singular Values and Singular Value Decomposition.	**12**
4.	**Matrix Calculus**	Powers and functions of matrices, approximation methods of function of matrices, application to solve discrete dynamical systems $x(t+1) = Ax(t)$, $x(0) = \alpha$ and a	**13**

		system of differential equations of the form dx/dt = Ax, x(0) =α.	
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments)
Total	**100**

Project based learning: Each student in a group of 3-4 will apply the concepts of matrix calculus to solve system of differential equations related to some practical problems.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**R. Bronson,** Matrix Methods an Introduction, Academic Press, 1991.
2.	**G. H. Golub,** Matrix Computations, 4th Edition, Johns Hopkins University Press, 2013.
3.	**K. B. Datta,** Matrix and Linear Algebra, 3rd Edition, Prentice Hall of India, 2016.
4.	**W. L. David,** Matrix Theory, World Scientific, 1991.
5.	**R. A. Horn and C. R. Johnson,** Topics in Matrix Analysis, Cambridge University Press, 2013.
6.	**G. Strang,** Linear Algebra and its Applications, Thomson, Brooks/Cole, 2006.

	PO1	**PO2**	**PO3**	**PSO1**
CO1	**3**	**2**	**-**	**2**
CO2	**3**	**2**	**-**	**2**
CO3	**3**	**2**	**-**	**2**
CO4	**3**	**2**	**-**	**2**

Continuum Mechanics (20M22MA212)

Course Description

Course Code	20M22MA212	**Semester** Odd	**Semester III Session 2021 -22** **Month from** Aug 2021 to Dec 2021
Course Name	Continuum Mechanics		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**	Dr. Sarfaraz, Dr. Amita Bhagat	
	Teacher(s) (Alphabetically)	Dr. Sarfaraz, Dr. Amita Bhagat	

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:		
CO 1	explain stress-strain diagram, stresses and strains on an oblique plane.	Understanding Level (C2)
CO 2	apply Affine transformation to derive the expressions for principal strains, equations of compatibility and finite deformations.	Applying Level (C3)
CO 3	apply stress theory to find the maximum normal and shear stresses.	Applying Level (C3)
CO 4	analyze generalized Hooke's law for isotropic and anisotropic materials.	Analyzing Level (C4)
CO 5	evaluate stresses and strains in problems of rotating disk and circular cylinders.	Evaluating Level (C5)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Basic Theory of Continuum Mechanics**	Stress, strain, stress-strain diagram, stresses on an oblique plane under uniaxial loading and biaxial loading, complementary shear stresses, biaxial stresses combined with shear stresses, strains on an oblique plane.	**9**
2.	**Analysis of Strain**	Affine transformation, Infinitesimal Affine transformation, geometrical interpretation of the components of strain, strain quadric of Cauchy, principal strains, equations of compatibility, finite deformations.	**9**
3.	**Analysis of Stress**	Body and surface forces, stress tensor, equations of equilibrium, transformation of coordinates,	**9**

		stress quadric of Cauchy, maximum normal and shear stresses.	
4.	**Stress-Strain Relations**	Hooke's law, generalized Hooke's law, homogeneous, isotropic bodies, elastic moduli of isotropic bodies, equilibrium equations for an isotropic elastic solid.	**6**
5.	**Two-Dimensional Formulation and Solution**	Plane strain, plane stress, Airy stress function, polar coordinate formulation, Cartesian coordinate solutions using polynomials, general solution in polar coordinates.	**9**
Total number of Lectures			**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Project Based learning: Each student in a group of 2 will apply the concepts of Stress-strain relations and two dimensional formulation of problems of rotating discs and cylinders used in many real life applications.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**I. S. Sokolnikoff,** Mathematical Theory of Elasticity, First Edition, McGraw-Hill, New York 1946.
2.	**P. N. Chandramouli,** Continuum Mechanics, Yes Dee Publishing India, 2014.
3.	**E. J. Hearn,** Mechanics of Materials, Vol. 1 & 2, 3rd Ed., Elsevier, 2008.
4.	**N. Noda N, R. B. Hetnarski and Y. Tanigawa**, Thermal Stresses, 2nd Ed., Taylor & Francis, New York 2003.

Fuzzy Sets and Applications (20M22MA213)

Course Description

Course Code	20M22MA213	**Semester Odd**	**Semester III Session 2021-22** **Month from** Aug 2021 to Dec 2021
Course Name	Fuzzy Sets and Applications		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**	**Dr. Neha Singhal**	
	Teacher(s) (Alphabetically)	**Dr. Neha Singhal**	

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
CO1	explain basic concepts of fuzzy sets and fuzzy relations.	Understanding Level (C2)
CO2	explain the relationship between possibility theory and probability theory along with an overview of fuzzy probability theory.	Understanding Level (C2)
CO3	apply fuzzy mapping and fuzzy rule-based models for function approximation.	Applying Level (C3)
CO4	examine fuzzy sets in decision making and multi criteria analysis.	Analyzing Level (C4)
CO5	analyze fuzzy relational data bases and fuzzy queries in crisp databases.	Analyzing Level (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**

1.	**Basic Concepts of Fuzzy Sets**	Motivation, fuzzy sets and their representations, membership functions and their designing, types of fuzzy sets, operations on fuzzy sets, convex fuzzy sets, alpha level cuts, Zadeh's extension principle, geometric interpretation of fuzzy sets.	**4**
2.	**Fuzzy Relations**	Fuzzy relations, projections and cylindrical extensions, fuzzy equivalence relations, fuzzy compatibility relations, fuzzy ordering relations, composition of fuzzy relations.	**4**
3.	**Fuzzy Arithmetic**	Fuzzy numbers, arithmetic operations on fuzzy numbers.	**3**

4.	**Fuzzy Logic**	Fuzzy propositions, fuzzy quantifiers, linguistic variables, fuzzy inference.	**3**
5.	**Possibility Theory**	Fuzzy measures, possibility theory, fuzzy sets and possibility theory, possibility theory versus probability theory.	**5**
6.	**Probability of a fuzzy event**	Baye's theorem for fuzzy events, probabilistic interpretation of fuzzy sets.	**4**
7.	**Fuzzy Implications and Approximate Reasoning**	Fuzzy mapping rules and fuzzy implication rules. fuzzy rule-based models for function approximation, types of fuzzy rule-based models (the Mamdani, TSK, and standard additive models).	**7**
8.	**Decision making in Fuzzy environment**	Fuzzy decisions, fuzzy linear programming, fuzzy multi criteria analysis, multi-objective decision making.	**7**
9.	**Fuzzy databases and queries**	Introduction, fuzzy relational databases, fuzzy queries in crisp databases.	**5**
		Total number of lectures	**42**

Evaluation Criteria

Components Maximum Marks
T1 20
T2 20
End Semester Examination 35
TA 25 (Quiz, Assignments, Tutorials)
Total 100

Project based learning: Students will be divided in the group of 2-3 students to collect the literature report and submit a report on applications of fuzzy decision making and explanation on probability and possibility theory.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**J. Yen and R. Langari,** Fuzzy Logic: Intelligence, Control, and Information, Pearson Education, 2003.
2.	**G. J. Klir, and B. Yuan,** Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice-Hall of India, 1997.
3.	**H. J. Zimmermann,** Fuzzy Set theory and its Applications, Kluwer Academic Publ, 2001.
4.	**A. K. Bhargava,** Fuzzy Set Theory Fuzzy Logic and Their Applications, S. Chand Publ., First Edition, 2013.
5.	**M. Ganesh,** Introduction to Fuzzy Sets and Fuzzy Logic, PHI Learning Private Limited, 2012.