JIWAJI UNIVERSITY, GWALIOR (M.P.)

School of Mathematics and Allied Sciences

The School of Mathematics and Allied Sciences (SOMAAS), established in 1978, is an internationally recognized centre of Biomathematics and a well-known centre for imparting higher education in the field of mathematical modeling and computer science. With the growth of allied sub disciplines like Mathematical Modeling, Mathematical Ecology, Mathematical Epidemiology, Numerical Methods etc. the school has developed a multidisciplinary research group. The School started M.Sc. (Mathematics), M.Phil. (Mathematics) & Ph. D. (Mathematics) programs and later on, it started M.Sc. Computer Sciences program also.

The faculty and research scholars of the department have received various awards and fellowships such as common wealth fellowship, BOYSCAST fellowship, M.P. Young Scientist awards of M.P.C.S.T., DST women's Fellowship. The faculty visited various foreign countries such as England, U.S.A. Italy and Thailand. The faculty has published many research papers in reputed International and National Journals with impact factors. The faculty has supervised more than 70 Ph.D. Students and about 100 M.Phil. Students.

THRUST AREAS

TEACHING

Modern Algebra
Mathematical Biology
Real Analysis
Wavelet Theory
Numerical Methods
Differential Equations
Special Functions
Advanced Mathematical Statistics

THE SCHOOL IS RUNNING FOLLOWING PROGRAMMES:

M. Sc. Mathematics (CBCS)
M.Sc. Computer Science (CBCS)
M. Phil. Mathematics
Ph.D. (Mathematics)

The School of Mathematics & Allied Sciences offers Ph. D. Program in various streams of Mathematics and Computer Science with an emphasis on Biomathematics/ Bio-systems.

Following are the thrust areas of research:

- **Mathematical Study of Bio-Diffusion.**
- **Mathematical Modeling in Population Dynamics.**
- **Mathematical Modeling of Communicable diseases.**
- **Lie theory and Special Functions.**
- **Fractional Calculus.**
- **Basic Hyper geometric Function.**
- **Air Pollution Modeling.**
- **Theoretical Computer Science.**
- **Mathematical Eco-toxicology.**
- **Mathematical Ecology.**

M.Sc.(Mathematics) Programme

[Program Outcomes (POs), Program Specific Outcomes (PSOs), and Course Outcomes (COs)]

Program Outcomes (POs)

• Inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.

• Equip the student with skills to analyze problems, formulate a hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.

• Prepare students for pursuing research or careers in industry in mathematical sciences and allied fields

• Imbibe effective scientific and/or technical communication in both oral and writing.

• Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematical sciences.

• Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges.

Program Specific Outcomes (PSOs)

PSO1: Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them.

PSO2: Inculcate mathematical reasoning.

PSO3: Prepare and motivate students for research studies in mathematics and related fields.

PSO4: Provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains.

PSO5: Provide advanced knowledge on topics in pure and applied mathematics, empowering the students to pursue higher degrees at reputed academic institutions.

PSO6: Train students in the area of Mathematical modeling specific to population dynamics ,epidemiology , ecotoxicology and immunology.

PSO7: Provide skill based knowledge in the field of Mathematical Biology.

.**PSO8**: Nurture problem solving skills, thinking, creativity through assignments, project work.

PSO9: Assist students in preparing (personal guidance, books) for competitive exams e.g. NET, GATE, etc.

Course Outcomes (COs)

101 (Advanced Abstract Algebra)

Students after studying this course are expected:

CO1: To understand group theory and existence of subgroup of group by Sylow's theorem

CO2: To know about modules and their types including fundamental structure theorem.

CO3: To get acquainted with field theory and understand Splitting field.

CO4: To know Galois group and understand fundamental theorem of Galois theory.

CO5: To apply linear transformation and know about Jordan normal form.

102 (Analysis)

Students after studying this course are expected:

CO1: To have in depth knowledge of metric spaces and its various properties.

CO2: To know about Riemann- Stieltjes integral and its various properties.

CO3: To be able to handle the convergence of sequence and series of functions.

CO4: To understand measure theory starting with Lebesgue outer measure.

CO5: To know about Lebesgue integral and various theorems like Monotone Convergence theorem, Lebesgue Convergence theorem etc.

103 (Integral Transforms)

Students after studying this course are expected:

CO1: To get acquainted with the notion of Laplace Transform, related properties and techniques.

CO2: To apply the Laplace Transform for solving the initial value problems and integral equations.

CO3: To use the method of Laplace Transform in finding out the solution of Heat equation, Wave equation and Laplace equation

CO4: To know about Fourier Transform, their properties and application oriented theorems.

CO5: To learn how to find out the Fourier Transforms of derivatives.

CO6: To apply Fourier Transform methods to solve initial and boundary value problems including Heat equation, Wave equation and Laplace equation.

104 (Computer Fundamentals And Programming In C)

At the end of the course, a student is expected:

CO1: To be able to describe the organization and operations of a computer processor, primary and secondary memory, peripheral devices and to give computer specifications.

CO2: To be able to illustrate flowchart and algorithm to the given problem.

CO3: To understand basic structure of the C programming, declaration and usage of variables.

CO4: To be able to code, compile, and test C program.

CO5: To develop conditional and iterative statements to write a C program .

CO6: To understand how C++ improves 'C' with Object Oriented features.

CO7: To identify the task in which the numerical techniques learned are applicable and apply them to write programs and hence use computer effectively to solve the task.

201 (Complex Analysis)

Students after studying this course are expected:

CO1: To know about the limit, continuity and differentiability of complex function and understand exponential, trigonometric and Logarithms function.

CO2: To learn complex integration and uses of Cauchy integral formula.

CO3: To gain knowledge about bilinear transformation and know about the conformal mapping.

CO4: To learn different types of singularity and uses of residue theorem.

202 Differential Equations

Upon successful completion of this course, students are expected:

CO1: To understand the initial valve problems and their applications in biological, physical and engineering dynamical systems.

CO2: To gain knowledge about the existence and uniqueness of solutions of differential equations.

CO3: To understand the differential and integral inequalities and their applications in studying the qualitative properties of solutions of ordinary differential equations.

CO4: To gain knowledge about linear homogeneous system and various properties of the solutions of linear system.

CO5: To understand periodic and inhomogeneous linear systems.

CO6: To determine critical points and to find the qualitative behaviour of the solutions of linear and nonlinear system around the critical points using various methods such as Eigen value method, Liapunov's method.

CO7: To understand bifurcation of fixed points of ordinary differential equation and its different types such as saddle-node, transcritical, pitchfork and hopf-bifurcations .

CO8: To determine bifurcation parameter of a system which causes qualitative changes in solutions of differential equations.

203 (Toplogy)

Students after studying this course are expected:

CO1: To understand topological spaces and have a grasp on basic results.

CO2: To know about homeomorphism and countability of topological spaces.

CO3: To learn about connected spaces and components of topological spaces.

CO4: To know about compact spaces and its various theorems.

CO5: To gain knowledge about Hausdorff, Regular and Normal spaces.

204 (Numerical Methods)

Students after studying this course are expected:

CO1: To learn about numerical solutions of first degree algebraic, transcendental and polynomial equations using the iterative methods and their rate of convergence.

CO2: To study basic knowledge of matrices and learn about numerical solutions of system of linear algebraic equations using direct and indirect methods.

CO3: To understand the knowledge of interpolation, approximations and finite difference operators. Also, learn about interpolating polynomials and their truncation error bound.

CO4: To gain the knowledge of numerical differentiation and numerical integration in given range of intervals.

CO5: To learn about numerical solutions of ordinary differential equations using certain methods.

301(Functional Analysis)

Students after studying this course are expected:

CO1: To gain knowledge about sets, spaces and continuous functions.

CO2: To understand norm, normed linear spaces and basic properties of finite dimensional normed linear space.

CO3: To acquire sufficient knowledge about uniform boundedness, open and closed graph theorems for real and complex linear spaces.

CO4: To know about Structure and Reflexivity of Hilbert spaces and to gain knowledge about orthonormal and complete orthonormal sets.

CO5: To study various operators and establish results like; Fundamental theorem on Variational calculus and in Bilinear forms.

302 (Integral Equations and Boundary Value Problems)

Students after studying this course are expected:

CO1: To study integral equation and their classification.

CO2: To learn solution of Fredholm integral equation with separable kernel and understand resolvent kernel.

CO3: To learn conversion of initial value problem to Volterra integral equation and boundary value problem to Fredholm integral equation and also vice versa.

CO4: To learn orthonormal system of function and understand Hilbert Schmidt theorem.

CO5: To learn Green's function by which differential equation is reduced to integral equation.

303 (Operation Research)

Upon successful completion of this course, students are expected:

CO1: To identify the scope of operation in different disciplines and also learn the formulation and finding of solution of LPP.

CO2: To learn the formulation and techniques of optimal solution of transportation and assignment problem.

CO3: To learn the method for determining the sequence of jobs, which minimizes the total elapsed time and also to optimize the outcome in production using replacement policy.

CO4: To learn the construction of networks of a project and determine the critical path in project management.

CO5: To understand the usage of game theory.

CO6: To understand the applications of queuing theory.

304(Mathematical Biology)

Students after studying this course are expected:

CO1: To understand modeling and perform stability analysis of single species continuous and discrete population models, to model and perform stability analysis of effect of delays in continuous time population models. Also learn about the effects of age structures on the growth

of a single species population and the effect of harvesting with an application to fishery population management.

CO2: To study modeling and stability analysis of the effects of the interaction of two or more populations for three types of interactions- Prey-Predator, Competition and mutualism (symbiosis).

CO3: To gain knowledge of mathematical modeling and analysis of basic epidemiological models of infectious diseases-SI, SIS, SIR and SIRS epidemic models. Also learn about modeling and analysis of venereal diseases and multi-group epidemiological models. Gonorrhea, AIDS and HIV transmission models are also studied as an application part.

CO4: To gain skills on modeling and analysis of compartmental systems with continuous and discrete transfers. Also learn about modeling single species population in discrete time settings with logistic growth and discrete delay as special focus and solution by Eigen value analysis.

CO5: To gain knowledge of elementary pharmacokinetics with an ability to use tracer methods in physiological models; to formulate and study the bath-tub model and continuous time infusion in compartments. Also learn the techniques of parameter estimation in two- compartment models in homogeneous and non-homogeneous cases with their applications.

305 (Advanced Numerical Methods)

Students after studying this course are expected:

CO1: To understand basic concepts of difference calculus and difference equations.

CO2: To know about finite difference approximations to partial derivatives.

CO3: To learn about Elliptic equations and numerical solution to Laplace and Poisson equations.

CO4: To know about Parabolic equations and numerical solution to diffusion and heat equations.

CO5: To gain knowledge about Hyperbolic equations and numerical solution to one-dimensional wave equations.

CO6: To understand variational finite element method for its applications.

401(Partial Differential Equations)

Students after studying this course are expected:

CO1: To gain an overall understanding of partial differential equations of first order and their solutions.

CO2: To learn classification of second order partial differential equations, canonical forms, boundary value problems, properties of harmonic functions and separation of variables method.

CO3: To understand Elliptic Differential Equations-Laplace and Poisson's equations with Dirichlet's and Neumann's problems in different geometrical conditions in Cartesian, cylindrical and spherical co-ordinate systems with various examples.

CO4: To understand Parabolic Differential Equations-Heat equation and Diffusion equation and corresponding boundary conditions. Also learn to solve diffusion equation using elementary solution techniques, Dirac delta functions and variable separation under different type of boundary conditions in different co-ordinate systems- Cartesian, cylindrical and spherical.

CO5: To understand Hyperbolic Differential Equations- Wave equations, the methods of canonical reduction of one dimensional wave equations, initial value problems and the D'Alemberts solutions. Also learn to apply the knowledge of hyperbolic partial differential equations to formulate and solve the vibrating string problems in homogeneous and non-homogeneous cases using the method of separation of variables.

402 (Wavelets)

Students after studying this course are expected:

CO1: To gain basic knowledge of Haar Wavelet transform and its inverse in various dimensions.

CO2: To apply wavelet theory in noise reduction, data compression etc. To know about Daubechies Wavelet transform.

CO3: To learn orthogonal projection and apply it in computer graphics. To understand discrete and fast fourier transform with inverse and applications.

CO4: To know about fourier series for periodic functions, its convergence, uniform convergence and inversion.

CO5: To gain knowledge about Fourier transform, its convolution and inversion.

403 (Mathematics of Finance and Insurance)

Students after studying this course are expected:

CO1: To gain knowledge about elements of theory of interest and probability theory.

CO2: To know about life insurance and its models including expenses.

CO3: To have basic knowledge of financial markets, stocks and bonds.

CO4: To have basic knowledge of stochastic calculus and its integration.

CO5: To learn about binomial model and Black Scholes option pricing model.

404 (Advanced Mathematical Statistics)

Students after studying this course are expected:

CO1: To know about the central tendencies and understand correlation and regression.

CO2: To learn basics of probability and different types of probability distribution.

CO3: To gain knowledge about the Estimators and Cramer - Rao Inequality.

CO4: To apply parametric and non- parametric test on population /sample.

CO5: To learn about one-way and two- way classification of variance.

405 (Discrete Mathematical Structures)

Upon successful completion of this course, students are expected:

CO1: To understand lattices, Boolean algebra, Boolean function and also to do the simplification of Boolean expressions using the properties of Boolean algebra.

CO2: To learn mathematical induction technique to prove hypotheses, and how sequences can be defined recursively and also to find the solution of linear recurrence relations and their generating functions.

CO3: To understand the concept of fuzzy sets, to know the types of fuzzy sets and basic operations on fuzzy sets.

CO4: To understand fuzzy relation and composition of fuzzy relations, to perform operations with fuzzy relations, and to apply fuzzy logic in different situations.

CO5: To understand the basic concepts of graphs, directed graphs, weighted graphs, Eulerian graphs, Hamiltonian graph, representation of graph by matrices, properties of trees and also be able to find a minimal spanning tree for a given weighted graph.

406 (Special Functions)

Students after studying this course are expected:

CO1: To learn the basic knowledge about series, their convergence, absolute convergence and uniform convergence.

CO2: To understand hypergeometric functions, hypergeometric differential equations and their generalizations.

CO3: To study various polynomials like; Legendre, Hermite, Laguerre and to establish their properties like, orthogonality, three term recurrence relation and Rodrigues formula.

CO4: To evaluate certain infinite products, Legendre's duplication formula, Gauss multiplication theorem and the behaviour of Euler's Beta and Gamma functions.

CO5: To have deep knowledge of Generating, exponential and binomial functions.

MSC (Computer Science)Programme

[Program Outcomes (POs), Programme Specific Outcomes (PSOs), and Course Outcomes (COs)]

Programme Outcomes (POs)

The M.Sc. Computer Science programme at our university (SOS) aims to inculcate a scientific mindset with specialist technical cognizance, enabling students to analyze, design, validate and implement ICT systems in their operational context. Students of the Post Graduate are trained to take a scientific, ethical and gregariously responsible approach for conducting and contributing to research in their categorical area of study.

Prominent attributes of this course are:

- ToDesign and develop computer software systems and products based on sound theoretical principles and solid software development skills.
- To Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
- Preparing students for careers as computer professionals in industry, government and academia.
- Advance the quality and impact of research with educational experience for student's career development, and professional growth in order to sustain in lifelong learning.
- Qualify for development-oriented outcome and prepare them for independent growth and progressive careers as IT professionals.

Programme Specific Outcomes (PSOs)

Course of study of Computer Science is designed to engender post graduates to procure the following program specific outcomes:

PSO1: To obtain sound knowledge of theory, principles and applications of computer science concepts.

PSO2: Understand to apply mathematical principles and algorithms in the design and development of system/application software**.**

PSO3: Configure recent software, apply test, and install and manage them on the computer systems.

PSO4: Understand user requirements, design and develop software within cost constraints.

PSO5: Identify, formulate and solve software engineering problems and understand the software project management principles.

PSO6: Well understanding of the computing needs for inter-disciplinary scientific and engineering disciplines.

PSO7: Effective Communication skills (oral, written and graphical) to extend entrepreneurship and leadership expertise.

PO8: Have the capacity to deal with professional, legal, and ethical issues and responsibilities

PO9: Communicate effectively in verbal and in writing including documentation and software systems.

PO10: To understand the impact of scientific solutions related to the environmental economical and social issues.

Course Outcomes (COs)

After studying following subjects, students are expected:

CO1: MCS 101 - Computer Architecture- To learn and understand the concept and their practices at the interface between computer software and hardware which includes (i) representing information in computers (ii) the CPU registers and (iii) assembly language programming.

CO2: MCS 102 - Discrete Mathematics with Data Structure- To learn the notion of mathematical thinking, mathematical proofs, algorithmic thinking, and be able to apply them in the problem solving.

To understand asymptotic notation and its significance, and to be able to use it for analyze asymptotic performance for the algorithm.

To understand basic properties of graphs and related discrete structures are be able to relate these to practical examples.

To explain and apply the basic methods of discrete (non continuous) mathematics in Computer Science and use these methods in subsequently in the design and analysis of algorithms, computability theory, software engineering, and computer systems.

To understand how the choice of data structures and algorithm design methods impacts the performance of programs.

To learn mathematical concepts about basic data types and structures (such as numbers, sets, graphs, and trees) used in computer algorithms and systems; distinguish rigorous definitions and conclusions from merely plausible ones; synthesize elementary proofs, especially proofs by induction.

To model and analyze computational processes using analytic and combinatorial methods.

To learn and choose the appropriate data structure and algorithm design method for a specified application.

To solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps tournament trees, binary search trees, and graphs and writing programs for these solutions.

To understand problems solving approach using algorithm design methods such as the greedy method divide and conquer, dynamic programming, backtracking and writing programs for these solutions.

CO3: MCS 103 - Operating System- To develop understanding for contrasting and comparing among the different structures for operating systems.

To understand and analyze theory and implementation of: processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and files.

CO4: MCS 104 - Object Oriented Programming with C++- To understand the difference between object oriented programming and procedural programming.

To understand the features of C++ supporting object oriented programming concepts.

To understand the merits of C++ as an object oriented programming language.

To learn program using more advanced C++ features such as composition of objects, operator overloads, dynamic memory allocation, inheritance and polymorphism, file I/O, exception handling, etc.

Learn to build C++ classes using appropriate encapsulation and design principles.

To understand implementation of object-oriented concepts (encapsulation, inheritance and polymorphism) in C++, programs.

CO5: MCS 201 - Computer Oriented Numerical & Statistical Methods- Numerical Methods/Statistics course consisting of two main components: Numerical Methods and Statistics.

In the numerical methods component, students learn to derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.

To understand common numerical methods and how they are used to obtain approximate solutions for mathematical problems.

To learn and apply numerical methods for obtain approximate solutions to mathematical problems.

In the statistical component, students learn descriptive statistics, inferential statistics, linear regression and correlation.

CO6: MCS 202 - Software Engineering- Learn to develop a broad understanding of the discipline of software engineering.

To understand the concepts and methods required for the construction of large software systems.

To develop skills that will enables to construct software of high quality – software that is reliable, and that is reasonably easy to understand, modifiable and maintainable.

CO7: MCS 203 - Database Management System- To understand and evaluate the roles of database management systems in information technology and applications.

To recognize logical design methods and tools for databases, derive a physical design for a database from its logical design; and implement a database solution to an information technology problem.

To understand the SQL data definition and SQL query languages and to develop sophisticated queries to extract information from large datasets.

To write SQL commands to create tables and indexes, insert/update/delete data, and query data in a relational DBMS.

To model an application's data requirements using conceptual modeling tools (e.g. ER diagrams) and design database schemas based on the conceptual model.

CO8: MCS 204 - Computer Networks- To understand the general principles of data communication, how computer networks are organized with the concept of layered approach, describe how signals are used to transfer data between nodes.

To learn Implementation of a LAN with hubs, bridges and switches, describe how packets in the Internet are delivered and analyze the contents in a given Data Link layer packet, based on the layer concept.

To design logical sub-address blocks with a given address block, decide routing entries given a simple example of network topology, describe what classless addressing scheme is, and describe how routing protocols work.

Learn to design and implementation of a network protocol.

CO9: MCS 301-Theory of Computation- To understand the mathematical foundations of, computation, automata theory, the theory of formal languages and grammars, the notions of algorithm, decidability, complexity, and computability.

Learn to understand and conduct mathematical proofs for computation and algorithms.

CO10: MCS 302 - Object Oriented Programming with JAVA- To understand the object-oriented approach in programming with JAVA and to analyze and design a computer program to solve real world problems based on object-oriented principles.

To write computer programs to solve real world problems in Java, to learn and appreciate the importance and merits of proper comments in source code and API documentations.
To understand GUI interfaces for a computer program to interact with users, and to understand the event-based GUI handling principles.

CO11: MCS 303 - Techniques of Operation Research- To learn quantitative tools and techniques, which are frequently applied to business decision-making and to provide a formal quantitative approach to problem solving and an intuition about situations where such an approach is appropriate.

To define and formulate linear programming problems and appreciate their limitations, solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action and conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship.
To develop mathematical skills to analyze and solve integer programming and network models arising from a wide range of applications.

CO12:MCS 304 - Algorithm Design - Algorithms are the core of most technologies used in contemporary computers. Practical applications of algorithms are ubiquitous. This subject introduces the fundamental techniques for designing and analyzing algorithms, including asymptotic analysis; divide-and-conquer algorithms, greedy algorithms, dynamic programming, multithreaded algorithms, number-theoretic algorithms and RSA cryptosystem, NP-completeness, and approximation algorithms. This senior-level course emphasizes techniques for constructing efficient algorithms and for analyzing the efficiency of an algorithm. Upon successful completion of this subject, learners will be able to:

- Describe the major modern algorithms and selected techniques that are essential to today's computers.
- Identify the key characteristics of a given problem and analyze the suitability of a specific algorithm design technique for the problem.
- Apply the algorithms and design techniques to solve problems, and mathematically evaluate the quality of the solutions, typically using the following algorithms:
    - ✓ dynamic programming
    - ✓ greedy method
    - ✓ Divide & Conquer method
    - ✓ multithreaded
    - ✓ number-theoretic
    - ✓ approximation
- Analyze NP-complete problems and develop algorithms to solve the problems.
- Implement a solution for a given problem and algorithm in high-level programming languages.

CO13:MCS 305 - Modeling and Simulation - This subject is designed to introduce the basic concepts of system modeling and computer simulation. The process and methodology of using simulation for problem solving and decision making are emphasized. Simulation language Arena will be used as a tool for model building. Students will be required to apply the modeling techniques to a real world problem through a term project. Advances in simulation research and development will be explored through reference reading, class discussion and team presentation. Upon completion of this subject, students will be able to complete the following key tasks:

- Define basic concepts in modeling and simulation (M&S).
- Classify various simulation models and give practical examples for each category.
- Construct a model for a given set of data and motivate its validity.
- Generate and test random number variates and apply them to develop simulation models.
- Analyze output data produced by a model and test validity of the model.
- Explain parallel and distributed simulation methods.

CO14: MCS 306 - Programming in HTML, CSS & PHP- To learn the use of HTML and CSS code, an HTML editor to create personal and/or business websites following current professional and/or industry standards and critical thinking skills to design and create websites.

To learn writing PHP code to produce outcomes and solve problems, display and insert data using PHP and MySQL, and test, debug, and deploy web pages containing PHP and MySQL.

CO15:MCS 307- Artificial Intelligence – The objective of the subject is to present an overview of artificial intelligence (AI) principles and approaches. Develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents: Search, Knowledge representation, inference, logic, and learning. Students will implement a small AI system in a team environment. The knowledge of artificial intelligence plays a considerable role in some applications students develop for courses in the program. Upon successful completion of this subject, learners will be able to:

- Understand the various searching techniques, constraint satisfaction problem and example problems- game playing techniques.
- Apply these techniques in applications which involve perception, reasoning and learning.
- Explain the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.
- Acquire the knowledge of real world Knowledge representation.

- Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.
- Use different machine learning techniques to design AI machine and enveloping applications for real world problems.

CO16: MCS 401- Systems Programming- To understand the designing and writing of computer programs that allow the computer hardware to interface with the programmer and the user, leading to the effective execution of application software on the computer system.

To learn system programs including the operating system and firmware, programming tools such as compilers, assemblers, I/O routines, interpreters, scheduler, loaders and linkers as well as the runtime libraries of the computer programming languages.

CO17: MCS 402 - Computer Graphics- To understand the principles of computer graphics and modeling 3D objects and efficiently generating photorealistic renderings on color raster graphics devices.

To learn the various elements that underlie computer graphics (algebra, geometry, algorithms and data structures, optics, and photometry) interact in the design of graphics software systems.

CO18: MCS - 403 Neural Network-To learn neuron models: McCulloch-Pitts model and the generalized one, distance or similarity based neuron model, radial basis function model, multilayer perceptron, distance or similarity based neural networks, associative memory and self-organizing feature map, radial basis function based multilayer preceptor, neural network decision trees, etc.

To understand learning algorithms: the delta learning rule, the back propagation algorithm, self-organization learning, the r4-rule and applications: pattern recognition, function approximation, information visualization, etc.

To understand the neural networks for classification and regression, design methodologies for artificial neural networks, provide knowledge for network tunning and over fitting avoidance, neural network implementations in MATLAB, and demonstrate neural network applications on real-world tasks.

CO19:MCS 404 - Parallel Processing - This subject covers topics such as design methodologies for parallel programming systems, performance of parallel processing systems, and the application of parallel programming for building active-process based, graphical interfaces. Emphasis will be given to practical case studies of parallel programming scenarios and solutions. After successful completion of this subject the learner will be able to:

- Analyze the requirements for programming parallel systems and critically evaluate the strengths and weaknesses of parallel programming models and how they can be used to facilitate the programming of concurrent systems.

- Discuss the difference between the major classes of parallel processing systems and design software solutions for a number of parallel processing models.
- Design and implement a SIMD and MIMD parallel processing solution.
- Analyze the efficiency of a parallel processing system and evaluate the types of application for which parallel programming is useful.

CO20:MCS 405 - Image Processing – This subject is an introduction to the fundamental concepts and techniques in basic digital image processing and their applications to solve real life problems. The topics covered include Digital Image Fundamentals, Image Transforms, Image Enhancement, Restoration and will be familiar with:

- Learning basic digital image representation principals,

  Ability to perform spatial and frequency domain analysis,

- Learning methods involving binary, gray scale and color image representations,

Gaining hands on experience in the use of Matlab. Compression, Morphological Image Processing, Nonlinear Image Processing, and Image Analysis. Application examples are also included for learners.

CO21: MCS 406 - Internet & Web Technology- To understand the historical background and evolution of today's Internet, examine network topologies and models (OSI model).

To develop an understanding of the technological foundations of the Internet and core Internet protocols (TCP/IP, SMTP, FTP, Telnet, ICMP, RSS, and HTTP), understand client/server relationships in the context of the Internet and intranets, and identify important Internet content and graphics formats and understand the access issues they present users and the software they require;

To understand the basic principles of WWW sites planning and creation, basics of sites creation using language HTML, Cascading Style Sheets, Client-side programming, Server-side programming, dynamic Web pages creation, Services creation, which based on databases, languages for description and data representation, Build dynamic web pages using JavaScript (client side programming), web sites testing and publications and also management by it.

To learn web enhancements possible with web programming techniques (ASP, PHP and JavaScript), examine Web 2.0, cloud computing, mobile web in the context of library services and consider current and future web issues and trends.

CO22:MCS 407 - Distributed Computing- Distributed Computing combine the computational power of multiple computers to solve complex problems. The individual computers in a distributed system are typically spread over wide geographies, and possess heterogeneous processor and operating system architectures. Hence, an important challenge in distributed computing is to design system models, algorithms and protocols that allow computers to communicate and coordinate their actions to solve a problem. After successful completion of this subject the learner will be able to:

- Identify distributed system characteristics
- Explain the models for distributed processing and communication
- Develop a simple distributed system
- Analyze distributed algorithms
- Evaluate the performance of distributed systems
- Evaluate the characteristics of a particular distributed system

CO23:MCS 409 - Data Mining and Data Warehousing- This subject provides students with an in-depth understanding of the design and implementation of data warehousing and data mining based systems. It will address the opportunities and challenges of applying data mining techniques in academics, industry, businesses, sciences and the Web. Several aspects of the data mining process are covered in this course such as: data gathering and storage, data selection and preparation, model building and testing, results interpretation and validation and models application. Upon completion of the course, learners will be able to:

- Understand what data mining is and how data mining can be employed and applied to solve real problems.
- Recognize wither a data mining solution is feasible alternative for a specific problem.
- Apply basic statistical to evaluate the results of data mining models.
- Develop a comprehensive understanding of how several data mining techniques can be applied to solve problems.
- Understand the common designs and structures of warehouse systems.

CO24:MCS 410- Bio-informatics - The aim of this subject is to provide learners with an understanding of the concept of bioinformatics and enable them to access genomic and proteomic databases. It will also help learners understand predicted protein structure and drug interaction and explore the techniques involved in aligning DNA and protein sequences. This subject will also acquaint students with the ability to analyze and differentiate between different data sets using web-based software. On successful completion of this subject a learners will be able to:

- Identify genes and proteins within data sets using available databases.

- Demonstrate critical in-depth knowledge of methods for DNA and protein
- Sequence analysis and its application to real datasets.
- Evaluate, predict and interpret the DNA, RNA and protein structure.
- Critically review the application of bioinformatics in biological sciences.
- Input data into the database and design secondary datasets appropriate for specific databases.

M.Phil.(Mathematics) Programme

[Program Outcomes (POs), Program Specific Outcomes (PSOs), and Course Outcomes (COs)]

Program Outcomes (POs)

The aim of M.Phil. (Mathematics) programme is to develop research orientation and inculcate the idea of research in the students in order to motivate them for doing research leading to Ph.D. degree or making their career in research organizations.

Program Specific Outcomes (PSOs)

Curriculum of M.Phil. (Mathematics) is designed to prepare the students to attain the following specific outcomes:

PSO1: An ability to do research in Mathematical Sciences, particularly in Applied Mathematics.

PSO2: Acquire the ability to use Mathematical Software in the analysis of the research problems.

PSO3: Ability to do advanced level research in the area of Mathematical Biology and Special Functions.

Course Outcomes (COs)

CO1: Research Methodology in Mathematical Sciences – The students after doing this course are expected to know problem formulation strategies, interpretation techniques and research paper preparation.

CO2: Computational Techniques using MATLAB Software – From this course, students are expected to use MATLAB in the numerical and quantitative analysis of their research problems.

CO3: Mathematical Ecology – The students are expected to develop and analyse mathematical models for the problems related to population dynamics.

CO4: Mathematical Epidemiology – The students are expected to develop and analyse mathematical models in the area of epidemiological problems.

CO5: Generalized Hyper geometric function – The students are expected to know about Special functions such as H- function, E-function and G- function.

Ph.D. (Mathematics) Programme
[Program Outcomes (POs), Program Specific Outcomes (PSOs), and Course Outcomes (COs)]

Program Outcomes (POs)

Students have/capable of:

- Relevant (taught) courses required for undertaking specialized research.
- Identifying unsolved yet relevant problem in a specific field.
- Articulating ideas and strategies for addressing a research problem.
- Undertaking original research on a particular topic.
- Effectively communicating research, through journal publications and conference presentations, to the mathematics community.
- Disseminating research in a broader perspective.

Program Specific Outcomes (PSOs)

PSO1: Generate publications in reputed mathematical journals.

PSO2: Provide scope for interaction with international researchers and developing collaborations WITH SCIENTIFIC ORGANIZATIONS.

PSO3: Demonstrate the highest standard of ethics in research.

PSO4: Provide opportunities to research students for communication (and discussion) of advanced mathematical topics to undergraduate and graduate students.

PSO5: Produce next generation researchers in mathematics.

Course Outcomes (COs)

Research Methodology

Students those are admitted in Doctor of Philosophy program, after successfully finishing the course, will be capable of:

CO1: Understand, describe and associate terminologies using Research Methodology.
CO2: Correlate various aspects of knowledge presented in an article and formulate opinions about its affirmation.
CO3: Analyze, sample and measure techniques to infer reliability and validity apply data collection techniques using statistical methods.
CO4: Implement Data Mining, Simulation, Optimization, and Modeling Techniques.
CO5: Adopt research ethics practices, formulate and assess survey research, correlation research, experimental research, action research, and qualitative research, Generalize research analysis techniques (e.g., content analysis, computational complexity, discourse analysis, conversational analysis, and longitudinal data analysis) in information sciences.

Review of Literature

After successful completion of review of literature the student will be able:

CO1: To give an overview of the "big issues" in a field of study, to summarize other people's work, to evaluate other people's work, to provide a context for your work, to identify gaps and to develop an understanding of theories and methods used in the field of study.
CO2: To ascertain the effects of co-witness information on the validity of eyewitness testimony.

Computer Applications

After successfully finishing the course, the student will be able:

CO1: to develop specialized computational skills;
CO2: to gain proficiency in working with different software, beneficial for them research studies.

Advance Course in Mathematics

After successfully finishing the course, the student will be able:

CO1: To conduct the stability analysis of linear and nonlinear dynamical systems.
CO2: To solve the partial differential equations arising in several problems related to physical, engineering and biological systems.
CO3: To analyze the different types of Special Functions occurring as solutions of differential equations
CO4: To handle optimization problems related to Inventory, Transportation and Assignment .To analyze Markov process and Markov chains.