Course Title with Credit Load
Ph.D. in Computer Application

Course Code	Course Title	Credit Hours	Semester
*MCA 601	Spatial Informatics, GIS and Remote Sensing	1+1	I
*MCA 602	Introduction to Computer Graphics	1+1	I
*MCA 611	Computer Oriented Numerical Analysis	2+1	II
*MCA 612	Artificial Intelligence and Machine Learning	2+1	II
*MCA 615	Bioinformatics Computing	2+0	II
MCA 691	Seminar I	0+1	I/II
MCA 692	Seminar II	0+1	I/II
MCA 699	Research	0+75	II-VI
MCA 603	Simulation and Modeling	1+1	I
MCA 604	Introduction to Big Data	2+1	I
MCA 605	Introduction to Iot	2+1	I
MCA 606	Management Information Systems	2+0	I
MCA 613	Multimedia And its Applications	1+1	II
MCA 614	Knowledge Based Systems for Semantic Web	1+1	II

* Core Course

Course Contents
Ph.D. in Computer Application

I. Course Title : **Spatial Informatics, GIS and Remote Sensing Techniques**

II. Course Code : **MCA 601**

III. Credit Hours : **1+1**

IV. Aim of the course

The basic objective of this course is to teach concepts of GIS and remote sensing with specific applications in agriculture related statistics.

V. Theory

Unit I

Introduction to Geographical Information System (GIS); Introduction- maps and spatial information, components of a GIS; GIS Internals - data representation-raster and vector data structures and analysistechniques.

Unit II

Digital Elevation Models; Data input, verification, storage and output.

Unit III

Spatial modelling- manual and automatic digitizing process; Data errors in GIS; Classification methods-multivariate analysis and classification.

Unit IV

Spatial interpolation; Current and potential uses of GIS in agricultural planning; Software components used in GIS; GIS in India.

Unit V

Physics of remote sensing, atmospheric effects and remote sensing sensors; Spectral signatures of earth surface features, spectral characteristics of vegetation, soil and water.

Unit VI

Data acquisition system, satellite image acquisition; Data collections: pre- processing and data storage; Visual and digital image interpretation; Digital image processing.

VI. Practical

- Digitization of a map with the help of a digitizer;
- Map editing;
- Geo- referencing and map projections;
- Creation of attribute database and linking with spatial data;
- General analysis of the data with the help software;
- Applications of digital elevation models using GIS;
- Spatial interpolations using GIS;
- Visual interpretations of remote sensing data;

- Geometric corrections of remote sensing digital data;
- Methods for improving quality of digital data and Techniques of image classifications.

VII. Suggested Reading

- Annadurai S and Shanmugalakshmi R. 2007. *Fundamentals of Digital Image Processing.* Pearson Edu.
- Burrough P.A. 1986. *Principles of Geographic Information System for Land Resources Assessment.* Oxford Univ. Press.
- Curran P.J. 1985. *Principles of Remote Sensing.* Longman.
- Jensen J.R. 2017. *Introductory Digital Image Processing.* 4th Ed. Prentice Hall.
- Lillesand T.M. and Kiefer R.W. 1987. *Remote Sensing and Image Interpretation.* John Wiley.
- Peuquet D.J. and Marble D.F. 1990. *Introductory Readings in Geographic Information System.* Taylor & Francis.

I. Course Title	: Introduction to Computer Graphics
II. Course Code	: MCA 602
III. Credit Hours	: 1+1

IV. Aim of the course

This course examines the principles of computer graphics, with a focus on the mathematics and theory behind 2D and 3D graphics rendering.

V. Theory

Unit I

Introduction, Application of Graphics, Elements of Graphics Workstation, Graphics I/P Devices; Development of computer graphics: Basic graphics system and standards.

Unit II

Raster scan and random scan graphics; Continual refresh and storages displays; Display processors and character generators; Colour display techniques.

Unit III

Frame buffer and bit operations, Concepts in raster graphics; Points, Lines and Curves; Scan conversion; Line-drawing algorithms; Circle and ellipse generation; Polygon filling; Conic-section generation.

Unit IV

Antialiasing; Two-dimensional viewing: Basic transformations; Co- ordinate systems; Windowing and clipping; Segments; Interactive picture- construction techniques; Interactive input/output devices.

Unit V

Three-dimensional concepts: 3-D representations and transformations; 3-D viewing; Algorithm for 3-D volumes, Spline curves and surfaces.

Unit VI

Fractals; Quadtree and Octree data structures; Hidden line and surface rendering and animation.

VI. Practical

- Implementation of algorithms for drawing geometrical figures, rotation, charts;

- Pixel handling on screen;
- Clipping – Line clipping – Polygon Clipping, Windowing;
- Use of primitive transformations and/or their combinations;
- Implementation of 3D Object Representation and Fractal programming and animation.

VII. Suggested Reading

- Hearn D and Baker M.P. 2004. *Computer Graphics*. Prentice Hall of India. Marshal G. 1983. *Programming with Graphics*. Granada Publ.
- Newman W.M. and Sproull R.F. 1981. *Principles of Interactive Computer Graphics*. McGrawHill.
- Prince D.M. 1979. *Interactive Graphics for Computer Aided Design (CAD)*. Addison Wesley.
- Rogers D.F. 2001. *Procedural Elements in Computer Graphics*. McGraw Hill.
- Shalini G.P. 2010. *Principles of Computer Graphics: Theory and Practice Using OpenGL and Maya*. McGraw Hill.

I. Course Title	: **Simulation and Modeling**
II. Course Code	: **MCA 603**
III. Credit Hours	: **1+1**

IV. Aim of the course

The courses aim at teaching simulation and modeling technique for conducting experiments on models that describe the behaviour, uncertainty and structure of real world systems. This course will help in simulation of agricultural research problems and systems.

V. Theory

Unit I

Uses and purposes of simulation; Classification of models.

Unit II

Generation and testing of random numbers.

Unit III

Simulation of stochastic events and processes, Discrete event simulation.

Unit IV

Design of simulation experiments. Analysis of data generated by simulation experiments. Verification and validation of simulation models.

Unit V

Simulation languages.

Unit VI

Simulation of agricultural problems and systems.

VI. Practical

- Generation of random numbers;
- Testing randomness of generated random numbers;
- Generation of random variates following Normal, Beta, Gamma, Exponential, Chi-square, Student's-t, F, Weibull, Binomial, Poisson distributions with the given parameters;

- Discrete event simulation and Simulation from specific models applicable in agriculture.

VII. Suggested Reading

- Averill M.L. and Kelton D. 2005. *Simulation, Modelling and Analysis*. Tata McGraw Hill.
- Banks J. 1998. *Handbook of Simulation*. John Wiley.
- Brately P, Fox B.L. and Scharge LE. 1987. *A Guide to Simulation*. Springer.
- Deo N. 1987. *System Simulation with Digital Computer*. Prentice Hall of India.
- Gentle G.E. 2005. *Random Number Generation and Monte Carlo Methods*. Springer.
- Gordan G. 2007. *System Simulation*. Pearson Edu.
- Kennedy W.J. and Gentle J.E. 1980. *Statistical Computing*. Marcel Dekker.
- Press W.H., Flannery B.P., Tenkolsky S.A. and Vetterling W.T. 1986. *Numerical Recipes: The Art of Scientific Computing*. Cambridge Univ. Press.
- Ripley B.D. 1987. *Stochastic Simulation*. John Wiley.
- Taha H.A. 2003. *Operations Research: An Introduction*. Prentice Hall of India.

Course Title	: **Introduction to Big Data**
Course Code	: **MCA 604**
Credit Hours	: **2+1**

Aim of the course

This course provides exposure to different aspects of use of big data in agriculture and industrial research. It helps in providing information about the analysis procedure for Big data.

Theory

Unit I

Introduction to Big Data; Big Data Foundations, Components of big data infrastructure; Hadoop; Spark 2.0, installation, Hadoop Distributed File System, reading and processing Big data

Unit II

Introduction to MapReduce, Algorithms for common problems; NoSQL, Scripting

Unit III

Data visualization and mining big data

Unit IV

Processing streaming data, text and natural language processing

Suggested Reading

- Davenport T.H. 2016. *Big Data at Work: Dispelling the Myths, Uncovering the Opportunities*. Kindle Ed.
- Maheshwari A. 2018. *Data Analytics Made Accessible*. Kindle Ed.
- Simon P. 2018. *Too Big to Ignore: The Business Case for Big Data*, Wiley and SAS Business Series
- Schönberger V.M. and Cukier K. 2015. *Big Data: A Revolution That Will Transform How We Live, Work, and Think*, Kindle Ed.

I. Course Title	: **Introduction to Internet of Things**
II. Course Code	: **MCA 605**
III. Credit Hours	: **2+1**

IV. Aim of the course

This course provides exposure to different aspects of research, implementation,

and business with IoT. It also deals withchallenges and techniques for building different IoT solutions. IoT-based applications such as innovative shopping system, infrastructure management in both urban and rural areas, remote health monitoring and emergency notification systems, and transportation systems.

V. Theory

Unit I

Introduction to IoT: Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-Machine Communications

Unit II

Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry, Implementation of IoT with Raspberry.

Unit III

Introduction to SDN, SDN for IoT, Data Handling and Analytics, Cloud Computing, Sensor-Cloud.

Unit IV

Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT.

VI. Practical

- Case Study: Agriculture, Healthcare, Activity Monitoring

VII. Suggested Reading

- Raj P. and Raman A.C. 2017. *The Internet of Things: Enabling Technologies, Platforms, and Use Cases*, CRC Press.
- Bahga A. and Madisetti V. 2017. *Internet of Things: A Hands-on Approach*, Universities Press.

I. Course Title	:	**Management Information System**
II. Course Code	:	**MCA 606**
III. Credit Hours	:	**2+0**

IV. Aim of the course

This course provides exposure to challenges and techniques for management Information Systems. The course deals with theoretical aspects on how to manage the information systems.

V. Theory

Unit I

Information Systems in Global Business – Role of Information Systems in Business; Emergence of Digital Firms, Perspectives on Information Systems.

Unit II

Business Processes and Information Systems; how Information Systems improve Businesses; Types of Information Systems – Transaction Processing Systems; Management Information Systems; Decision Support Systems; Executive Information System.

Unit III

Organizations and Information Systems – Impact of Information System on organization –Economic, Organization and behavioral impacts; Competitive Advantages using Information Systems.

Unit IV

Enterprise wide Applications – ERP, CRM, Business Intelligence, Collaboration Tools and its use; E-Commerce; Social Media; Ethical Issues, privacy and regulations.

VI. Suggested Reading

- Amoroso E. 1994. *Fundamentals of Computer Security Technology.* Prentice-Hall.
- Bhushan M. 2017. *Fundamentals of Cyber Security* Prentice Hall.
- Chapman B & Zwicky ED. 2000. *Building Internet Firewalls.* O'Reilly.

I. Course Title	: **Computer Oriented Numerical Methods**
II. Course Code	: **MCA 611**
III. Credit Hours	: **2+1**

IV. Aim of the course

This is a course on computer oriented numerical methods that aims at exposing the students to introduce numerical algorithms and to solve mathematical problems using numerical approximations

V. Theory

Unit I

Errors in computations: Basic concepts: Floating point number system, Implication of finite precision, Rounding off errors

Unit II

Finite Differences, Interpolation: Polynomial interpolation, Inverse interpolation, Spline interpolation; Numerical integration: Trapezoidal rule, Simpson's 1/3rd and 3/8th rules; Ordinary differential equations: Runge-Kutta methods, Predictor - correctormethods.

Unit III

Linear system of equations: Gaussian's elimination, Operation counts, Implementation including pivoting and scaling, Direct factorization methods, Iterative techniques and their analysis.

Unit IV

Linear Difference equations; Non-linear equations: Bisection, Newton Raphson, false positions, Secant methods, Iterative methods.

Unit V

Inverse of Matrices; Computation of Eigen values and Eigen vectors: Error estimates, the power methods – Jaccobi and Householder Method.

VI. Practical

- Solving polynomial and algebraic equations using numerical approximations, finding minimum and maximum of functions;
- Inversion of matrices, rank of a matrix,

- Choleskey Decompositions,
- Structural Value Decomposition and Eigen Values.

VII. Suggested Reading

- Atkinson K.E. and Han W. 2003. *Elementary Numerical Analysis*. 3rd Ed. John Wiley.
- Atkinson K.E. 1978. *An Introduction to Numerical Analysis*. John Wiley.
- Jain M.K., Iyengar S.R.K. and Jain R.K. 2007. *Numerical Methods for Scientific and Engineering Computation*. 7th Ed. New Age.
- Kennedy W.J. and Gentle J.E. 1980. *Statistical Computing*. Marcel Dekker.
- Krishnamurthi E.V. and Sen S.K. 1986. *Computer-Based Numerical Algorithms*. East West Publ.
- MacMillan. C. 2012. *Elementary Numerical Analysis An Algorithmic Approach:* John Wiley

I. **Course Title**	:	**Artificial Intelligence and Machine Learning**
II. **Course Code**	:	**MCA 612**
III. **Credit Hours**	:	**2+1**

IV. Aim of the course

The primary objective of this course is to provide an introduction to the basic principles and applications of Artificial Intelligence that includes problem solving, knowledge representation, reasoning, decision making, planning, perception & action, and learning.

V. Theory

Unit I

Introduction to Artificial Intelligence (AI); Scope of AI: Games, theorem proving, natural language processing, robotics, expert system.

Unit II

Knowledge: General concept of knowledge, Knowledge based system, Representation of knowledge, Knowledge organization and manipulation, Acquisition of knowledge.

Unit III

Symbolic approach: Syntax and Semantics for Prepositional Logic (PL) and First order predicates logic (FOPL), Properties of well-formed formulas (wffs), Conversion to clausal form, Inference rules, Resolution principle, Non deductive inference methods.

Unit IV

Search and Control strategies: Blind search, Breadth- first search, Depth – First search, Hill climbing method, Best – First search, Branch and Bound search.

Unit V

Learning: Concept of learning, learning automation, genetic algorithms, learning by induction.

Unit VI

Expert System: Introduction to expert system, Characteristics features of expert system, Applications, Importance of Expert system, Rule based system architecture.

VI. Practical

- Search and Control strategies: Blind search, Breadth- first search, Depth – First search, Hill climbing method, Best – First search, Branch and Bound search;

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- Learning by induction;
- Genetic algorithms;
- Case study of a rule based expert system and Construction of Decision tree.

VII. Suggested Reading

- Akerkar R. 2005. *Introduction to Artificial Intelligence*. Prentice-Hall of India.
- Giarratano J. and Riley G. 1998. *Expert Systems - Principles and Programming*. 3rd Ed. PWS Publ.
- Gonzalez A. and Dankel D. 2004. *The Engineering of Knowledge-Based Systems*. Prentice Hall.
- Hill E.F. 2003. *Jess in Action*. Manning Publ.
- Jackson P. 1999. *Introduction to Expert Systems*. Addison Wesley.
- Nilson N.J. 2014. *Artificial Intelligence: A New Synthesis*. Maurgan Kaufman.
- Nilson N.J. 2001. *Principles of Artificial Intelligence*. Narosa.
- Rich E. and Knight K. 2002. *Artificial Intelligence*. Tata McGraw Hill.
- Russell S. and Norvig P. 2003. *Artificial Intelligence: A Modern Approach*. Prentice Hall.

I. Course Title	:	**Multimedia and Applications**
II. Course Code	:	**MCA 613**
III. Credit Hours	:	**1+1**

IV. Aim of the course

This course introduces students to current practices, technologies, methodologies, and authoring systems in the design and implementation of systems that incorporate text, audio, images, animation and full-motion video.

V. Theory

Unit I

Introduction to Multimedia Technology - Computers, communications and entertainment; Framework for multimedia systems.

Unit II

M/M devices, presentation devices and the user interface, M/M presentation and authoring.

Unit III

Digital representation of sound and transmission; Brief survey of speech recognition and generation; Digital video and image compression; JPEG image compression standard; MPEG motion video compression.

Unit IV

DVD technology, Time based media representation and delivery; M/M software environment; Limitation of workstation operating systems.

Unit V

M/M systems services; OS support for continuous media applications; Media stream protocol; M/M file system and information representation.

Unit VI

Data models for M/M and Hypermedia information.

VI. Practical

- Script Writing and Story Boards;

- Hot Spots and Buttons, Layouts and designing of visuals, Basics of colors;
- Working with text, presentations, charts and putting animations;
- Creating interactive presentations;
- Adobe Photoshop – Introduction, Working with images, Image editing and cleaning;
- Macromedia Flash - Introduction, Creating shapes, Inserting text, Concepts of colors, layers, frames and timelines;
- Creating Animation - Creating scenes, creating movie, testing and playing movie;
- Adobe Acrobat – Overview, Creating Adobe PDF e-Books;
- Macro Media Director Basics.

VII. Suggested Reading

- Furhet B. 1998. *Multimedia Technologies and Applications for the 21st Century*. Kluwer.
- Gibbs S.J. and Tsischritziz D.C. 1995. *Multimedia Programming - Objects, Environment & Framework*. Addison-Wesley.
- Kerman P. 2002. *Teach Yourself Macromedia Flash MX*. Sams Publ. Luther AC. 1994. *Authoring Interactive Multimedia*. Academic Press. Parekh R. 2006. *Principles of Multimedia*. TataMcGraw-Hill.
- Vaughan T. 2017. *Multimedia-Making it Work*.McGraw-Hill.

List of Journals

Agricultural Statistics

- *American Statistician*
- *Annals of Institute of Statistical Mathematics*
- *Annals of Statistics*
- *Australian and New Zealand Journal of Statistics*
- *Biometrical Journal*
- *Biometrics*
- *Biometrika*
- *Bulletin of Calcutta StatisticalAssociation*
- *Canadian Journal of Statistics*
- *Communication in Statistics (Simulation and Computation)*
- *Communication in Statistics (Theory and Methods)*
- *Experimental Agriculture*
- *Institute of Mathematical Statistics Bulletin (IMSB)*
- *Journal of American Statistical Association*
- *Journal of Applied Statistics*
- *Journal of the Indian Society of Agricultural Statistics*
- *Journal of the International Statistical Review*
- *Journal of Statistical Planning and Inference*
- *Journal of Statistical Theory andPractice*
- *Journal of Statistics, Computer and Applications*
- *Journal of Royal Statistical Society, Series A*
- *Journal of Royal Statistical Society, Series B*
- *Journal of Royal Statistical Society, Series C*
- *Metrika*
- *Metron*
- *Scandinavian Journal of Statistics (Theory & Applied)*
- *Sankhya*
- *Statistica*
- *Statistical Science*
- *Statistics and Probability Letters*
- *Technometrics*
- *Utilitas Mathematica*

Computer Application

- *ACM Transactions on Knowledge Discovery from Data*
- *Applied Intelligence–The International Journal of Artificial Intelligence, Neural Networks, and Complex Problem-Solving Technologies*
- *Computational Statistics and Data Analysis, Elsevier Inc.*
- *Computers and Electronics in Agriculture, Elsevier Inc.*
- *Data Mining and Knowledge Discovery: An International Journal (DMKD)*
- *Expert Systems with Applications, Elsevier Inc.*
- *IEEE Transactions on Knowledge and Data Engineering*
- *IEEE Transactions on Neural Networks*
- *IEEE Transactions on Pattern Analysis and Machine Intelligence*
- *International Journal of Computing and Information Sciences*
- *International Journal of Information and Management Sciences*
- *International Journal of Information Technology*
- *Journal of Artificial Intelligence Research*
- *Journal of Combinatorics, Information and System Sciences*
- *Journal of Computer Sciences and Technology*
- *Journal of Computer Society of India*
- *Journal of Indian Society of Agricultural Statistics*
- *Journal of Intelligent Information Systems - Integrating Artificial Intelligence and Database Technologies*
- *Journal of Machine Learning Research*
- *Journal of Statistics, Computer and Applications*
- *Journal of Systems and Software*
- *Journal of Theoretical and Applied Information Technology*
- *Knowledge and Information Systems: An International Journal (KAIS)*
- *Lecture Notes in Computer Science, Springer Verlag.*
- *Machine Learning*
- *Transactions on Rough Set*

e-Resources

- Design Resources Server. *Indian Agricultural Statistics Research Institute (ICAR), New Delhi 110 012, India*.www.drs.icar.gov.in.
- Free Encyclopedia on Design of Experiments
- http: //en.wikipedia.org/wiki/Design_of_experiments
- Statistics Glossaryhttp: //www.cas.lancs.ac.uk/glossary_v1.1/main.html.
- Electronic Statistics Text Book: http://www.statsoft.com/textbook/stathome.html.
- Hadamard Matriceshttp: //www.research.att.com/~njas/hadamard;
- Hadamard Matrices http: //www.uow.edu.au/~jennie/WILLIAMSON/williamson.html.
- Course on Experimental design: http://www.stat.sc.edu/~grego/courses/stat706/.
- Learning Statistics: http: //freestatistics.altervista.org/en/learning.php.
- Free Statistical Softwares: http://freestatistics.altervista.org/en/stat.php.
- Statistics Glossaryhttp: //www.cas.lancs.ac.uk/glossary_v1.1/main.html.
- Statistical Calculators: http: //www.graphpad.com/quickcalcs/index.cfm
- SAS Online Doc 9.1.3: http: //support.sas.com/onlinedoc/913/docMainpage.jsp

Suggested Broad Topics for Research Agricultural Statistics

- Design and analysis of multi-response experiments
- Design and analysis of micro-array experiments
- Design and analysis of experiments for precision agriculture
- Design and analysis of agroforestry experiments
- Designs for computer experiments.
- Bayesian designing of experiments, Bayesian optimality and Bayesian analysis of experimental data

- Computer aided search of efficient experimental designs for various experimental settings
- Fractional factorials including search designs, supersaturated designs, computer experiments, etc.
- Statistical techniques in bioinformatics, biotechnology, microbiology, genomics, etc.
- Optimality aspects and robustness of designs against several disturbances under various experimental settings (single factor, multi-factor, nested classifications, etc.)
- Small area estimation
- Computer intensive techniques in sample surveys
- Analysis of survey data, regression analysis, categorical data analysis, analysis of complex survey data
- Assessment and impact survey methodologies, valuation of natural resources, its degradation, depletion, etc.
- Linear and non-linear modeling of biological and economical phenomena
- Non-linear time series modeling
- Non-linear stochastic modeling
- Forecast models for both temporal and spatial data
- Innovative applications of resampling techniques
- Applications of remote sensing, GIS, ANN, etc. in modeling various phenomena
- Econometric models for risk, uncertainty, insurance, market analysis, technical efficiency, policy planning, etc.
- Statistical studies on value addition to crop produce

Computer Application

- Web solutions inagriculture
- Decision Support/ Expert Systems/ Information Management Systems in Agriculture
- Software for Statistical DataAnalysis
- Modelling and Simulation of Agricultural Systems
- Application Software for GIS and Remote Sensing
- Office Automation and Management System

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