REVA UNIVERSITY
Bengaluru, India

School of CSA

M.Sc (Data Science)

HANDBOOK
2022-2023

Rukmini Knowledge Park
Kattigenahalli, Yelahanka, Bengaluru – 560064
www.reva.edu.in

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF COMPUTER SCIENCE AND APPLICATIONS

HANDBOOK

for

Master of Science in Data Science (M.Sc-DS)

2022-24

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Rukmini Educational
Charitable Trust

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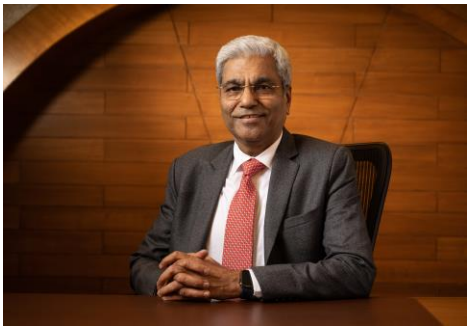

"Education is the most powerful weapon which you can use to change the world."
- Nelson Mandela.

There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it. Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look for information and those who look for knowledge.

It is deemed virtuous to serve seekers of knowledge and as educators it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts in to develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centered and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me and I believe, it takes team-work to build successful institutions. I welcome you to REVA University to join hands in laying the foundation of your future with values, wisdom and knowledge.

Dr. P. Shyama Raju
The Founder and Hon'ble Chancellor, REVA University

Vice-Chancellor's Message

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum "Knowledge is Power", REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this 'temple of learning' has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - a large number of faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of Reva University.

At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome of the research is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks the effectiveness of these programs. The entrepreneurship development activities and establishment of "Technology Incubation Centers" in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

With firm faith in the saying, "Intelligence plus character –that is the goal of education" (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavor to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS".

Welcome to the portals of REVA University!

Dr. M. Dhanmjaya
Vice Chanceller, Reva University

Director –Message

Welcome note to students

It's my pleasure to welcome you to the School of Computer Science and Applications. Computer, being considered as most significant and revolutionary invention of mankind has metamorphosed the planet earth completely. Predominantly School of Computer Science and Applications have acquired the control of the modern life in a myriad way.

The MS (Data Science) program is designed keeping in view the current situation and possible future developments, both at national and global levels. This program is designed to give greater emphasis on Data science. The programme deals with important topics like data analytics; information; Data warehousing and Data mining; Machine learning, Deep Learning, and cloud computing.

The aim of the programme is to create motivated, innovative, creative thinking graduates to fill in the roles of data scientists who can play an important role in helping businesses make strategic decisions and optimize outcomes. The programme is designed to develop human resources to meet the challenges of ever-growing technologically advanced IT industry and digital revolution.

The main focus of the programme is to create motivated, innovative, creative thinking graduates to fill in the roles of data scientists who can play an important role in helping businesses in making strategic decisions and optimized outcomes.

A variety of activities such as mini projects, seminars, interaction with industries, cultural activities and social activities are in place to shape the all-round development of students.

The benefits of choosing MS (Data Science) program are:

- Flexibility to choose Data Science career upon graduation.
- Opportunity to work on live problems.
- Opportunity to work on environmental related technologies.

Students after successful completion of MSc (Data Science) program:

- Can start-up their career in either government sector or private sector since there are ample employment opportunities in these sectors.
- Students will be skilled in Data Science with higher order critical, analytical, problem solving and transferable skills;

- Will acquire ability to think rigorously and independently to meet higher level expectations of ICT industry, academics, research establishments or take up entrepreneurial route.

- Can seek placements in diversified fields like banking, e-commerce, insurance, entertainment, and such others.

I am sure the students choosing MS (Data Science) in REVA University will enjoy the curriculum, teaching and learning environment, the vast infrastructure and the experienced teachers involvement and guidance. We will strive to provide all needed comfort and congenial environment for their studies. I wish all students pleasant stay in REVA and grand success in their career.

Dr. S. Senthil
Director – School of Computer Science and Applications

RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of Rukmini Educational Charitable Trust (RECT), in the year 2002. **Rukmini Educational Charitable Trust** (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfill its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right and the Chairman and Managing Director of the DivyaSree Group of companies. The idea of creating these top notched educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond road park, building and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 13,000 students study various courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conducive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette No. 80 dated 27thFebruary, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 45 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, custom-built teaching facilities, fully air-conditioned library and central computer center, the well-planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

The University is presently offering 23 Post Graduate Degree programs, 20 Degree and PG Degree programs in various branches of studies and has 12000+ students studying in various branches of knowledge at graduate and post graduate level and 302 Scholars pursuing research leading to PhD in 18 disciplines. It has 800+ well qualified, experienced and committed faculty members of whom majority are doctorates in their respective areas and most of them are guiding students pursuing research leading to PhD.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who

have the capabilities to surpass others. These programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has also entered MOUs with many industries, business firms and other institutions seeking their help in imparting quality education through practice, internship and also assisting students' placements.

REVA University recognizing the fact that research, development, and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology, and other areas of study. The interdisciplinary-multidisciplinary research is given the topmost priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries, and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop the much-required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class

infrastructure, headed by a dynamic experienced Professor & Dean, and supported by well experienced Trainers, Counselors and Placement Officers.

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognized as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Okalahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC^2, VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitate students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

The University has also given greater importance to quality in education, research, administration, and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing and developing different quality tools, implementing them and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and

successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director IISc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defense Dr. Sathish Reddy, Scientific Advisor, Ministry of Defense, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

As a part of our effort in motivating and inspiring youth of today, REVA University also has instituted awards and prizes to recognize the services of teachers, researchers, scientists, entrepreneurs, social workers and such others who have contributed richly for the development of the society and progress of the country. One of such award instituted by REVA University is 'Life Time Achievement Award' to be awarded to successful personalities who have made mark in their field of work. This award is presented on occasion of the "Founders' Day Celebration" of REVA University in presence of dignitaries, faculty members and students gathering and the first "REVA Life Time Achievement Award" for the year 2015 has been awarded to Shri. Kiran Kumar, Chairman ISRO on the occasion of Founder's Day Celebration, 6th January, 2016 and the second "REVA Life Time Achievement Award" for the year 2016 has been awarded to Shri. Shekhar Gupta, Renowned Journalist on the occasion of Founder's Day Celebration, 6th January, 2017.

REVA organizes various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVOTSVA conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another important event is Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. Convocation marks the end of the students journey at REVA, which is

celebrated with much pomp and splendor. During this occasion, the students who have achieved top ranks in academic are felicitated. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga classes every day to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

Recognizing the fast growth of the university and its quality in imparting higher education, the BERG (Business Excellence and Research Group), Singapore has awarded BERG Education Award 2015 to REVA University under Private Universities category. The University has also been honored with many more such honors and recognitions.

REVA University Vision

‘’REVA University aspires to become an innovative university by developing excellent human resources with leadership qualities, ethical and moral values, research culture and innovative skills through higher education of global standards”.

Mission

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centers
- To provide student-centric learning environment through innovative pedagogy and education reforms
- To encourage research and entrepreneurship through collaborations and extension activities
- To promote industry-institute partnerships and share knowledge for innovation and development
- To organize society development programs for knowledge enhancement in thrust areas
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism and moral values.

Objectives

- Creation, preservation and dissemination of knowledge and attainment of excellence in different disciplines
- Smooth transition from teacher - centric focus to learner - centric processes and activities
- Performing all the functions of interest to its major constituents like faculty, staff, students and the society to reach leadership position
- Developing a sense of ethics in the University and Community, making it conscious of its obligations to the society and the nation
- Accepting the challenges of globalization to offer high quality education and other services in a competitive manner

ABOUT SCHOOL OF COMPUTER SCIENCE AND APPLICATIONS

The School of Computer Science and Applications is shouldered by well qualified, experienced and highly committed faculty. The state-of-the-art infrastructure digital classrooms, well equipped advanced computer laboratory, conference rooms and the serene academic atmosphere at REVA University will enhance the transfer as well as creation of knowledge. The School offers Under Graduate programs: BCA, B. Sc. (Honors) in Computer Science with specialization in Cloud Computing and Big Data, B. Sc. In Computer Science with specialization in Multimedia and Animation and B. Sc. In Computer Science with specialization in Cyber Security. The School offers two Post Graduate programs: MCA and M.Sc (Data Science) programs. The School also has research program leading to doctoral degree. The curriculum of both graduate and post graduate degree programs have been designed to bridge the gap between industry – academia and hence they are industry oriented. These programs provide ample scope to enter into a wide range of business opportunities, entrepreneurship ventures and as well as job opportunities in different sectors. This is reflected in various core subjects / courses offered within the program. Further the school provides an interactive, collaborative peer tutoring environment that encourages students to break down complex problems and develop strategies for finding solutions across a variety of situations and disciplines. The school aims to develop a learning community of critical thinkers who serve as models of innovative problems solving in the university environment to enrich their academic and professional careers.

VISION

To transform students into responsible citizens with high morale, leadership qualities and competent professionals of global standards emphasizing on Research and Innovation in the domain of Computer Science and Applications.

MISSION

- To impart quality education to meet the needs of profession and society, and achieve excellence in teaching-learning and research in the area of Computer Applications;
- To attract and develop talented and committed human resource, and provide an environment conducive to innovation, creativity, team-spirit and entrepreneurial leadership in Computing field;
- To facilitate effective interactions among faculty and students of the School of Computer Applications, and foster networking with alumni, industries, institutions and other stake-holders; and
- To practice and promote high standards of professional ethics, transparency and accountability.

OBJECTIVES

- To impart programs at graduate, post-graduate and doctoral levels in the field of computer applications;
- To adopt innovative methods of teaching and promote student centric learning process;
- To create infrastructure of international standard and facilitate and create conducive environment for teaching, learning and research;
- To promote faculty development and encourage faculty members and students to organize and participate in national and international level conferences, seminars, symposia and such others;
- To encourage teachers and students to take-up interdisciplinary studies and research;
- To promote students participation in co-curricular and extension activities and develop their personality traits and team spirit.

ADVISORY COMMITTEE

Sl. No	Name and Affiliation
1	Dr. P Nagabhusan Director, IIIT Allahabad.
2	Dr. Arunkumar Thangavelu Professor, School of Computer Science and Engineering VIT University, Vellore, Tamilnadu.
3	Dr. Srikanta Patnaik Professor, Department of Computer Science and Engineering, SOA University, Bhubaneswar.
4	Dr. Pethuru Raj Chief Architect & Vice President Site Reliability Engineering (SRE) Division Reliance Jio Infocomm Limited, Bengaluru
5	Mr. Raja Krishnamoorthy, Director, SAP, Cognizant Technology Pvt.Ltd, Bengaluru.
6	Dr. Madan Kumar Srinivasan Associate Vice President, AI Innovation Centre Accenture, Bengaluru.

SCHOOL OF COMPUTER SCIENCE AND APPLICATIONS
Master of Science in Data Science – M. Sc. (DS) Programme

Programme Overview

Computers have become ubiquitous part of modern life, and new applications are introduced every day. The use of computer technologies is also commonplace in all types of organizations, in academia, research, industry, government, private and business organizations. As computers become even more pervasive, the potential for computer-related careers will continue to grow and the career paths in computer-related fields will become more diverse. Since 2001, global information and communication technologies (ICTs) have become more powerful, more accessible, and more widespread. They are now pivotal in enhancing competitiveness, enabling development, and bringing progress to all levels of society.

The School of Computer Science and Applications at REVA UNIVERSITY is offering Master of Science in Data Science (M.Sc.) –a two year postgraduate programme. The aim of the programme is to create motivated, innovative, creative thinking graduates to fill in the roles of data scientists who can play an important role in helping businesses make strategic decisions and optimize outcomes. The programme is designed to develop human resources to meet the challenges of ever-growing technologically advanced IT industry and digital revolution. The programme deals with important present day topics like data analytics; information; Data warehousing and Data mining; mobile application development and cloud computing.

Eligibility Criteria

B E / B Tech in ECE / IT / EEE / CSE / ISE / TE / BCA / B Sc in Computer Science / Mathematics / Information Science / Information Technology with a minimum of 50% (45% in case of SC/ST) marks in aggregate from any recognized university / institution or AMIE or any other qualification recognized as equivalent there to.

Different Job Roles for Data Science Experts:

Most companies are adopting data analysis for their growth. Data Scientists are in a growing demand not just in technology, but also in all other major sectors ie, Data Scientists, Statisticians, Data Analyst, Data Engineer, Business Intelligence Analyst, Marketing and stock Analyst.

The aim of the programme is to produce postgraduates with advanced knowledge and understanding of Data Science; higher order critical, analytical, problem solving and transferable skills; ability to think rigorously and independently to meet higher level expectations of ICT industry, academics, research establishments or take up entrepreneurial route. The main focus of the programme is to create motivated, innovative, creative thinking graduates to fill in the roles of data scientists who can play an important role in helping businesses in making strategic decisions and optimized outcomes.

SCHOOL OF COMPUTER SCIENCE AND APPLICATIONS
Master of Science in Data Science – M. Sc. (DS) Programme

Program Educational Objectives (PEO's)

The aim of the programme is to create motivated, innovative, creative thinking graduates to fill in the roles of data scientists who can play an important role in helping businesses make strategic decisions and optimize outcomes. The programme is designed to develop human resources to meet the challenges of ever-growing technologically advanced IT industry and digital revolution. The programme deals with important present day topics like data analytics; information; Data warehousing and Data mining; mobile application development and cloud computing.

The Programme Educational Objectives are to prepare the students to:

PEO-1	Be skilled data scientists, use existing techniques to develop Computer Engineering, Data Science solutions, Provide computer based solutions for real life problems, design, develop and test real life data science applications for specific needs
PEO-2	Understand the concepts and theories behind data science and adapt to the upcoming trends and technologies to the level of developing of commercially viable, robust and reliable software by ensuring that projects are completed satisfactorily, on time, and within budget ,
PEO-3	Work as a member of a team and communicate effectively across team members, to be equipped to be competent in the field of computer science and be equipped to act as business administrators or as administrators in public, private and government organisations or become an entrepreneur.
PEO-4	understand environmental, legal, cultural, social, ethical, public safety issues work along with engineering, medical, ICT professionals and scientists to assist them in their research and development work after further training

Program Outcomes (POs)

After undergoing this programme, a student will be able to:

PO 1: **Disciplinary knowledge**: Capable of demonstrating comprehensive knowledge and understanding of computer science that form a part of the graduate programme Master of Science in Computer Science.

PO 2: **Scientific reasoning**: Ability to analyse, and understand concepts in computer science, and explain the theories behind computer science. critically evaluate ideas, logical reasoning and experiences in programming, software development and application development.

PO 3: **Problem solving**: Capacity to extrapolate and apply competencies to solve different kinds of non-familiar problems, such as solving of real life problems through computing, provide Solutions to computing problems, analyze existing algorithms of different applications, design and develop new algorithms, operate various commercial software tools to solve scientific and business problems.

PO 4**: Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development and provide solutions for the same using domain knowledge in Computer science.

PO 5**: Research-related skills**: Ability to recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyze, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation in current technologies.

PO 6**: Ethics**: Conduct as a responsible citizen by recognizing different value systems and understand and accept responsibility of the moral dimensions and take decisions which conform to cultural, environmental, sustainability and ethical issues for them.

PO 7: **Cooperation/Team work**: Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.

PO 8: **Communication Skills**: Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.

PO 9: **Self-directed and Life-long Learning**: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

Programme Specific Outcomes (PSO)

After successful completion of the programme, the graduates will be able to

1. Apply the latest trends in technology to design, develop and test software applications for specific needs.
2. Explore the concepts and theories behind computer science to develop innovative software applications.
3. Instill life-long learning skills through the development of a research environment and higher educational opportunities.

Mapping of COs with Respect POs and PSOs

Course Code	POS/ COs	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PSO1	PSO2	PSO3
M21DG0101	CO1	H	H	H	H	H	L	L	M	L	H	L	L
	CO2	H	H	H	H	H	L	L	M	L	H	L	H
	CO3	L	H	L	H	L	L	L	M	L	H	L	H
	CO4	H	H	H	H	H	L	L	L	L	L	H	H
M21DG0102	CO1	H	M	H	M	H	L	H	M	M	H	H	H
	CO2	H	H	M	M	H	L	H	H	M	H	H	H
	CO3	M	H	H	H	M	L	H	H	M	H	H	H
	CO4	M	H	H	H	M	L	H	H	M	H	H	H
M21DG0103	CO1	H	M	M	M	M	L	H	L	M	H	M	H
	CO2	H	M	M	M	M	L	M	M	M	M	L	M
	CO3	H	H	H	L	M	L	M	M	M	L	L	L
	CO4	M	M	M	H	L	L	L	L	L	H	M	H
M21DG0104	CO1	M	M	L	L	L	L	L	L	L	M	H	M
	CO2	M	M	M	L	L	L	L	L	L	M	H	L
	CO3	M	M	H	L	H	L	L	L	L	M	L	M
	CO4	H	H	H	M	L	L	M	L	L	H	H	M
M21DG0105	CO1	H	H	M	L	H	L	H	H	H	H	M	M
	CO2	H	M	M	L	H	L	H	H	H	H	H	H
	CO3	H	M	M	L	H	L	H	H	H	M	H	M
	CO4	H	L	L	L	H	L	H	H	H	L	M	M
M21DGS111	CO1	H	H	L	M	H	L	H	H	L	H	H	H
	CO2	H	M	H	H	H	L	L	H	L	H	L	H
	CO3	M	H	L	L	L	L	L	H	M	H	M	M
	CO4	M	H	L	M	L	H	H	H	H	M	H	H
M21DGS112	CO1	H	H	L	M	L	L	L	L	M	H	M	L
	CO2	H	H	L	H	L	L	L	L	L	H	M	L
	CO3	M	M	H	M	M	L	L	M	L	M	L	L
	CO4	H	M	L	L	L	L	M	L	L	M	L	M

M21DGS113	**CO1**	M	H	H	M	H	L	H	L	M	H	H	H
	CO2	H	H	H	M	H	L	M	L	M	H	H	H
	CO3	M	H	H	M	H	L	H	L	H	H	H	H
	CO4	H	H	H	M	H	L	M	L	H	H	H	H
M21DG0106	**CO1**	H	H	H	L	H	L	L	L	H	L	H	H
	CO2	H	H	H	L	H	L	L	L	H	H	H	H
	CO3	M	H	H	L	H	L	L	L	H	H	H	H
	CO4	H	H	H	L	H	L	L	L	H	H	H	H
M21DG0107	CO1	H	H	H	L	H	L	M	L	M	H	H	H
	CO2	L	H	H	M	H	L	H	L	H	H	H	H
	CO3	H	H	H	M	H	L	M	L	H	H	H	H
	CO4	H	M	H	L	H	L	L	L	H	M	H	H
M22AS0201	CO1							H		H			
	CO2							H		H			
	CO3							H		H			
	CO4							H		H			
M21DG0201	CO1	M	H	H	L	M	L	L	L	H	H	H	H
	CO2	H	H	H	L	H	L	L	L	H	H	H	H
	CO3	H	H	H	L	H	L	M	L	M	H	H	H
	CO4	L	H	H	M	H	L	H	L	H	H	H	H
M21DG0202	CO1	H	H	M	M	L	L	L	L	M	M	L	H
	CO2	H	H	M	H	L	L	L	L	L	M	L	M
	CO3	M	M	H	L	L	L	M	L	M	L	M	M
	CO4	M	M	L	L	L	L	L	L	L	M	M	M
M21DG0203	**CO1**	M	M	M	L	H	L	L	L	L	M	M	M
	CO2	M	H	H	L	H	L	L	L	L	M	H	H
	CO3	M	H	H	L	H	L	L	L	L	M	H	H
	CO4	H	H	L	H	H	L	L	L	M	H	H	L
M21DG0204	**CO1**	L	M	H	H	H	H	L	M	M	L	L	L
	CO2	M	H	H	L	H	M	M	M	M	L	H	M
	CO3	M	M	L	L	L	L	M	M	M	M	L	L
	CO4	L	H	L	L	L	L	L	L	L	M	L	L
M21DGS211	**CO1**	M	H	H	L	H	L	L	L	H	M	M	H
	CO2	M	H	H	M	M	H	L	H	H	L	H	M
	CO3	M	H	M	M	H	H	L	L	H	L	H	H
	CO4	M	M	H	L	M	L	L	L	H	M	H	H
M21DGS212	**CO1**	M	H	H	L	H	L	L	L	L	M	H	H
	CO2	H	H	L	H	H	L	L	L	M	H	H	L
	CO3	L	M	H	H	H	H	M	M	M	M	L	L
	CO4	M	H	H	L	M	M	M	M	M	L	H	M

M21DGS213	**CO1**	M	H	H	M	H	M	L	L	H	H	H	M
	CO2	H	H	H	M	M	L	L	L	H	H	H	H
	CO3	H	H	H	H	H	M	M	L	H	H	H	H
	CO4	H	H	H	M	H	M	L	L	H	H	H	M
M21DGS221	**CO1**	H	H	M	M	M	L	M	L	M	M	L	H
	CO2	H	M	M	H	L	L	M	L	M	M	L	M
	CO3	H	H	H	L	L	L	M	L	M	L	M	M
	CO4	M	M	L	L	L	L	L	L	L	M	M	M
M21DGS222	**CO1**	H	H	H	L	M	M	L	L	M	L	L	H
	CO2	L	H	M	M	M	M	L	H	M	M	H	M
	CO3	L	L	L	M	M	M	M	L	L	M	M	H
	CO4	M	M	L	M	L	H	H	H	H	M	M	M
M21DGS223	**CO1**	M	M	H	L	L	L	L	L	L	H	M	H
	CO2	H	L	L	M	H	L	M	M	M	L	L	M
	CO3	L	M	H	H	H	H	L	M	M	L	L	L
	CO4	M	H	H	L	H	M	M	M	M	L	H	M
M21DG0205	**CO1**	M	H	H	L	H	L	L	L	L	M	H	H
	CO2	H	H	L	H	H	L	L	L	M	H	H	L
	CO3	L	M	H	H	H	H	M	M	M	M	L	L
	CO4	M	H	H	L	M	M	M	M	M	L	H	M
M21DG0206	**CO1**	M	H	H	L	H	L	L	L	L	M	H	H
	CO2	H	H	L	H	H	L	L	L	M	H	H	L
	CO3	L	M	H	H	H	H	M	M	M	M	L	L
	CO4	M	H	H	L	M	M	M	M	M	L	H	M
M21DG0301	**CO1**	M	M	H	L	L	L	L	L	L	H	M	H
	CO2	H	L	L	M	H	L	M	M	M	L	L	M
	CO3	L	M	H	H	H	H	L	M	M	L	L	L
	CO4	M	H	H	L	H	M	M	M	M	L	H	M
M21DG0302	**CO1**	M	H	H	M	H	M	L	L	H	H	H	M
	CO2	H	H	H	M	M	L	L	L	H	H	H	H
	CO3	H	H	H	H	H	M	M	L	H	H	H	H
	CO4	H	H	H	M	H	M	L	L	H	H	H	M
M21DGS311	**CO1**	M	H	H	L	H	L	L	L	H	M	M	H
	CO2	M	H	H	M	M	H	L	H	H	L	H	M
	CO3	M	H	M	M	H	H	L	L	H	L	H	H
	CO4	M	M	H	L	M	L	L	L	H	M	H	H
M21DGS312	**CO1**	M	M	H	L	L	L	L	L	L	H	M	H
	CO2	H	L	L	M	H	L	M	M	M	L	L	M
	CO3	L	M	H	H	H	H	L	M	M	L	L	L
	CO4	M	H	H	L	H	M	M	M	M	L	H	M
M21DGS313	**CO1**	M	H	H	M	H	M	L	L	H	H	H	M
	CO2	H	H	H	M	M	L	L	L	H	H	H	H
	CO3	H	H	H	H	H	M	M	L	H	H	H	H
	CO4	H	H	H	M	H	M	L	L	H	H	H	M
M21DGS321	**CO1**	M	M	H	L	L	L	L	L	L	H	M	H
	CO2	H	L	L	M	H	L	M	M	M	L	L	M
	CO3	L	M	H	H	H	H	L	M	M	L	L	L
	CO4	M	H	H	L	H	M	M	M	M	L	H	M
M21DGS322	**CO1**	M	H	H	L	H	L	L	L	H	M	M	H
	CO2	M	H	H	M	M	H	L	H	H	L	H	M
	CO3	M	H	M	M	H	H	L	L	H	L	H	H
	CO4	M	M	H	L	M	L	L	L	H	M	H	H
M21DGS323	**CO1**	M	H	H	M	H	M	L	L	H	H	H	M

	CO2	H	H	H	M	M	L	L	L	H	H	H	H
	CO3	H	H	H	H	H	M	M	L	H	H	H	H
	CO4	H	H	H	M	H	M	L	L	H	H	H	M
M21DG0303	**CO1**	M	M	H	L	M	L	L	L	L	M	H	M
	CO2	H	L	L	L	M	M	M	M	M	M	L	M
	CO3	L	M	H	H	H	H	M	H	L	H	M	L
	CO4	M	H	H	M	M	M	H	M	M	H	M	L
M21DGO301	**CO1**	M	M	H	L	L	L	L	L	L	H	M	H
	CO2	H	L	L	M	H	L	M	M	M	L	L	M
	CO3	L	M	H	H	H	H	L	M	M	L	L	L
	CO4	M	H	H	L	H	M	M	M	M	L	H	M
M21DG0401	**CO1**	M	M	M	M	M	L	M	M	L	H	H	H
	CO2	M	H	H	M	M	M	H	M	M	H	H	H
	CO3	H	H	H	M	M	M	M	M	H	H	H	M
	CO4	M	M	H	M	M	L	H	M	M	H	H	H
M21DG0402	**CO1**	M	M	H	L	L	L	L	L	L	M	H	M
	CO2	H	L	L	M	H	M	M	M	M	M	L	M
	CO3	L	M	H	H	H	H	L	M	H	H	M	H
	CO4	M	H	H	L	H	M	M	M	M	H	M	H
M21DG0403	**CO1**	M	M	H	L	L	L	L	L	L	M	H	H
	CO2	H	L	L	M	H	M	M	M	M	M	L	M
	CO3	L	M	H	H	H	H	L	M	H	H	M	H
	CO4	M	H	H	L	H	M	M	M	M	H	M	H

Mapping of PEOS with Respect POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
PEO1	H	H	H	M	H	M	M	M	M	H	H	H
PEO2	H	H	H	L	M	L	M	M	M	H	M	M
PEO3	M	M	M	L	H	L	M	M	M	M	H	H
PEO4	M	M	M	H	L	H	H	H	H	M	H	H

SCHOOL OF COMPUTER SCIENCE AND APPLICATIONS

Master of Science in Data Science – M. Sc. (DS) Programme
Scheme of Instructions-2022

FIRST SEMESTER

SL. No.	Course Code	Course Title	HC/SC/FC	Credit Pattern			Credits	Working Hrs
				L	T	P		
1	M21DG0101	Principles of Data Science	HC	4	0	0	4	4
2	M21DG0102	Programming with Python	HC	2	1	0	3	4
3	M21DG0103	Data Mining	HC	2	1	0	3	4
4	M21DG0104	Data Preparation and information Retrieval	HC	4	0	0	4	4
5	M21DG0105	Mathematical Foundations for Data science-I	HC	4	0	0	4	4
6	M21DGS111	Advanced Computer Networks	SC	2	1	0	3	4
	M21DGS112	Advanced DBMS						
	M21DGS113	Advanced operating Systems						
Practical Courses								
7	M21DG0106	Data Mining with R Lab	HC	0	0	2	2	4
8	M21DG0107	Python Lab	HC	0	0	2	2	4
***Mandatory - (Non Creditable Courses)**								
9	M21DGM101/ M21PTM101	Soft Skills (Research Methodology)						
10	M21DGM102	Skill Development Programme						
Total Credit				**18**	**3**	**4**	**25**	**32**

SECOND SEMESTER

SL. No	Course Code	Course Title	HC/SC FC	Credit Pattern			Credits	Working Hrs
				L	T	P		
1	**M22AS0201**	Tree Plantation in Tropical Region: Benefits and Strategic Planning	FC	1	0	0	1	1
2	M21DG0201	Machine Learning using Python	HC	3	0	1	4	5
3	M21DG0202	Mathematical Foundations for Data science-II	HC	4	0	0	4	4
4	M21DG0203	Big Data with NoSQL	HC	4	0	0	4	4
5	M21DG0204	Foundation of Data Visualization	HC	2	1	0	3	4
6	M21DGS211	Big Data Security	SC	2	1	0	3	4
	M21DGS212	Image and Video Analytics						
	M21DGS213	Cloud Computing						
7	M21DGS221	Parallel and Distributed Systems	SC	2	1	0	3	4
	M21DGS222	Natural Language Processing						
	M21DGS223	Internet of Things						
Practical Courses								
7	M21DG0205	Data Visualization Lab (Tools: Excel, Tabuleau)	HC	0	0	2	2	4
8	M21DG0206	NoSQL lab	HC	0	0	2	2	4
***Mandatory - (Non Creditable Courses)**								
9	M21DGM201/ M21PTM201	Soft Skills						
10	M21DGM202	Skill Development Programme						
Total Credits				18	3	5	26	33

THIRD SEMESTER

SL. No	Course Code	Course Title	HC/SC FC	Credit Pattern			Credits	Working Hrs
				L	T	P		
1.	M21DG0301	Deep Learning	HC	4	0	0	4	4
2.	M21DG0302	Data Wrangling	HC	3	0	1	4	5
3.	M21DGS311	Intelligent Systems	SC	2	1	0	3	4
	M21DGS312	Graphs-Algorithms & Mining						
	M21DGS313	Cloud Analytics						
4.	M21DGS321	Time Series Analysis and Forecasting	SC	2	1	0	3	4
	M21DGS322	Multivariate Methods for data Analysis						
	M21DGS323	Recommender Systems						
5.		Open Elective ******	OE	4	0	0	4	4
6	M21DG0303	Minor Project	HC	0	0	6	6	12
***Mandatory - (Non Creditable Courses)**								
6.	M21DGM301/M21PTM301	Soft Skills						
7.	M21DGM302	Skill Development Programme						
Total Credits				**16**	**2**	**6**	**24**	**32**

Course Code	Digital Marketing	Course Type	L	T	P	C	Hrs. /Wk.
M21DGO301		OE	4	0	0	4	4

FOURTH SEMESTER

SL. No	Course Code	Title of the Course	Credit Pattern L:T:P:J	Credits
1	M21DG0401	Research/Technical paper	0:0:2	2
2	M21DG0402	Internship/ Certification	0:0:4	4
3	M21DG0403	Major Project	0:0:10	10
Total Credits				**16**

*** Note:**

1. Project Work and Dissertation will be mandatory of 12 Credits

2. The student can select either Internship (4 weeks) or Certification Course for 6 Credits.

3. All final year project students must write & publish a technical/Research paper based on their area of interest that carries 2 credit.

SEMESTER WISE CREDIT SUMMARY

Semester	Credits
First	25
Second	26
Third	24
Fourth	16
Total	**91**

CREDIT DISTRIBUTION

Sem	Hard Core (HC)	Foundation Course(FC)	Softcore Course(SC)	Open Elective(OE)	Project& Technical Paper	Internship/ Certification	Total Credits
I	22		3	-	-	-	25
II	19	1	6	-	-	-	26
III	14		6	4		-	24
IV	-		-	-	10+2	4	16
	52	1	18	04	12	04	**91**

Master of Science in Computer Science – MS (CS)
Detailed Syllabus

FIRST SEMESTER

M21DG0101	Principles of Data Science	L	T	P	C
Duration:52 Hrs		4	0	0	4

Course Description

This course will introduce to the students the principles of Data Science that underpin key tools and techniques used both to describe and to gain insights into the properties of often large and complex datasets. The course has many case studies taken from real-world application domains. Data science involves analytics applications that are more advanced. In addition to descriptive analytics, it encompasses predictive analytics that forecasts future behaviour and events, as well as prescriptive analytics, which seeks to determine the best course of action to take on the issue being analyzed. The students will be getting an overall understanding of the data science process and learn about the roles and responsibilities of a Data scientist.

Prerequisites:

Basics of DataBase Management systems and Data processing

Course Objectives:

The objectives of this course are to:

- To introduce the core concepts in Data Science.
- To provide strong foundation in application area related to Data science.
- To provide a domain knowledge on the emerging technologies in data science.
- Understand the various techniques used in Data Science.

Course Outcomes:

On successful completion of this course; the student will be able to:

- Determine the challenges in working with big data platform and understand its importance with its applications and understand the various big data technologies like Hadoop MapReduce.
- Understand the basics of Data science to Apply tools and techniques to analyze Big Data.
- Design a solution for a given problem using suitable Big Data Techniques and Interpret business models and scientific computing paradigms.
- Correlate the existing Big Data use cases to Design new Big Data applications with Ethics and human values

Course Content:

UNIT I Big Data and Data science [13 Hours]

Introduction to Big Data: Big Data and its Importance – Four V's and the 5th V -VALUE in Big Data – -Facets of Data(T1) -Big data Overview- Understanding the Waves of managing Data, Big Data architecture, Big Data Technology Components.

Basics of Data Science:

State of the practice in analytics-key roles of the new Big data Eco system- Role of a Data scientist, Profile of a Data Scientist (T2) Overview of the data science process (T1).

UNIT II Big Data Analytics [13 Hours]

Big Data Analytics- Importance, Types of Big data Analytics: Diagnostic, Descriptive, Predictive and Prescriptive analytics- Examples of Big Data Analytics-Data Analytics Life cycle(T2)-Epicycles of Analysis- Stating and Refining the Question(T3) - Text Analytics-Text Analytics steps-Text Analysis Example.

UNIT III Processing Big Data [13 Hours]

Challenges in Handling large data:

The problems you face when handling large data- General techniques for handling large volumes of data(T1).

Big Data Technologies:

Integrating disparate data stores, Mapping data to the programming framework, Connecting and extracting data from storage - Transforming data for Processing.

First steps in big data -Hadoop's Parallel World -cloud and Big Data Analytics, Distributed File System- Hadoop Architecture, Hadoop Storage: HDFS. Investigating the Hadoop Distributed File

System. Data ingestion tools in Hadoop. Selecting appropriate execution modes: local, pseudo-distributed, fully distributed.

Map Reduce process, Map Reduce Examples. The Building Blocks of Hadoop Map Reduce.

UNIT IV Ethics in Data Science and use cases for Data Science [13 Hours]

Data Science and Ethics- Doing good Data Science- owners of data – valuing different aspects of privacy- getting informed The Five Cs – Diversity – Inclusion – Future Trends.

Use cases for Big data Analytics – Industry examples of Big Data , big data and Digital marketing, fraud and big data, risk and big data, credit risk management, big data and healthcare, advertising and big data. Mobile business intelligence, Crowd sourcing analytics.

Text books:

1. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Introducing Data Science, Manning Publications, 2016.
2. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, 2015
3. Vijay Kotu, BalaDeshpande, Data Science Concepts and Practice, Morgan Kaufmann publishers,2019 Elsevier Inc
4. Roger D. Peng and Elizabeth Matsui, The art of Data Science
5. D J Patil, Hilary Mason, MikeLoukides, Ethics and Data Science, O' Reilly, 1st edition, 2018

References:

1. Douglas Eadline, Hadoop Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem, Addison-Wesley, Pearson Education India; First edition (1 March 2016).
2. Ambiga Dhiraj , Michael Minelli, Michehe Chambers, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business", 1st Edition, , Wiely CIO Series, 2013.
3. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.

Course Code	Programming with Python	L	T	P	C
M21DG0102		2	1	0	3

Course Description

Introduction to programming basics (what it is and how it works), binary computation, problem-solving methods and algorithm development. Includes procedural and data abstractions, program design, debugging, testing, and documentation. Covers data types, control structures, functions, parameter passing, library functions, arrays, inheritance and object oriented design. Laboratory exercises in Python.

Prerequisites:

Basics of coding.

Course Objectives:

The objectives of this course are:

1. Understand and demonstrate the usage of built-in objects in Python.
2. Use a range of Python features for numerical analysis.
3. Introduce numerical programming, data handling through NumPy and Pandas modules.
4 . Understand the data visualization using MatplotLib modules.

Course Outcomes:

On successful completion of this course; the student shall be able to:

- Analyze the significance of python program development environment and apply it to solve real world applications.
- Demonstrate the usage of lists arrays and loops concepts.
- Investigate and apply Numpy, Pandas and Matplot.
- Create a mathematical and visualization model using time series/ any real time data and plot 2D and/or 3D plots as suggested.

Course Content:

UNIT I INTRODUCTION TO PYTHON [10 Hours]

Structure of Python Program-Underlying mechanism of Module Execution-Branching and Looping-Problem Solving Using Branches and Loops-Functions - Lists and Mutability- Problem Solving Using Lists and Functions,

UNIT II USING NUMPY [10 Hours]

Basics of NumPy-Computation on NumPy-Aggregations-Computation on Arrays- Comparisons, Masks and Boolean Arrays-Fancy Indexing-Sorting Arrays-Structured Data: NumPy's Structured Array**.**

UNIT III DATA MANIPULATION WITH PANDAS [10 Hours]

Introduction to Pandas Objects-Data indexing and Selection-Operating on Data in Pandas-Handling Missing Data-Hierarchical Indexing - Combining Data Sets,

UNIT IV VISUALIZATION AND MATPLOTLIB [10 Hours]

Basic functions of matplotlib-Simple Line Plot, Scatter Plot-Density and Contour Plots-Histograms, Binnings and Density-Customizing Plot Legends, Colour Bars-Three- Dimensional Plotting in Matplotlib.

Text books:

1. Jake VanderPlas ,Python Data Science Handbook - Essential Tools for Working with Data, O'Reily Media,Inc, 2016.
2. Zhang.Y ,An Introduction to Python and Computer Programming, Springer Publications,2016.

Reference Books:

1. Joel Grus, Data Science from Scratch First Principles with Python, O'Reilly Media,2016.
2. T.R.Padmanabhan, Programming with Python,Springer Publications,2016.
3. "CS41 - The Python Programming Language", Stanfordpython.com, 2019. [Online]. Available: https://stanfordpython.com/#overview. [Accessed: 20- Jun- 2019].
4. "Python for Data Science", Cognitive Class, 2019. [Online]. Available: https://cognitiveclass.ai/courses/python-for-data-science/. [Accessed: 20- Jun- 2019].

Course code	Data Mining	L	T	P	C
M21DG0103		2	1	0	3

Course Description

Data Mining studies algorithms and computational paradigms that allow computers to find patterns and regularities in databases, perform prediction and forecasting, and generally improve their performance through interaction with data. It is currently regarded as the key element of a more general process called Knowledge Discovery that deals with extracting useful knowledge from raw data. The knowledge discovery process includes data selection, cleaning, coding, using different statistical and machine learning techniques, and visualization of the generated structures. The course will cover all these issues and will illustrate the whole process by examples. Special emphasis will be give to the Machine Learning methods as they provide the real knowledge discovery tools.

Prerequisites:

Basic statisistics

Course Objectives:

The objectives of this course are to:

- Learn data analysis techniques through Data Mining.
- Understand Data mining techniques and algorithms.
- Comprehend the data mining environments and application.
- Understand the process of Knowledge discovery.

Course Outcomes:

On successful completion of this course; the student shall be able to:

- Compare various conceptions of data mining as evidenced in both research and application.

- Characterize the various kinds of patterns that can be discovered by association rule mining.
- Evaluate mathematical methods underlying the effective application of data mining.
- Apply the data mining methods in real world applications and problems.

Course Content:

UNIT I Introduction to Data Mining **[10 Hours]**

Basic Data Mining Tasks, Classification, Regression, Time Series Analysis, Prediction, Clustering, Summarization, Association Rules, Sequence Discovery, Data Mining Versus Knowledge Discovery in Database, The Development of Data Mining, Data Mining Issues, Data Mining Metrics, Social Implications of Data Mining, Data Mining from a Database Perspective.

A Statistical Perspective on Data Mining, Point Estimation, Models Based on Summarization, Bayes Theorem, Hypothesis Testing, Regression and Correlation, Similarity Measures.

UNIT II Classification **[10 Hours]**

Introduction, Issues in Classification, Statistical-Based Algorithms, Regression, Bayesian Classification, Distance-Based Algorithms, Simple Approach, K Nearest Neighbors, Decision Tree-Based Algorithms, ID3, C4.5 and C5.0, CART, Scalable DT Techniques.

Rule-Based Algorithms, Generating Rules from a DT, Generating Rules from a Neural Net, Generating Rules without a DT or NN.

UNIT III Clustering **[10 Hours]**

Introduction, Similarity and Distance Measures, Outliers, Hierarchical Algorithms, Agglomerative Algorithms, Divisive Clustering, Partitional Algorithms, Minimum Spanning Tree, K -Means Clustering, Nearest Neighbor Algorithm, DBSCAN, Clustering with Categorical Attributes.

Association Rules, Introduction, Large Itemsets, Basic Algorithms, Apriori Algorithm, Sampling Algorithm, Partitioning, Comparing Approaches, Incremental Rules, Measuring the Quality of Rules.

UNIT IV R Programming **[10 Hours]**

Download and install R – R IDE environments – Why R – Getting started with-Introduction to R Programming – Vectors, Matrices and Array, lists, data frames, Maths Function, Basic Statistical functions, Sorting, String Manipulation, reading data in R, Reading CSVs, Excel data, Control statement and Loops, writing R function, R Chats and Graphs.

Text Books:

1. Margaret H Dunham “Data Mining: Introductory and Advanced Topics”. India, Pearson Education, 2006(Unit I, II &III)
2. Norman Matloff, “The Art of R Programming”, Published by William Pollock, 2011.
3. Introduction to Data Science (Data Analysis and Prediction Algorithms with R, Rafael A. Irizarry, https://rafaLabgithub.io/dsbook/)

Reference Books:

1. Daniel. T. Larose Knowledge discovery, An Introduction to Data Mining, Wiley Publishers, 2014
2. Jiawei Han and Micheline Kamber, “Data Mining - Concepts and Techniques”, Third Edition, Elsevier, 2012)
3. G. K. Gupta: Introduction to Data Mining with Case Studies, 3rd Edition, PHI, New Delhi, 2009.

Course code	Data Preparation and information Retrieval	L	T	P	C
M21DG0104		4	0	0	4

Course Description

Data preparation involves transforming raw data into a form that is more appropriate for modeling.Preparing data may be the most important part of a predictive modeling project and the most time-consuming, although it seems to be the least discussed. Instead, the focus is on machine learning algorithms, whose usage and parameterization has become quite routine. Information retrieval is the process through which a computer system can respond to a user's query for text-based information on a specific topic. IR was one of the first and remains one of the most important problems in the domain of natural language processing (NLP).

Prerequisites:

Database storage and retrieval.

Course Objectives:

The objectives of this course are:

- Describe the need of storage and information retrieval.
- Discuss the indexing model to identify the similarity of query and document
- Introduce the data warehouses for the information retrieval model.
- Provide comprehensive details of Data Mining Classification methods like Bayesian Classification, Rule based, and Neural Network etc. in IR.

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the importance of pre-processing and Apply data pre-processing concepts in real data.
2. Understand the basics of exploratory Data analysis.
3. Analyze the involvement of the information retrieval & indexing in modern life.

4. Evaluate the effectiveness and efficiency of different information retrieval systems.

Course Content:

UNIT I Data preparation [13 Hours]

Getting to know your Data-Data Pre-processing: An Overview – Data Cleaning – Data Integration – Data Reduction – Data Transformation and discretization. Describing data- Preparing data Tables-understanding relationships (T1).

UNIT II Building Models with Data [13 Hours]

Identifying and understanding groups(T1) Understanding Exploratory Data Analysis- Using Models to Explore Your Data(T2) – Building Models from Data(T1) -Use of open source data mining tool WEKA, XL Miner (or Use Traceis 2014 available in http://www.makingsenseofdata.com).

UNIT III Data Warehouse & Modeling [13 Hours]

What is a Data Warehouse, Differences between operational database systems and Data Warehouses, Multi-tiered Architecture, Data Warehouse models, Extraction, Transformation and Loading, Metadata repository. Data Warehouse modeling: Data Cube and OLAP, Data cube: A Multidimensional Data model, Schemas for multidimensional data models, Dimensions: The role of concept hierarchies, Measures: Their categorization and computation, Typical OLAP operations. Introduction to Data Lakes.

UNIT IV Introduction to Information Retrieval and Indexing [13 Hours]

Significance of information retrieval and storage, Definition of information retrieval system, Objectives of information retrieval system, Function overview, Relationships between Digital library and IRS, Measure of information systems, Logical organization, Physical organization, Components of information retrieval systems, Comparisons among different information systemsInverted files, encoding, Zipf'sLaw, compression, boolean queries; Fundamental IR models: Boolean, Vector Space, probabilistic.

Text Books:

1.Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data I: A Practical guide to Exploratory Data Analysis and Data Mining , Second Edition, John-Wiley 2014

2. Roger D. Peng and Elizabeth Matsui, The art of Data Science, 2015 - 2016 Skybrude Consulting, LLC

3. Introduction to information retrieval", Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schutze, Cambridge University Press. 2008

4. Jiawei Han, MichelineKamber&Jian Pei, "Data Mining Concepts and Techniques", Morgan Kaufmaan Publishers, 2011

Course code	Mathematical Foundations for Data Science - I	L	T	P	C
M21DG0105		4	0	0	4

Course Description

The course provides comprehensive **understanding of vector spaces** and the use of linear algebra for Data Science applications. This course aims at introducing the basic notions of vector spaces, Linear Algebra and the use of Linear Algebra in applications to Data Science.

Prerequisites:

Basic Mathematics.

Course Objectives:

The objectives of this course are to:

- To demonstrate basic concepts of vector spaces and interpret the concepts of linear transformations by using the matrices Introduce Random variables and Probability distributions.
- .To develop methods of computing and using Eigen values and Eigen vectors.
- To acquaint students with various statistical methods and cultivate statistical thinking among students.
- To help students understand the basics of probability.

Course Outcomes:

On successful completion of this course; the student will be able to:

- Summarize the vector space properties and analyze different forms of the Linear Transformations.
- Derive the Norms and Inner Product Spaces.
- Recognize and compute the single and multi-sample tests for m descriptive and inferential statistics in many different fieldsstatistics in many different fields.
- Understand the concepts of probability and its applications.

Course Content:

UNIT I **[15 Hours]**

Vector space and Transformations

Vector Spaces, Subspaces, Linear Combinations and Systems of Linear Equations, Linear Dependence and Linear Independence, Bases and Dimension, Maximal Linearly Independent Subsets; Linear Transformations, Null Spaces, and Ranges, The Matrix Representation of a Linear Transformation, Composition of Linear Transformations, and Matrix Multiplication, Invertibility and Isomorphisms, The Change of Coordinate Matrix, The Dual Space.

UNIT II **[15 Hours]**

Inner Products and Eigen Values & Eigen Vectors

Inner Products and Norms (No theorem proof). The Adjoint of a Linear Operator, Normal and Self-Adjoint Operators, Unitary and Orthogonal Operators and Their Matrices, Orthogonal Projections, The Gram-Schmidt Orthogonalization Process and Orthogonal Complements. Eigenvalues and Cayley-Hamilton Theorem (Statement and properties with relevant problems only), Eigenvectors, and properties of Eigen values and Eigen vectors.

UNIT III **[15 Hours]**

Descriptive Statistics

Meaning of Statistics and its definition-Functions-Characteristics-limitations. Collection of data Classification of data, preparation of frequency distribution and tabulation of data. Graphical representation of median and mode by - histograms, Cumulative frequency curves (Ogives).

Measure of Central Tendency - Arithmetic Mean (Average), Partition values – Median, quartiles, and Mode and its applications. Methods of Dispersion Range, Quartile deviation, Standard deviations and Coefficient of Variation, Measure of Skewness and Kurtosis.

UNIT IV **[15 Hours]**

Probability

Random experiments, trial, sample space, events. Approaches to probability- classical, empirical, subjective and axiomatic. Addition rules of probability. Conditional probability, independence of events and multiplication rule of probability. Bayes theorem (no proof any theorem) and its applications.

Text Books:

1. S. Friedberg, A. Insel, and L. Spence - Linear Algebra, Fourth Edition, PHI, 2009.
2. Kenneth Hoffman, Ray Kunze- Linear Algebra, Second Edition, Eastern Economy Edition, 2011.
3. Gupta. S.C and Kapoor V.K. Fundamentals of Mathematical Statistics, Sultan Chand and sons, (2001)
4. Freund J.E., Mathematical Statistics, Prentice hall, (2001)

Reference Books:

1. Ron Larson and David C. Falvo, Elementary Linear Algebra, Sixth Edition, Houghton Mifflin Harcourt Publishing Company, 2009.
2. Jimmie Gilbert and Linda Gilbert – Linear Algebra and Matrix Theory, Academic Press, An imprint of Elsevier.
3. S. Kumeresan – Linear Algebra, A Geometric approach, Prentice Hall India, 2000.
4. S.P.Gupta, “Statistical methods”- Sultan Chand & Sons, New Delhi, 2012 Edition
5. P K Srimani and M Vinayaka Murthy, “Probability and Statistics”, Subhas Stores, 2000
6. Ross Sheldon, A First Course in Probability, Macmillan (6th edition).W.N. Venables, D.M Smith, “An introduction to R”
7. D.C. Montogomery and G.C.Runger, “Applied Statistics and Probability for engineers”, New Jersey, John Wiley and Sons, 3rd edition.

Course Code	Advanced Computer Networks	L	T	P	C
M21DGS111		2	1	0	3

Course Description:

This course covers a set of advanced topics in computer networks. The focus is on principles, architectures, and protocols used in modern networked systems, such as the Internet itself, wireless and mobile networks and high performance networks. The Internet protocols have revolutionized communications. This advanced networking course will equip you with a deep knowledge of network concepts, protocol design, and performance analysis that make the Internet work, help you develop critical insight into their design, and obtain a firsthand feel for implementation through homework and project exercises. Another key goal is to prepare you for doing research in the field of networking.

Course Prerequisites:

Operating Systems & Unix.

Course Objectives:

The objectives of this course are to:

1. Make students build an understanding of the fundamental concepts of computer networking.
2. Make students to become Familiar with the basic taxonomy and terminology of the computer networking area.
3. Introduce the students to advanced networking concepts, preparing the student for entry Advanced courses in computer networking.
4. Allow the students to gain expertise in some specific areas of networking such as the design and maintain of individual networks.

Course Outcomes:

On completion of this course the student will be able to:

1. Independently understand basic computer network technology.
2. Understand and explain Data Communications System and its components.
3. Identify the different types of network topologies and protocols.

4. Become familiar with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.

Course Content:

UNIT I Computer Networks and the Internet [10 Hours]

What Is the Internet? Network Edge; Network Core; Delay, Loss, and Throughput in Packet-Switched Networks; Protocol Layers and Their Service Models

Application Layer: Principles of Network Applications; Web and HTTP; File Transfer: FTP; Electronic Mail in the Internet; DNS—The Internet's Directory Service; Peer-to-Peer Applications; Socket Programming: Creating Network Application.

UNIT II Transport Layer : [10 Hours]

Introduction and Transport-Layer Services; Multiplexing and Demultiplexing; Connectionless Transport: UDP; Principles of Reliable Data Transfer; Connection-Oriented Transport: TCP; Principles of Congestion Control; TCP Congestion Control.

The Network Layer: Introduction; Virtual Circuit and Datagram Networks; what's Inside a Router? The Internet Protocol (IP): Forwarding and Addressing in the Internet; Routing Algorithms; Routing in the Internet; Broadcast and Multicast Routing.

UNIT III The Link Layer: Links, Access Networks, and LANs [10 Hours]

Introduction to the Link Layer; Error-Detection and -Correction Techniques; Multiple Access Links and Protocols; Switched Local Area Networks; Link Virtualization: A Network as a Link Layer; Data Center Networking.

Wireless and Mobile Networks

Introduction; Wireless Links and Network Characteristics; WiFi: 802.11 Wireless LANs; Cellular Internet Access; Mobility Management: Principles; Mobile IP; Managing Mobility in Cellular Networks; Wireless and Mobility: Impact on Higher-Layer Protocols.

UNIT IV Security in Computer Networks [10 Hours]

What Is Network Security? Principles of Cryptography; Message Integrity and Digital Signatures; End-Point Authentication; Securing E-Mail; Securing TCP Connections: SSL; Network-Layer Security: IPsec and Virtual Private Networks; Operational Security: Firewalls and Intrusion Detection Systems.

Network Management: What Is Network Management? The Infrastructure for Network
Management.The Internet-Standard Management Framework.

Text books:

1. "James F. Kurose and Keith W.Ross, Computer Networking: A Top- Down Approach,. Addison- Wesley,6/E edition,2013. (Ch 1 to 8)

Reference Books:

1. Nader F.Mir, Computer and Communication Networks, Pearson Education, 2007.
2. Behrouz A. Forouzan, Data Communications and Networking, Fourth Edition, Tata Mc GrawHill, 2007.
3. Andrew S. Tanenbaum, Computer Networks, Prentice Hall, 5th edition, 2011.
4. Larry L Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, Morgan Kaufmann, 5th edition, 2011.

Course Code	Advanced DBMS	L	T	P	C
M21DGS112		2	1	0	3

Course Description:

This course is intended to provide with an understanding of the Advanced topics of DBMS such as Indexing, storage and emerging technologies in the field of database; query processing and optimization; advanced indexing techniques, Query evaluation, new database applications. This course helps to fully understand and appreciate the principle behind and gives a solid technical overview of how it works.

Course Prerequisites:

Basic DBMS concepts.

Course Objectives:

The objectives of this course are to:

1. learn the modeling and design of databases
2. acquire knowledge on parallel and distributed databases and its applications
3. study the usage and applications of Object Oriented database
4. understand the usage of advanced data models

Course Outcomes:

On completion of the course, learners will be able to:

1. Select the appropriate high performance database like parallel and distributed database.
2. Design a semantic based database to meaningful data access.
3. Embed the rule set in the database to implement intelligent databases.
4. Represent the data using XML database for better interoperability.

Course Content:

UNIT I Overview of Storage and Indexing [10 Hours]

Memory hierarchy: RAID; Disk space management; Buffer manager: Files of records; Page formats and record format, Structured Indexing,, Data on external storage; File organizations and Indexing, Index data structures; Comparison of file organizations; Indexes and performance tuning. Intuition for tree indexes; Indexed sequential access method; B+trees , Hash-Based Indexing.

UNIT II Overview of Query Evaluation, External Sorting and Relational Query Optimizer

[10 Hours]

The system catalog, Introduction to operator evaluation; Algorithm for relational operations; Introduction to query optimization; When does a DBMS sort data? A simple two-way merge sort; External merge sort, Evaluating Relational Operators The Selection operation; General selection conditions; The Projection operation; The Join operation; The Set operations; Aggregate operations; The impact of buffering.

UNIT III Concurrency Control [10 Hours]

Serializability and Transaction processing: Enforcing, Serializability by Locks, Locking Systems With Several, Lock Modes, Architecture for a Locking Scheduler Managing . **Transaction**

processing: Introduction of transaction processing, advantages and disadvantages of transaction processing system, online transaction processing system, resolving deadlock, Transaction management in multi-database system, long duration transaction, high-performance transaction system.

UNIT IV Parallel and Distributed Databases and XML data [10 Hours]

Architectures for parallel databases; Parallel query evaluation; Parallelizing individual operations; Parallel query optimizations; Introduction to distributed databases; Distributed DBMS architectures; Storing data in a Distributed DBMS; Information retrival and XML data: Colliding Worlds: Databases, IR, and XML, Introduction to Information Retrieval, Indexing for Text Search, Web Search Engines, Managing Text in a DBMS, A Data Model for XML, XQuery: Querying XML Data. Mobile databases, Multimedia databases, geographic databases, temporal databases, biological databases.

Text Books:

1. Raghu Ramakrishnan and Johannes Gehrke: Database Management Systems, 3rd Edition, McGraw-Hill, 2003[Chapters:8,9,10,11,12,13,14,22,23,27,29]

Reference Books:

1. Michael Rosenblum and Dr. Paul Dorsey," PL/SQL FOR DUMMIES",WILLEY Publications 2006
2. Elmasri and Navathe: Fundamentals of Database Systems,5th Edition, Pearson Education, 2007
3. Conolly and Begg: Database Systems, 4th Edition, Pearson Education, 2002.
4. Steven Feuerstein,"oracle PL/SQL Programming", OREILLYpublications, Sixth edition 2014.

Course Code	Advanced Operating Systems	L	T	P	C
M21DGS113		2	1	0	3

Course Description

An advanced look at the principles of modern operating systems. **The process and the kernel**, communication between processes, interrupt handling in the kernel. Message passing and synchronization primitives and their implementation. Implementation of virtual memory and file systems.

Prerequisites:

Basics of Operating Systems.

Course Objectives:

The objectives of this course are to:

- Introduce the overview of operating system, process description and its control.
- Study Threads, SMP, and microkernel and virtual memory concepts.
- Provide systematic and comprehensive treatment of operating system;
- Provide a strong foundation in distributed resource management components. viz. the algorithms for implementation of distributed shared memory, recovery and commit protocols.

Course Outcomes:

On completion of this course the student will be able to:

- Demonstrate a fundamental knowledge of Windows, Linux, Unix, TinyOS, description and its control.
- Impart the knowledge about Threads, SMP, microkernel and virtual memory concepts.
- Demonstrate a fundamental knowledge of the various resource management techniques for distributed systems.
- Gain expertise in the security and kernel organization.

Course Content:

UNIT I Multiple Processor Systems [18 Hours]

MULTIPROCESSORS: Definition, Advantages, Classification, Multiprocessor Interconnections, Types of Multiprocessor Operating Systems, Multiprocessor OS Functions and Requirements, OS Design and Implementing Issues, Multicomputer, Virtualization, Multiprocessor Scheduling.

UNIT II Distributed Operating System [14Hours]

Definition, Need, Models of Distributed Systems, Distributed Message Passing, Remote Procedure calls, Algorithms for Distributed Processing.

UNIT III Multimedia Operating Systems [14Hours]

Introduction to Multimedia; Multimedia files: Video Encoding, Audio Encoding; Video compression: The JPEG Standard, The MPEG Standard; Audio compression; Multi-media process Scheduling.

UNIT IV Embedded System & Network Operating Systems [14Hours]

Embedded System: Definition, Need, Characteristics, Types of Embedded OS- Tiny OS; Network OS: Definition, Features of NOS, Types Of NOS, Windows Server VS Linux Server.

Recommended Learning Resources:

1) Andrew S Tanenbaum ,"Modern Operating System", 3rd ed (ch 7, 8)

2) Milan Milinkovic ,"Operating Systems" concepts and design, 2nd ed

3) "Operating Systems" Internals and design Principles By William Stallings ,6th ed

4) Springer, Springer transaction for advance in Distributed computing and middleware.

5) IEEE,IEEE transaction for Real time operating system.

6) ACM, ACM transaction for embedded operating system

Course Code	Data Mining with R Lab	L	T	P	C
M21DG0106		0	0	2	2

PART A

1. Creating Vectors and Matrices.
2. Managing Data frames and Functions
3. R script to find basic descriptive statistics using summary
4. Write an R script to find subset of dataset by using subset ()
5. Find the data distributions using box and scatter plot.
6. Find the outliers using plot.
7. Plot the histogram, bar chart and pie chart on sample data
8. Read and Write EXCEL files with package xlsx
9. Reading different types of data sets (.txt, .csv) using package

PART B

Classification:

10. Decision Trees with Package rpart
11. Random Forest using Package randomForest

Regression

12. linear regression model using function lm()
13. Multiple regression model using function lm()

Clustering

14. k-means clustering using function kmeans()
15. k-medoids clustering with functions pam() and pamk()

Association Rules

16. Association rule mining using function apriori()

TEXT BOOK:

Yanchang Zhao, “R and Data Mining: Examples and Case Studies”, Elsevier, 1st Edition, 2012

Course Code	Python Lab	L	T	P	C
M21DG0107		0	0	2	2

PART A

1. Demonstrate runtime reading of Strings.
    i) Illustrate the concept of String Slicing.
    ii) Also demonstrate a minimum of 5 functions defined on Strings.
2. Write a program to add two integers and print the result on the screen. Accept the values at runtime.
3. Demonstrate the usage of math and cmath UNIT.(For Ex. Program to find the roots of a Quadratic Equation)
4. Illustrate the usage of files with the help of different functions defined on Files(such as write, read(demonstrate all four forms), open, and close(use both the forms of closing a file)
5. Write a program to find the largest of two numbers
6. Write a program to find the biggest of three numbers
7. Show the different operations defined on Lists, Tuples and Dictionaries
8. Write a program to find the factorial of a number using functions and without using functions. Accept the input at runtime.
9. Demonstrate the i) Designing of a class ii) Creation of Object of that class iii) accessing the methods and instance variables in the class. The student is at the liberty of choosing their own Description of the object for designing the class.

PART B

1. Create, access, modify, and sort multidimensional NumPy arrays (ndarrays)
2. Load and save ndarrays • Use slicing, boolean indexing, and set operations to select or change subsets of a ndarray

3. Create, access, and modify the main objects in Pandas, Series and DataFrames • Perform arithmetic operations on Series and DataFrames • Load data into a DataFrame
4. Create a scatter plot showing the co-variation between two columns of your choice. Label the axes
5. Plotting a line graph and Plotting a histogram using matplotlib

TEXT BOOK:

VanderPlas, J. (2016). *Python data science handbook: Essential tools for working with data*. " O'Reilly Media, Inc.".
McKinney, W. (2012). *Python for data analysis: Data wrangling with Pandas, NumPy, and IPython*. " O'Reilly Media, Inc.".

SECOND SEMESTER

Course Code		L	T	P	C
M22AS0201	Tree Plantation in Tropical Region: Benefits and Strategic Planning	1	0	0	1

Course Description:

This course introduces significance of trees that provide us with a great many ecosystem services, including air quality improvement, energy conservation, stormwater interception, and atmospheric carbon dioxide reduction. These benefits must be weighed against the costs of maintaining trees, including planting, pruning, irrigation, administration, pest control, liability, cleanup, and removal.

Prerequisites:

NIL

Course Objectives:

The Course objectives are to

1. Develop basic understanding of role of trees in climate change
2. Emphasize on the selection and placing a tree for maximum benefit to environment
3. Involve in planting a tree and nurture till the completion of the degree program
4. Generate experiential report on the tree plantation process involved

Course Outcomes:

On successful completion of this course; the student will be able to:

1. Interpret the possible key benefits of trees arresting climate change and global warming
2. Develop the ability to identify the type of a tree to be planted in urban areas, agricultural fields and forestry areas
3. Make use of reading different literature on climate change and global warming by adopting various reading strategies (Reading Skills)
4. Take part in planting a tree and nurturing it and Generate report on tree plantation process involved

Course Content:

Unit 1: **[7 Hours]**

Introduction: The tropical region, Benefits and costs of urban and community forests

UNIT II **[7 Hours]**

Unit 2: General Guidelines for Selecting and Placing Trees: Guidelines for Energy Savings, Guidelines for Reducing Carbon Dioxide, Guidelines for Reducing Stormwater Runoff, Guidelines for Improving Air Quality Benefits, Guidelines for Avoiding Conflicts with Infrastructure, Guidelines for Maximizing Long-Term Benefits, Trees for Hurricane-Prone Areas

Activity based learning

Every student has to thoroughly understand the significance of planting a tree, identify type of tree and place to be planted, plant a tree and nurture till the completion of the degree.

Text Books:

1. Kelaine E. Vargas, E. Gregory McPherson, James R. Simpson, Paula J. Peper, Shelley L. Gardner, and Qingfu Xiao, “Tropical community tree guide: Benefits, Costs and Strategic Planting”, U.S. Department of Agriculture, Forest Service Pacific Southwest Research Station Albany, California, 2008

Reference Books:

1. Peter Wohlleben, The Heartbeat of Trees, Penguin Books, 2021
2. Daniel Chamovitz, “What a Plant Knows: A Field Guide to the Senses”, 2020

Course Code	Machine Learning using Python	L	T	P	C
M21DG0201		3	0	1	4

Course Description:

Machine Learning is a key to develop intelligent systems and analyze data in science and engineering. It covers theoretical foundations as well as essential algorithms for supervised and unsupervised learning.It also covers semi-supervised learning techniques.

Prerequisites:

Data Mining.

Course Objectives:

The objective of this course are to

1. Describe the basic components of Machine Learning with concepts of Python.
2. Differentiate broad categories of Machine learning.
3. Compare different types of algorithms used in Machine Learning domain with limitations.
4. Examine the limitations of various machine learning algorithms and the way to evaluate performance of machine learning algorithms.

Course Outcomes:

On successful completion of this course; the student will be able to:

- Explain concepts and theories of Machine Learning
- Formulate innovative ideas or techniques of machine learning for the real world problems
- Apply Machine Learning algorithms for specific problems.
- Understand the challenges and issues related to machine learning application areas.

Course Content:

UNIT **[10 Hours]**

Introduction: Definition, Applications for Machine Learning in data Science, Machine learning used in the data Science Process, Python tools used in Machine Learning, Modeling process, Types of Machine Learning.

Reinforcement Learning: Introduction, The Learning Task, Q Learning, Nondeterministic Rewards and Actions, Temporal Difference learning, Generalization from Examples, Relationship to Dynamic programming.

UNIT II **[10 Hours]**

Support Vector machine: Maximum margin hyperplanes: Rationale for Maximum Margin, Linear SVM: Separable Case: Linear Decision Boundary, Margin of a Linear Classifier, learning a Linear SVM model, Linear SVM: Nonseparable Case, Nonlinear SVM: Attribute Transformation, Learning a Nonlinear SVM, Kernel Trick, Characteristics of SVM. (Chapter 5.5 from TextBook-2).

UNIT III Neural Network **[10 Hours]**

Introduction, basic Architecture of NN, Training a NN with Backpropagation, Practical Issues in NN training, Secrets to the power of function composition, Common Neural Architecture, Advanced topics.

UNIT IV Model Evaluation and Improvement [10 Hours]

Cross-Validation, Cross-Validation in scikit-learn, Benefits of Cross-Validation, Stratified k-Fold Cross-Validation and Other Strategies, Grid Search, Simple Grid Search, The Danger of Overfitting the Parameters and the Validation Set, Grid Search with Cross-Validation, Evaluation Metrics and Scoring, Keep the End Goal in Mind, Metrics for Binary Classification, Metrics for Multiclass Classification, Regression Metrics, Using Evaluation Metrics in Model Selection.

Text Books:

1. Meysman, A., Cielen, D. (2016). Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools. (n.p.): Manning Publications. (Unti-I)
2. Amanda Casari, Alice Zheng, "Feature Engineering for Machine Learning", O'Reilly, 2018(Unit-II)
3. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013. (Unit-I)
4. Aggarwal, C. C. (2018). Neural Networks and Deep Learning: A Textbook. Germany: Springer International Publishing. (Unit-III)
5. Introduction of Machine Learning with Python – by Andreas C Muller & Sarah Guidp – O'Reilly & Shroff publishers. (Unit-IV).

Reference Books:

1 Peter Flach ,Machine Learning: The Art and Science of algorithms – Cambridge University Press.

2 EthemAlpaydin, Machine Learning – PHI learning private limited.

3 David barber ,Bayesian Reasoning and Machine Learning - Cambridge University Press.

4 Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

5 Tom M Mitchell, Machine Learning , McGraw Hill Education publication – 2013.

6 Trevor Hastie, Robert Tibshirani and Jerome Friedman The Elements of Statistical Learning, Springer 2017 publication.

7 Michael Dawson, Python Programming for absolute beginners-3rd Edition.

LAB Programs:

1. Installing python tools.
2. Implementation of Q- algorithm
3. Implementation Neural Network
4. Implementation of Back propagation NN
5. Implementation of SVM algorithm
6. Implementation of Cross validation
7. Implementation of Regression Metrics
8. Implementation of Evaluation Metrics for above algorithm.

Course Code	Mathematical Foundations for Data Science – II	L	T	P	C
M21DG0202		4	0	0	4

Course Description:

This course introduces fundamental mathematical concepts relevant to computer science and provides a basis for further postgraduate study in data science, statistical machine learning, and cybersecurity. Topics covered are probability: sets, counting, probability axioms, Bayes theorem; optimisation and calculus: differentiation, integration, functions of several variables, series approximations; linear algebra: vector and matrices, matrix algebra, vector spaces; discrete mathematics and statistics: linear regression, linear least squares, regularisation. Applications of the theory to data science and machine learning will be developed.

Prerequisites:

Basic Maths

Course Objectives:

This course will:

- To prepare students for future courses having quantitative components..
- To expose the students to the basics of probability
- To expose the students to the basics of random processes
- To recognize and compute the single and multi-sample tests for m descriptive and inferential statistics in many different fields.

Course Outcomes:

On the successful completion of this course, Students shall be able to

- Understand and apply statistical theory to analytics field.
- Design Probability Distribution Problems to solve by computing.
- Illustrate and apply the concepts of random variables and solve real world problems in appropriate contexts by using standard techniques.
- Deal with the different Sampling Techniques used in Big data and related areas.

Course Content:

UNIT I Predictive Analytics **[15 Hours]**

Predictive modeling and Analysis - Regression Analysis, Correlation analysis, Rank correlation coefficient, multiple correlation, least square, Curve fitting and goodness of fit.

UNIT II Probability Distribution **[15 Hours]**

Some special probability distribution – Bernoulli, Binomial, Poison, Uniform, Triangular, Exponential and Normal Distribution.

UNIT III Random Variable & Mathematical Expectation **[15 Hours]**

Introduction probability and its property, Random variable, its types DRV, CRV and its distributions, two dimensional R V, joint probability function, marginal density function and Mathematical expectation.

UNIT IV Hypothesis Testing **[15 Hours]**

Introduction Sampling, Sampling distribution, one and two tailed test, Test of significance, (mean, difference of means), confidence interval 1% and 5% level of significance - Design of Experiments, one way classification, two way classification, ANOVA.

Text Books:

1. Gupta. S.C and Kapoor V.K. Fundamentals of Mathematical Statistics, Sultan Chand and sons, (2001)
2. Freund J.E., Mathematical Statistics, Prentice hall, (2001).

Reference Books:

1. P K Srimani and M Vinayaka Murthy, "Probability and Statistics", Subhas Stores, 2000
2. Berenson and Levine, Basic Business Statistics, Prentice- Hall India (1996, 6thedition)
3. D.C. Montogomery and G.C. Runger, "Applied Statistics and Probability for engineers", New Jersey,John Wiley and Sons, 3rd edition, 2003.
4. S M Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Academic Foundation, 2011.
5. Medhi.J, "Statistical methods - An introductory text", new age publications, 2009 edition.
6. S.P.Gupta, "Statistical methods"- Sultan Chand & Sons, New Delhi, 2012 Edition
7. P K Srimani and M Vinayaka Murthy, "Probability and Statistics", Subhas Stores, 2000
8. Berenson and Levine, Basic Business Statistics, Prentice- Hall India (1996, 6thedition)
9. D.C. Montogomery and G.C. Runger, "Applied Statistics and Probability for engineers", New Jersey,John Wiley and Sons, 3rd edition, 2003.
10. S M Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Academic Foundation, 2011.
11. Medhi.J, "Statistical methods - An introductory text", new age publications, 2009 edition.
12. S.P.Gupta, "Statistical methods"- Sultan Chand & Sons, New Delhi, 2012 Edition

13. P K Srimani and M Vinayaka Murthy, “Probability and Statistics”, Subhas Stores, 2000
14. Berenson and Levine, Basic Business Statistics, Prentice- Hall India (1996, 6th edition)
15. D.C. Montogomery and G.C. Runger, “Applied Statistics and Probability for engineers”, New Jersey,John Wiley and Sons, 3rd edition, 2003.
16. S M Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, Academic Foundation, 2011.
17. Medhi.J, “Statistical methods - An introductory text”, new age publications, 2009 edition.
18. S.P.Gupta, “Statistical methods”- Sultan Chand & Sons, New Delhi, 2012 Edition
19. P K Srimani and M Vinayaka Murthy, “Probability and Statistics”, Subhas Stores, 2000
20. Berenson and Levine, Basic Business Statistics, Prentice- Hall India (1996, 6th edition)
21. D.C. Montogomery and G.C. Runger, “Applied Statistics and Probability for engineers”, New Jersey,John Wiley and Sons, 3rd edition, 2003.
22. S M Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, Academic Foundation, 2011.
23. Medhi.J, “Statistical methods - An introductory text”, new age publications, 2009 edition.
24. S.P.Gupta, “Statistical methods”- Sultan Chand & Sons, New Delhi, 2012 Edition
25. P K Srimani and M Vinayaka Murthy, “Probability and Statistics”, Subhas Stores, 2000
26. Berenson and Levine, Basic Business Statistics, Prentice- Hall India (1996, 6th edition)
27. D.C. Montogomery and G.C. Runger, “Applied Statistics and Probability for engineers”, New Jersey,John Wiley and Sons, 3rd edition, 2003.
28. S M Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, Academic Foundation, 2011.
29. Medhi.J, “Statistical methods - An introductory text”, new age publications, 2009 edition.
30. S.P.Gupta, “Statistical methods”- Sultan Chand & Sons, New Delhi, 2012 Edition
31. P K Srimani and M Vinayaka Murthy, “Probability and Statistics”, Subhas Stores, 2000
32. Berenson and Levine, Basic Business Statistics, Prentice- Hall India (1996, 6th edition)

33. D.C. Montogomery and G.C. Runger, “Applied Statistics and Probability for engineers”, New Jersey,John Wiley and Sons, 3rd edition, 2003.
34. S M Ross, “Introduction to Probability and Statistics for Engineers and Scientists”,.
35. P K Srimani and M Vinayaka Murthy, “Probability and Statistics”, Subhas Stores, 2000
36. Berenson and Levine, Basic Business Statistics, Prentice- Hall India (1996, 6th edition)
37. D.C. Montogomery and G.C. Runger, “Applied Statistics and Probability for engineers”, New Jersey,John Wiley and Sons, 3rd edition, 2003.
38. S M Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, Academic Foundation, 2011.
39. Medhi.J, “Statistical methods - An introductory text”, new age publications, 2009 edition.
40. S.P.Gupta, “Statistical methods”- Sultan Chand & Sons, New Delhi, 2012 Edition

Course Code	BigData with NoSQL	L	T	P	C
M21DG0203		4	0	0	4

Course Description:

The course has been designed to give learners a very comprehensive understanding of Big Data and MongoDB. This will give a comprehensive look at the wide landscape of database systems and how to make a good choice in your next project. This course covers almost all classes of databases or data storage platform there are and when to consider using them. Students will learn how to design, build, launch, deploy, and scale an application using MongoDB with PHP.

Prerequisites:

Data Bases and RDBMS

Course Objectives:

The objectives of this course are to:

- Learn the latest trends in databases.
- Learn various NoSql systems and their features.
- Compare NoSql databases with each other and relational systems.
- Acquire knowledge in parallel, distributed databases and its applications.

Course Outcomes:

On completion of this course the student will be able to:

1. Define, compare and use the four types of NoSQL Databases (Document oriented, Key Value Pairs, Column oriented and Graph).
2. Analyze the need of NoSQL databases in handling Big data
3. Compare the Difference between the types of NOSQL databases.
4. Evaluate NoSQL database development tools and programming languages.

Course Content:

UNIT I Introduction to NOSQL [13 Hours]

Introduction to NoSQL Definition of NOSQL-Challenges in traditional RDBMS- Need for NOSQL-Big Data and NoSQL, Need for schema less databases. History of NOSQL. Aggregate data models, Distribution models, CAP theorem, Types of NOSQL Data bases- key-value Column store, document data models and Graph Data models. Scalability and NoSQL.

UNIT II Key-Value Stores and Column Stores [13 Hours]

Introduction to Key-value stores- Exploring RedisRedis data model Storing Data in and Accessing Data from Apache Redis –Querying in Redis using examples Redis use cases. Introduction to Column stores- Exploring HBASE – HBASE data model Storing Data CRUD operations in HBASE.

UNIT III Document stores and its applications [13 Hours]

Introduction to Document stores, Exploring MongoDB, MongoDB data model, Storing Data in and Accessing Data from MongoDB, Querying in MongoDB using examples, Interact with MongoDB using any one Language Binding with PHP.

UNIT IV Big Data Handling and Graph Databases [13 Hours]

Big Data processing with MongoDB, Import and Export commands in MongoDB, MongoDB Indexing. MongoDB DatabaseAdministration.

Graph Databases, Introduction,What Is a Graph-A High-Level View of the Graph Space, Performance, Graph Databases, Graph Compute Engines, The Power of Graph Databases,, Options for Storing Connected Data, Relational Databases Lack Relationships, NOSQL Databases Also Lack Relationships, Graph Databases Embrace Relationships.

Data Modeling with Graphs, Models and Goals, The Labeled Property Graph Model, Querying Graphs: An Introduction to Cypher, Cypher Philosophy, MATCH, RETURN, other Cypher clauses.

Text Books:

1. Pramod. J. Sadalge, Martin Fowler, NoSQL distilled, A brief guide to emerging world of Polyglot persistence. Addison-Wesley 2013.
2. Lars GeorgeHBase: A definitive Guide, OReilly publications,2011.
3. Josiah L. Carlson, Redis in Action,Manning Publications, 2013.
4. The Definitive guide to MongoDB, The NoSQL Database for Cloud and Desktop Computing, Apress2010.
5. Ian Robinson, Jim Webber & Emil Eifrem, Graph Databases.

Reference Books:

1. "Professional NOSQL" by Shashank Tiwari, 2011, WROX Press.
2. Kristina Chodorow, MongoDB: The Definitive Guide, 2nd Edition, O'Reilly publications,2013.

Course Code	Foundation of Data Visualization	L	T	P	C
M21DG0204		2	1	0	3

Course Description:

This course explores **the design, development, and evaluation of such information visualizations**. By combining aspects of design, computer graphics, HCI, and data science, you will gain hands-on experience with creating visualizations, using exploratory tools, and architecting data narratives.

Prerequisites:

Probability & Statistics

Course Objectives:

The objectives of this course are to:

1. Discuss concepts and principles of data visualization particularly related to decision making.
2. Investigate technologies and practices for visualizing data as part of a data management and analytics system.
3. Apply user interface design principles and practices to develop interactive data visualizations.
4. Design effective dashboard for decision making at various levels.
5. Conduct research on relevant data visualization topics.

Course Outcomes:

On successful completion of this course, the student is expected to be able to:

1. Evaluate a visualization solution based on quantitative metrics such as time and error, as well as more complex and qualitative metrics.

Course Content:

1. Articulate human, visual, and interactive design issues for creating effective visualizations.
2. Identify appropriate data visualization techniques given particular requirements imposed by the data.
3. Use existing visualization tools and techniques to analyze basic datasets.
4. Apply existing techniques from scalar, volume, multidimensional, textual, graph-based, tree-based, and temporal visualization to actual problems and data.

UNIT I Introduction **[10 Hours]**

Basics of data visualization, Getting started with Tableau.

Connecting to Data Sources: Connecting to Text file, Excel file, database, Understanding the dimensions and measure, applying filters. Creating Univariate charts: Creating Table, bar graph, pie charts, graphs, histograms, line chart, box plot, showing aggregate measures.

UNIT II Bivariate and Multivariate Charts **[10 Hours]**

Creating tables, scatter plots, swapping rows and columns, adding trend lines, selecting color palettes, dates, creating facets, area charts, bullet graphs, gantt charts, heat maps.

UNIT III Maps and Fields **[10 Hours]**

Creating Map: setting geographic roles, placing marks on map, overlaying demographic data, choropleth maps, polygon shapes, customizing maps, Calculating User-define Fields: predefined functions, percentages, if-then logic, logical function, totals, discretizing data, Manipulating text.

UNIT IV Sharing and Advanced Features **[10 Hours]**

Saving a workbook on a tableau, web, exporting images, data, Presentation mode, adding annotation, excluding data on the fly, adding drop-down selectors, creating dashboards, creating animated visualizations, parameters.

TextBooks:

1. Nandeshwar, A. (2013). Tableau Data Visualization Cookbook. India: Packt Publishing.
2. Wexler, S., Cotgreave, A., Shaffer, J. (2017). The Big Book of Dashboards: Visualizing Your Data Using Real-World Business Scenarios. Germany: Wiley.

Reference Books:

1. 1. Jones, Ben. Communicating Data with Tableau: Designing, Developing, and Delivering Data VisualizationsLinks to an external site.. 1 edition. Sebastopol, CA: O'Reilly Media, 2014.
2. Ware, C & Kaufman, M. (2008). Visual thinking for design. Burlington: Morgan Kaufmann Publishers.
3. Sosulski, K. (2018). Data Visualization Made Simple: Insights into Becoming Visual. New York: Routledge.

Course Code	BIG DATA SECURITY	L	T	P	C
M21DGS211		2	1	0	3

Course Description:

Explores the foundations of big data, including it's foundations in computing technology and statistics. Explores the nature of underlying technical challenges and statistical assumptions used to understand relationships in a variety of applied fields, with a focus on the fields of fraud detection and communication monitoring. Engages with the social implications of increased knowledge, surveillance, and behavioral prediction made possible by big data, and the ethical tradeoffs faced. While the course includes an analytics project, no prior technical experience is required.

Prerequisites:

Basics of Big data Management.

Course Objectives:

The objectives of this course are to:

- Discover fundamental concepts of system security management and risk management
- Explore understanding in authentication and encryption key management
- Analyze the security architecture and frameworks
- Explain the fundamental of ethics in Cyber Security

Course Outcomes:

On completion of this course the students will be able to:

- Understand the basic concepts of managing Big Data and the security risks involved in it
- Demonstrate the role of encryption key in Big data security management
- Explore the facets of Authentication and authorization in Big Data secuirty
- 4.Understand the principles of Ethics behind Big data Security

Course Content:

UNIT I Data Security Fundamentals [10 Hours]

Big data security- Data Protection - Security and Privacy Issues of Big Data - Big Data Security – Organizational Security -Secure Computations in Distributed Programming Frameworks - Security Best Practices for Non- Relational Data Stores- Secure Data Storage and Transactions Logs – Endpoint Input Validation/Filtering- Big data privacy.

Understanding Privacy: Social Aspects of Privacy Legal Aspects of Privacy and Privacy Regulations Effect of Database and Data Mining technologies on privacy challenges raised by new emerging technologies such RFID, biometrics, etc., Privacy Models -Scalable and Composable Privacy-preserving analytics.

UNIT II Security,Compliance,Auditing and Protection [10 Hours]

Steps to secure big data – Classifying Data – Protecting – Big Data Compliance – Intellectual Property Challenge .Real-Time Security/Compliance Monitoring - Cryptographic Technologies for Big data.

Classical Encryption Techniques Symmetric Cipher Model, Cryptography, Cryptanalysis and Brute-Force Attack, Substitution Techniques, Caesar Cipher, Monoalphabetic Cipher, Data Encryption standards.

Public Key Cryptography

Principles of Public-key Cryptosystems, Public-Key Cryptosystems, Applications for Public-Key Cryptosystems, Requirements for Public-Key Cryptosystems. Public-Key Cryptanalysis. The RSA Algorithm, Description of the Algorithm, Computational Aspects, the Security of RSA.

UNIT III Authentication and Authorization [10 Hours]

Authentication Vs Authorization, Authentication Methods –Password authentication, Public Key Cryptography, Biometric authentication, Out of band, Authentication Protocols – SSL, Password Authentication Protocol (PAP), Kerberos, Email authentication,- PGP, Database authentication, Message authentication; secure hash functions and Authorization digital signatures, key

management. Kerberos,. Authorization Definition, Multilayer authorization -Granular Access Control-Granular audits - Data Provenance.

UNIT-IV Ethics and Cyber Security [10 Hours]

Ethics – Ownership – Ethical Guidelines -Data Science Ethics – Doing good data science – Owners of the data - Valuing different aspects of privacy - Getting informed consent - The Five Cs – Diversity – Inclusion –Future Trends.

Introduction to Cyber Security and its problem- Introduction to the Legal Perspectives of Cybercrimes and Cyber security, Cybercrime and the Legal Landscape around the World, Need of Cyber laws, Security policies.

Text Books:

1. Davi Ottenheimer, Big Data Secuirty.
2. Cryptography and Network Security Principles and Practice William Stallings, 6th edition, Pearson Education.
3. Sunit Belapure and Nina Godbole, Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives, Wiley India Pvt. Ltd, 2011.

Reference Books:

1. https://arxiv.org/ftp/arxiv/papers/1601/1601.06206.pdf
2. https://downloads.cloudsecurityalliance.org/assets/research/big-data/BigData_Security_and_Privacy_Handbook.pdf
3. Principles of Information Security : Michael E. Whitman, Herbert J. Mattord, CENGAGE Learning, 4th Edition

Course Code	Image and Video Analytics	L	T	P	C
M21DGS212		2	1	0	3

Course Description:

The course will enable computer science undergraduates to apply their **mathematical knowledge and understanding** of algorithms to problems in image and video processing: from preprocessing, to quantitation, video compression and video interpretation.

Prerequisites:

Basics of Multimedia and Image processing.

Course Objectives:

This Course will enable students to

- Learn the fundamentals of digital image processing, image and video analysis.
- Understand different filtering techniques in image and video.
- Learn different Compression techniques in Image and video analysis.
- Introduce the students to advanced object detection and recognition.

Course Outcomes:

Upon completion of the course, the student should be able to:

- Describe the fundamental principles of image and video analysis and have an idea of their application.
- Identify the different types of filtering techniques for different applications.
- Become familiar with the basic Compression techniques in Image and video analysis and implementation.
- Apply image and video analysis in real world problems.

Course Content:

UNIT I Introduction [10 Hours]

Digital image representation, Sampling and Quantization, Types of Images, Basic Relations between Pixels - Neighbors, Connectivity, Distance Measures between pixels Linear and Non Linear Operatiopns, Introduction to Digital Video, Sampled Video, Video Transmission.

UNIT II Fundamentals of filtering [10 Hours]

Spatial correlation and convolution-smoothing blurring-sharpening- edge detection - Basics of filtering in the frequency domain: smoothing-blurring- sharpening--Histograms and basic statistical models of image.Morphological filtering, Frequency domain – Homomorphic Filtering, Blotch Detection and Removal - Blotch Detection, Motion Vector Repair and Interpolating Corrupted Intensities, Intensity Flicker Correction - Flicker Parameter Estimation, Brief introduction towards Wavelets.

UNIT II Image and Video Compression [10 Hours]

Image Compression: Huffman coding, Run length coding, LZW coding, Lossless Coding.

Video Compression: Basic Concepts and Techniques of Video Coding, Video Standards.

UNIT IV Colour models and Transformations [10 Hours]

Colour models and Transformations – Image and Video segmentation-Image and video demonizing- Image and Video enhancement- Image and Video compression.
Object detection and recognition in image and video-Texture models Image and Video classification models- Object tracking in Video.

Text Books:

1. R.C. Gonzalez and R.E. Woods.” Digital Image Processing”. 3rd Edition. Addison Wesley, 2007
2. Alan Bovik, Handbook of Image and Video Processing, Second Edition, Academic Press, 2005
3. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Third Edition,Pearson Education, 2008.

Reference Books:

1. Anil K Jain, Fundamentals of Digital Image Processing, PHI, 2011.
2. Jean-Yves Dufour, "Intelligent Video Surveillance Systems", Wiley, 2013.
3. Caifeng Shan, Fatih Porikli, Tao Xiang, Shaogang Gong, "Video Analytics for Business Intelligence", Springer, 2012.
4. AsierPerallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García.

Course Code	Cloud Computing	Course Type	L	T	P
M21DGS213		HC	2	1	0

Course Description:

Cloud Computing is the on-demand solution for storing and retrieving data globally. Softlogic Systems provides the best practice on cloud computing usage to handle big data of an organization with the remote server access. We offer preeminent placement assistance and worthwhile certification after the successful course completion along with adequate hands-on experiences based on our industry-relevant cloud computing course syllabus to perform well in the companies from the beginning.

Prerequisites:

Computer Networks and parallel processing basics.

Course Objectives:

The objectives of this course are to:

- Introduce the broad perceptive of cloud architecture and model.
- Understand the concept of Virtualization and design of cloud Services.
- Be familiar with the lead players in cloud.
- Apply different cloud programming model as per need.

Course Outcomes:

On completion of the course, learners will be able to:

- Compare the strengths and limitations of cloud computing.
- Identify the architecture, infrastructure and delivery models of cloud computing.
- Apply suitable virtualization concept.
- Choose the appropriate cloud player, Programming Models and approach.

Course Content:

UNIT I Fundamentals of Cloud Computing [**10 Hours]**

Introduction to Software Project Management: Why software project important?, software project Cloud computing at a glance, The vision of cloud computing, Defining a cloud, A closer look, Historical developments, Building cloud computing environments Application development. Characteristics of Cloud computing. Scalability, types of scalability. Horizontal Scalability and Cloud Computing. Computing platforms and technologies, Principles of Parallel and Distributed Computing. Programming Models : Parallel and Distributed Programming Paradigms , MapReduce.

UNIT II Fundamental Concept on Virtualization and Models **[10 Hours]**

Basics of Virtualization, Characteristics of virtualized environments, Taxonomy of virtualization techniques, - Types of Virtualization, Virtualization and cloud computing, Technology examples, Xen: paravirtualization, VMware: full virtualization –Just introduction.

UNIT III Cloud Infrastructure Mechanisms and Architecture: **[10 Hours]**

Fundamentals of Cloud Architecture, The cloud reference model, Cloud Delivery Models: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), Comparing Cloud Delivery Models, Cloud Deployment Models: Public Clouds, CommUnity Clouds, Private Clouds, Hybrid Clouds.

Cloud Platforms – Aneka.Framework overview, Anatomy of the Aneka container, Aneka Deployment modes-Private, Public and Hybrid.

Amazon Web Services overview.

UNIT IV Fog and Edge Computing [10 Hours]

Fog Computing, Fog computing architecture, Fog Node, Fog Computing Essential Characteristics, Fog Node Attributes, Fog Service and Deployment models, Fog enabled IOT network.

Edge computing –overview, architecture, Edge vs Fog, Edge computing and IOT, Impact of Edge computing in 5G network.

Text Books:

1. Rajkumar Buyya, Christian Vechiolla, Thamarai Selvi, "**Mastering Cloud Computing**, Elsevier publications, 2013, USA. (UNIT-I : Chapter 1 and 2, UNIT-II: Chapter 3, UNIT-III:Chapter 4,5.1, UNIT-IV: Chapter 8,9.1,9.2 and 10.

Reference Books:

1. Rajkumar Buyya, James Broberg, Andrzej Goscinski, "**Cloud Computing: Principles and Paradigms",** Wiley, India.
2. KaiHwang, Geoffrey C Fox, Jack G Dungaree, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers,2012http://en.wikipedia.org/wiki/Comparison_of_project_management_software
3. Thomas Erl, Zaigham, Mahmood, Ricard o Puttini, "**Cloud Computing: Concepts, Technology & Architecture"**, Prentice Hall/Pearson.

Course Code	Parallel and Distributed Systems	L	T	P	C
M21DGS221		2	1	3	3

Course Description:

This course covers a broad range of topics related to parallel and distributed computing, including parallel and distributed architectures and systems, parallel and distributed programming paradigms, parallel algorithms, and scientific and other applications of parallel and distributed computing. In lecture/discussion sections, students examine both classic results as well as recent research in the field. The lab portion of the course includes programming projects using different programming paradigms, and students will have the opportunity to examine one course topic in depth through an open-ended project of their own choosing. Course topics may include: multi-core, SMP, MMP, client-server, clusters, clouds, grids, peer-to-peer systems, GPU computing, scheduling, scalability, resource discovery and allocation, fault tolerance, security, parallel I/0, sockets, threads, message passing, MPI, RPC, distributed shared memory, data parallel languages, MapReduce, parallel debugging, and applications of parallel and distributed computing.

Prerequisites:

Web programming and Networks

Course Objectives:

The objectives of this course are to:

Course Outcomes:

On successful completion of this course; the student will be able to:

- Apply knowledge of parallel and distributed computing techniques.
- Design, development, and performance analysis of parallel and distributed applications.
- Use the application of fundamental Computer Science methods and algorithms in the development of parallel applications.

Non Token based Algorithms:- Lamport Algorithm, Ricart–Agrawala's Algorithm, Maekawa's Algorithm

. • Explain the design, testing, and performance analysis of a software system, and to be able to communicate that design to others.

Course Content:

UNIT I Introduction [10 Hours]

Parallel Computing, Parallel Architecture, Architectural Classification Scheme, Performance of Parallel Computers, Performance Metrics for Processors, Parallel Programming Models.

Types of distributed systems, Distributed System Models, Hardware & Software Concept, Middleware: introduction, Models, Services, Client Server model.

UNIT II Pipeline Processing [10 Hours]

Introduction, Pipeline Performance, Arithmetic Pipelines, Pipelined Instruction Processing, Pipeline Stage Design, Hazards, Dynamic Instruction Scheduling.

Synchronous Parallel Processing: SIMD Architecture and Programming Principles, SIMD Parallel Algorithms, Data Mapping and memory in array processors, Case studies of SIMD.

UNIT III Resource and Process Management [10 Hours]

Resource Management in Distributed System, Desirable Features of Global Scheduling Algorithm, Scheduling in the Distributed System, Taxonomy of the Distributed Scheduling, Task Assignment Approach, Load Balancing Approach, Issues in Designing Load Balancing Algorithm, Load Sharing Approach, Introduction to Process Management.

UNIT IV Synchronization [10 Hours]

Introduction: Clock Synchronization, Physical Clock, Logical Clock, Election Algorithms, Mutual Exclusion, Centralized Algorithm, Distributed Mutual Exclusion, Token based &

Token Based Algorithms:- Suzuki-Kasami's Broardcast Algorithms, Singhal's Heurastic Algorithm

Text Books:

1. Parallel and Distributed Systems, 2ed, Arun Kulkarni, Nupur Prasad Giri, Nikhilesh Joshi, Bhushan Jadhav. ISBN: 9788126565825.

Reference books:

1. Introduction to Parallel Computing, by Kumar, Grama, Gupta and Karypis, Benjamin Cummings Publishing Co., 2nd Ed., 2003.

2. Using MPI: Portable Parallel Programming with the Message-Passing Interface, by William Gropp, Ewing Lusk, and Anthony Skjellum, 2nd Ed., 1999.

Course Code	Natural Language Processing	L	T	P	C
M21DGS222		2	1	0	3

Course Description:

Natural Language Processing (NLP) is a rapidly developing field with broad applicability throughout the hard sciences, social sciences, and the humanities. The ability to harness, employ and analyze linguistic and textual data effectively is a highly desirable skill for academic work, in government, and throughout the private sector. This course is intended as a theoretical and methodological introduction to a the most widely used and effective current techniques, strategies and toolkits for natural language processing, with a primary focus on those available in the Python programming language.

Prerequisites:

Data Mining, Data Analysis.

Course Objectives:

The objectives of this course are to:

- Introduce the fundamental concepts and techniques of natural language processing
- Learn the basic concept of Regular expressions and semantics of English language for processing
- Understand the concept of Parsing and Speech Phonetics
- Introduce NLP in real life example

Course Outcomes:

On successful completion of this course, the student will be able to:

- Apply key concepts from NLP to describe and analyze language
- Understand the semantics and pragmatics of English language for processing
- Gain an in-depth understanding of the computational properties of natural languages algorithms for processing linguistic information
- Examine NLP models and algorithms in real life

Course Content:

UNIT I Introduction **[10 Hours]**

Introduction, Machine Learning and NLP, General Characteristics of Natural language – ambiguity, incompleteness, imprecision; Linguistic Essentials – Part of speech, Lexicography, morphology; WordNet, Wordnet; Application in Query Expansion, Measures of WordNet Similarity.

UNIT II Regular expressions **[10 Hours]**

Regular expressions, Finite State Automata, word recognition, lexicon. Morphology, acquisition models, Finite State Transducer. N-grams, smoothing, entropy, HMM, ME, SVM, CRF.

Part of Speech tagging- Stochastic POS tagging, HMM, Transformation based tagging (TBL), Handling of unknown words, named entities, multi word expressions.

UNIT III Parsing **[10 Hours]**

Speech : Phonetics, Hidden Markov Model, Morphology, Graphical Models for Sequence Labeling in NLP, Consonants (place and manner of articulation) and Vowels.

Probabilistic parsing; Sequence labelling, PCFG, Probabilistic parsing: Training issues, Arguments and Adjuncts, Probabilistic parsing; inside-outside probabilities.

UNIT IV Discourse and Applications **[10 Hours]**

Discourse- Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure.

Applications of NLP- Spell-checking, Summarization

Information Retrieval- Vector space model, term weighting, homonymy, polysemy, synonymy, improving user queries.

Text Books:

1. Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.
2. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.
3. Jurafsky, Dan and Martin, James, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
4. Daniel Jurafsky and James H Martin. Speech and Language Processing, 2e, Pearson Education, 2009.

Reference Books:.

1. James A.. Natural language Understanding 2e, Pearson Education, 1994.

2. Bharati A., Sangal R., Chaitanya V.. Natural language processing: a Paninian perspective, PHI, 2000.

3. Siddiqui T., Tiwary U. S.. Natural language processing and Information retrieval, OUP 2008

4. Manning, Christopher and Heinrich, Schutze, Foundations of Statistical

5. Natural Language Processing, MIT Press, 1999

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Course Code	Internet of Things	CourseType	L	T	P	C
M21DGS223		SC	2	1	0	3

Course Description:

This Course focuses on hands-on IoT concepts such as sensing, actuation and communication. It covers the development of Internet of Things (IoT) prototypes—including devices for sensing, actuation, processing, and communication—to help you develop skills and experiences. The Internet of Things (IOT) is the next wave, world is going to witness. Today we live in an era of connected devices the future is of connected things.

Prerequisites:

Nil

Course Objectives:

The objectives of this course are to:

- Discuss the basics of Internet of Things.
- Identify different IoT applications and their application areas.
- Explain the emerging field of wireless sensor networks and IoT, which consist of many tiny, low-power devices equipped with sensing, computation, and wireless communication capabilities.
- Describe operating systems, radio communication, networking protocols, Methodologies of IoT.

Course Outcomes:

On completion of the course, learners will be able to:

- Create the IoT applications with the help of IoT enabled Technologies.
- Sketch protocols for IoT Applications.
- Analyze low-power devices equipped with sensing, computation, and wireless communication capabilities.
- Develop the operating systems, radio communication, networking protocols, using Methodologies of IoT.

Course Content:

UNIT I Introduction to Internet of Things [10 Hours]

Definition & Characteristics of IoT, Physical Design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT Functional Blocks, Communication Models, IoT Communication APIs, IoT Enabling Technologies, Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, RFID Basics, Embedded Systems, IoT Levels & Deployment Templates.

UNIT II IoT and M2M [10 Hours]

Introduction; M2M, Difference between IoT and M2M , SDN and NFV for IoT , Software Defined Networking , Network Function Virtualization , IoT System Management with NETCONF-YANG, Need for IoT Systems Management, Simple Network Management Protocol (SNMP) , Limitations of SNMP , Network Operator Requirements, NETCONF, YANG, IoT Systems Management with NETCONF-YANG.

UNIT III Developing Internet Of Things [10 Hours]

IoT Design Methodology **:**

Step 1: Purpose & Requirements Specification.
Step 2: Process Specification.
Step3: Domain Model Specification.
Step4: Information Model Specification.
Step 5: Service Specifications.
Step6: IoT Level Specification.
Step7: Functional View Specification
Step8: Operational View Specification
Step9: Device & Component Integration
Step10: Application Development.
Logical Design of IOT using Python, Introduction to Python, Basics of Programming with Rasphberry PI with PYTHON, IOT Physical devices and end points.

UNIT IV IoT Architecture **[10 Hours]**

IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control.

Text Books

1. Internet of Things-An Hands on Approach-Vijay Madisetti (Author), Arshdeep Bahga,2014 (chapter 1,3,4, 5, 6).
2. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer.

Reference Books:

1. Cuno P fister Getting Started with the Internet of Things, OReilly, 2011.
2. Francis Da Costa, Rethinking Internet of things, Apress Open Edition, 2013.
3. Adrian Mc Ewen, Hakim Cassimally, Design of Internet of Things, 2014 John Wiley and Sons, Ltd.

Course Code		Course Type	C	T	P	C
M21DG0205	**Data Visualization Lab**	HC	0	0	2	2

PART A: EXCEL

1 : Building a Classic Excel Dashboard

a) Formatting Data

b) Building a Pivot Table

c) Adding pivot charts and a slicer

2: Explore an Excel Data Model

a) Create Calculated Columns

b) Format Data Model Data

c) Create Measures

d) Analyze the Data

3 : Importing Data from a CSV File

a) Import and Transform Data from a CSV File

b) Add Data from a Folder

4: Import Data from Multiple Sources

a) Import Data from SQL Server

b) Import Data from a CSV File

c) Create a Data Table

5: Importing Data from a Report

a) Import Data from Excel

b) Transform the Excel Data

c) Load the Data into an Excel Data Model

6 : Data Visualization in Excel

a) Create a Tabular Report

b) Create a Pivot Chart

c) Add Slicers to Charts

PART B: TABLEAU

1. Data source connection.
2. Create First Tableau worksheet.
3. Add Filters in Tableau.
4. Create an area chart in Tableau.
5. Create an area chart in Tableau for Profit.
6. Create a Dashboard in Tableau.

M21DG0206	NoSQL Lab	Course Type	L	T	P	C
Duration : 26 Hrs		HC	0	0	2	2

LAB EXPERIMENTS:

CRUD Operations in MONGODB

1: Student Database

Create a Student database with the fields: (SRN, sname, degree, sem, CGPA)

i. Insert 10 documents.
ii. Display all the documents.
iii. Display all the students in BCA.
iv. Display all the students in ascending order.
v. Display first 5 students.
vi. Display students 5,6,7.
vii. List the degree of student "Rahul".
viii. Display students details of 5,6,7 in descending order of age.

ix. Display the number of students in BCA.
x. Display all the degrees without _id.
xi. Display all the distinct degrees.
xii. Display all the BCA students with CGPA greater than 6, but less than 9.
xiii. Display all the students in BCA and in 6th Sem.

2. Employee Database

Create an employee database with the fields: {eid, ename, dept, desig, salary, yoj, address {dno, street, locality, city}}

i. Insert 10 documents.
ii. Display all the employees with salary in range (50000, 75000).
iii. Display all the employees with designation.
iv. Display the Salary of "Rahul".
v. Display the city of employee "Rahul".
vi. Update the salary of developers by 5000 increment .
vii. Add field age to employee "Rahul".
viii. Remove YOJ from "Rahul".
ix. Add an array field project to "Rahul".
x. Add p2 and p3 project to "Rahul".
xi. Remove p3 from "Rahul".
xii. Add a new embedded object "contacts" with "email" and "phone" as array objects to "Rahul".
xiii. Add two phone numbers to "Rahul".

3. Book Database

Create a book Data Base with the fields: (isbn, bname, author [], year, publisher, price)

i. Insert 5 documents.
ii. List all the documents.
iii. List all book names except year and price.
iv. Display all the books authored by rudresh.

v. List all the books published by pearson.
vi. List the publisher of book java.
vii. List the author, publisher and year of the book let us see.
viii. Display the price of "let us see" except _id.
ix. Sort and display all books in ascending order of book names.
x. Sort and display only 3 books in descending order of price.
xi. Display all the books written by herbet and kuvempu.
xii. Display all the books either written by herbet and kuvempu.
xiii. Display all the books where rama is the first author.

4. Food Database

Create a Food Database with the fields: (food id, food cat, food name, chef name [ ], price, ingredients [], hotel name, hotel address {no, street, locality, city})

i. Insert 10 documents.
ii. List the price of pizza with ingredients.
iii. Display the item in the price range(500,800).
iv. Display the item prepared by x and y.
v. Display the item prepared by x or y.
vi. Add one chef to the food pizza.
vii. Add ingredients to the food Burger.
viii. Delete last ingredient added to the food burger.
ix. Delete all the ingredients from the food biryani.
x. Add food type to the food Burger.
xi. Modify the burger price by 200.
xii. Add or insert a new food item with the food Id "f08 " usingupsert as True.
xiii. Increment the price of all food item in food cat: fastfood by 120.

4. Import and export Bigdata to MongoDB

PART B

PHP with MONGODB

1. Demonstrate how to establish connection between PHP and MongoDB.
2. Grouping Data with Map/Reduce
3. Create Employee Database (PHP) and perform following operations.
   i. Connect to MongoDB.
   ii. Insert 5 documents into the employee database.
   iii. Find all documents in the database.
   iv. Find one document with condition.
   v. Display two Documents in the database using LIMIT Command.
   vi. Display from 5^{th} document.
   vii. Sort the documents in Ascending order based on pin.
   viii. Display the prescribed number in an array object using SLICE operator.
   ix. Display the prescribed number in an array object using SLICE with SKIP-LIMIT.
4. Create Employee Database (PHP) and perform following operations.
   i. Connect to MongoDB.
   ii. Insert 5 documents into the employee database.
   iii. Display find with condition (where)
   iv. Demonstrate OR condition, AND condition, Conditional operators lt,lte,gt,gte,ne, in operator, all operator, EXISTS operator-checks whether field has a value.
5. Demonstrate Indexing in MongoDB.

THIRD SEMESTER

SL. No	Course Code	Course Title	HC/SC FC	Credit Pattern			Credits	Working Hrs
				L	T	P		
1.	M21DG0301	Deep Learning	HC	4	0	0	4	4
2.	M21DG0302	Data Wrangling	HC	3	0	1	4	5
3.	M21DGS311	Intelligent Systems	SC	2	1	0	3	4
	M21DGS312	Graphs-Algorithms & Mining						
	M21DGS313	Cloud Analytics						
4.	M21DGS321	Time Series Analysis and Forecasting	SC	2	1	0	3	4
	M21DGS322	Multivariate Methods for data Analysis						
	M21DGS323	Recommender Systems						
5.		Open Elective ******	OE	4	0	0	4	4
6	M21DG0303	Minor Project	HC	0	0	6	6	12
***Mandatory - (Non Creditable Courses)**								
6.	M21DGM301/M21PTM301	Soft Skills						
7.	M21DGM302	Skill Development Programme						
Total Credits				**16**	**2**	**6**	**24**	**32**

Course Code	Digital Marketing	Course Type	L	T	P	C	Hrs. /Wk.
M21DGO301		OE	4	0	0	4	4

M21DG0301	Deep Learning	Course Type	L	T	P	C
Duration :52 Hrs		SC	4	0	0	4

Course Description

Understanding the latest advancements in artificial intelligence can seem overwhelming, but it really boils down to two very popular concepts Machine Learning and Deep Learning. But lately, Deep Learning is gaining much popularity due to its supremacy in terms of accuracy when trained with huge amount of data. Deep learning is a type of machine learning that mimics the neuron of the neural networks present in the human brain. The "Big Data Era" of technology will provide huge amounts of opportunities for new innovations in deep learning. Deep Learning really shines when it comes to *complex problems such as image classification, natural language processing, and speech recognition*. The course will examine neural networks and deep learning techniques in detail that can be applied to solve a complex real-world scenario.

Prerequisites:

Basic Mathematical Knowledge on Algebra, Calculus and Probability, Programming Knowledge of Python to implement techniques

Course Objectives:

The objectives of this course are to:

1. Illustrate the foundation of neural networks and deep learning.
2. Formulate deep networks for different applications.
3. Demonstrate major deep learning architectures

Course Outcomes:

On successful completion of this course; the student will be able to:

1. Understand the need of data and pre-processing, machine learning techniques for various application
2. Explain the concepts and applications of AI and Deep Learning.
3. Identify and apply the appropriate techniques to process the data and solve the applications using deep learning techniques

Course Content:

UNIT Applied Maths and Machine Learning Basics [13 Hours]

Learning Machine, **Linear Algebra**: Scalars, Vectors, Matrices, Tensors, Hyperplanes, Statistics: Probability, Distributions, likelihood, **Machine Learning models**: Regression, Classification, Clustering, Underfitting and Overfitting, Optimization, Gradient Descent, Stochastic Gradient Descent, Hyperparameters and Validation sets, Estimators, Bias, Variance. Challenges Motivating Deep Learning

UNIT II Foundations of Neural Network and Deep Network [13 Hours]

Neural Networks: The biological Neuron-The Perceptron-Multilayer feed forward networks. Training neural networks: Back propagation learning. Activation function, Loss functions. Hyper parameters.

Deep Network: Defining deep learning and deep networks, advantages in network architecture, common architecture principles of deep networks: Parameters, layers, activation function, loss function, optimization methods, hyper parameters. Building blocks of deep networks: RBMs-auto encoders- variational auto encoders.

UNIT III Major Architecture of Deep Networks [13 Hours]

Unsupervised pre trained networks: Deep belief networks-generative adversarial networks, **Convolutional neural networks (CNNs)**: Biological inspiration-intuition, CNN architecture overview, input layers, convolutional layers, pooling layers, fully connected layers, other applications of CNNs.

UNIT IV Recurrent and Recursive Neural Networks [13 Hours]

Recurrent neural networks: Modelling the time dimension, 3D volumetric input, general recurrent neural network architecture, LSTM networks, domain specific applications and blended networks. **Recursive neural networks**: Network architecture, varieties of recursive neural networks, Basic concepts in tuning deep networks and vectorization. Applications in object recognition and computer vision. Transformer Architectures - Introduction to Transformer Architectures and applications.

Text books:

1. Josh Patterson and Adam Gibson, "Deep Learning A practitioners Approach",Shroff publishers & Distributors, First edition 2017. https://pdfcoffee.com/qdownload/deep-learning-a-practitioners-approach-pdf-free.html (Chapter 1,2,3,4,6,7 & 8)
2. Ian Goodfellow and Yoshua Bengio and Aaron Courville. Deep Learning. An MIT Press book. 2016. https://github.com/janishar/mit-deep-learning-book-pdf .(Chapter 5, Pages 120-122)

References:

1. Charu C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Springer. 2019. https://dl.uswr.ac.ir/bitstream/Hannan/141305/2/9783319944623.pdf
2. Rojas, Raúl. Neural networks: a systematic introduction. Springer Science & Business Media, 2013. http://page.mi.fu-berlin.de/rojas/neural/neuron.pdf
3. Dive into Deep Learning. https://d2l.ai/chapter_preface/index.html

4. https://towardsdatascience.com/a-deep-dive-into-the-transformer-architecture-the-development-of-transformer-models-acbdf7ca34e0

M21DG0302	Data Wrangling	L	T	P	C
Duration: 52 Hrs		3	0	1	4

Course Description

In a Data Science Project, data is easily accessible very rarely. Data may be in a file, a database or extracted from various documents like web pages, tweets of PDFs. So, the first step is import the data and tidy the data. Data Wrangling/Data Munging is the process of transforming data from its original raw form into more suitable form for further processing. 50 to 80 percent of an analyst's time is spent wrangling data. Data wrangling not only consume most of an analyst's workday, it also represents much of the analyst's professional process: it captures activities like understanding what data is available; choosing what data to use and at what level of detail; understanding how to meaningfully combine multiple sources of data; and deciding how to distil the results to a size and shape that can drive downstream analysis. This course provides an introduction to data wrangling and the Students will learn various methods and skills involved in data collection, cleaning, and organizing.

Prerequisites:

Basic level knowledge in Python, Rudimentary knowledge in Relational Data base and SQL.

Course Objectives:

The objectives of this course are to:

1. To impart the knowledge of data wrangling framework.
2. To implement various transformation techniques in Data Wrangling.
3. To explain working with various types of files, Acquiring, cleaning and storing the data.
4. To equip with the concept of Web Scraping and automation.

Course Outcomes:

On successful completion of this course; the student will be able to:

1. Acquire the basic knowledge of Data flow in a project and Data Wrangling
2. Apply various techniques of Transformations on data.
3. Practically implement various techniques on importing different data, Cleaning, Exploration and Presentation of Data.

4. Implement Web scraping and automation

Course Content:

UNIT I **[13 Hours]**

Introduction to Data Wrangling: Definition, Importance, Benefits, Steps to perform Data Wrangling. Differences between Data wrangling , Data Pre-processing and ETL , **Tools and techniques for data wrangling, How Data Wrangling solves major Big Data / Machine Learning challenges,** Data Workflow framework: How data flows during and across projects, connecting analytic actions to data movement, Raw data storage actions, Refined Data Stage actions ,Production data stage actions, Data Wrangling in the workflow framework.

UNIT II **[13 Hours]**

Profiling.: Overview, Individual value profiling, Syntacting , semantic and set based profiling. Structuring: Overview, Intra record structuring, Extracting values, Combining multiple record fields, Filtering records and fields, Aggregations and Pivots. **Transformation Enriching:** Unions, Joins, inserting Meta Data, Derivation of Values. Using Transformation to clean the Data .Data Wrangling tools.

UNIT III **[13Hours]**

Data Wrangling using Python: Python Basics: Basic datatypes, Data Containers, What can various datatypes Do?, **Data meant to be ready by Machines**: CSV,JSON and XML Data, Working with Excel files, PDFs and Problem Solving in Python, Acquiring and storing the Data , **Data Clean up:** Investigation, Matching and Formatting, Standardizing and Scripting. Data Exploration and Analysis, Presenting your Data.

UNIT IV **[13 Hours]**

Web Scraping: Acquiring and storing Data from the Web: What to Scrape, Analyzing a Web Page, Getting Pages: How to request on the internet, Case study. **Advanced Web Scraping**: Browser based Parsing, Spidering the web, **API**: Features, Data pull from Twitter's REST API, Advanced Data Collection from Twitter's REST and Streaming API. **Automation and Scaling:** Why and Where to automate? Tools for automation, Simple and Large Scale Automation, Monitoring your automation.

Text books:

1. Principles of Data Wrangling , Practical Techniques for Data Preparation, Tye Rattenbury, Joseph M. Hellerstein, Jeffrey Heer, Sean Kandel, and Connor Carreras, Published by O'Reilly Media.
2. Data Wrangling with Python, Jacqueline Kazil and Katharine Jarmul, Published by O'Reilly Media.

References:

1. Data Wrangling with Python: Creating actionable data from raw sources, Dr. Tirthajyoti Sarkar Shubhadeep Roycho, Packt Publishing.
2. The Data Wrangling Workshop: Create your own actionable insights using data from multiple raw sources, Brian Lipp, Shubhadeep Roychowdhury 2nd Edition, Packt Publishing.

LAB PROGRAMS

Note: Programs can be implemented using Python

1) Perform the following operations using Python on any open source dataset (e.g., data.csv)

Import all the required Python Libraries.

- Locate open source data from the web (e.g. https://www.kaggle.com).
- Provide a clear description of the data and its source (i.e., URL of the web site).
- Load the Dataset into the pandas data frame.
- Data Pre-processing: check for missing values in the data using pandas insult(), describe() function to get some initial statistics. Provide variable descriptions. Types of variables etc. Check the dimensions of the data frame.
- Data Formatting and Data Normalization: Summarize the types of variables by checking the data types (i.e., character, numeric, integer, factor, and logical) of the variables in the data set. If variables are not in the correct data type, apply proper type conversions.
- Turn categorical variables into quantitative variables in Python.

2) Program to perform transformation operations on a dataset.

3) Program to implement the extraction of data from multiple sources and data cleaning techniques.

4) Program to implement Web Scraping.

5) Program to implement automation of data wrangling.

Note: Additional programs can be given by respective faculty.

M21DGS311	Intelligent Systems	L	T	P	C
Duration: 4 Hrs		2	1	0	3

Course Description

This course introduces students to the field of Artificial Intelligence (AI) with emphasis on its use to solve real world problems for which solutions are difficult to express using the traditional algorithmic approach. It explores the essential theory behind methodologies for developing systems that demonstrate intelligent behavior including dealing with uncertainty, learning from experience and following problem solving strategies found in nature.

Prerequisites:

Basic knowledge of Artificial Intelligence.

Course Objectives:

The Objectives of this course are to:

1. Introduce Intelligent Systems and its applications.
2. Explain the concepts of Rule-Based Systems and its usage in developing Intelligent Systems.
3. Familiarize with Handling Uncertainty, Probability and Fuzzy Logic.
4. Introduce Agents and understand its architecture to build Intelligent Systems.

Course Outcomes:

On successful completion of this course; the student will be able to:

1. Demonstrate good knowledge of theoretical foundations of Intelligent Systems.
2. Explain the concepts of Rule Based Systems, analyze the algorithm and evaluate its usage to develop new Intelligent Systems.
3. Analyze the existing system, evaluate ideas and apply the knowledge to develop new systems to solve real life problems.
4. Understand Intelligent Agents and its architecture, apply the concepts to analyze and build Intelligent Systems using suitable software tools.

Course Content:

UNIT I **[10 Hours]**

Introduction to Intelligent Systems: Intelligent Systems, a Spectrum of Intelligent Behavior**,** Knowledge-Based Systems**,** the Knowledge Base**:** Rules and Facts**,** Inference Networks**,** Semantic Networks**.** Deduction, Abduction, and Induction**,** the Inference Engine**,** Declarative and Procedural Programming**,** Expert Systems**,** Knowledge Acquisition**,** Search**,** Computational Intelligence**,** Integration with Other Software.

UNIT II **[10 Hours]**

Rule-Based Systems:

Rules and Facts, Rule-Based System for Boiler Control, Rule Examination and Rule Firing, Maintaining Consistency, Use of Local Variables within Rules, Forward Chaining (a Data-Driven Strategy): Single and Multiple Instantiation of Local Variables, Rete Algorithm. Conflict Resolution: First Come, First Served, Priority Values, Metarules, Backward Chaining (a Goal-Driven Strategy): The Backward-Chaining Mechanism, Implementation of Backward Chaining, Variations of Backward Chaining, Format of Backward-Chaining Rules.

UNIT III **[10 Hours]**

Handling Uncertainty, Probability and Fuzzy Logic:
Sources of Uncertainty, Bayesian Updating: Representing Uncertainty by Probability, Direct Application of Bayes' Theorem, Likelihood Ratios, Combining Evidence, Advantages and Disadvantages of Bayesian Updating.
Certainty Theory: Introduction, Making Uncertain Hypotheses, Logical Combinations of Evidence, Conjunction, Disjunction, Negation.
Fuzzy Logic: Type-1, Crisp Sets and Fuzzy Sets, Fuzzy Rules, Defuzzification, Stage 1: Scaling the Membership Functions, Stage 2: Finding the Centroid, Fuzzy Control Systems, Crisp and Fuzzy Control, Fuzzy Control Rules, Defuzzification in Control Systems, Fuzzy Logic: Type-2.

UNIT IV **[10 Hours]**

Agents Systems:

Birds of a Feather: Agents, Intelligent Agents, And Agent Architectures: Logic-Based Architectures, Emergent Behavior Architectures, Knowledge-Level Architectures, Layered Architectures. Multiagent Systems: Benefits of a Multiagent System, Building a Multiagent System, Contract Nets, Cooperative Problem-Solving (CPS), Shifting Matrix Management (SMM), Comparison of Cooperative Models, Communication between Agents. Swarm Intelligence, Frame-Based Systems.

Text books:

1. Adrian A. Hopgood, "Intelligent Systems for Engineers and Scientists", Third Edition, CRC Press, Taylor and Francis Group, Boca Raton, London, Newyork.

References:

1. Michael Negnevitsky, "Artificial Intelligence – A Guide To Intelligent Systems", 3rd Edition, Addison Wesley, 2011, ISBN-13: 978-1408225745
2. G.J.Klir& Bo Yuan, "Fuzzy Sets and Fuzzy Logic Theory and Applications", Prentice Hall of India, 2009.
3. Timothy S.Ross, "Fuzzy Logic with engineering applications", Weily India Pvt. Ltd., 2011.

M21DGS312	Graphs-Algorithms & Mining	L	T	P	C
Duration: 4 Hrs		2	1	0	3

Course Description

Graph have experienced an Explosion in the number of applications and have proved high versatility in different domains such as biology, social analysis, climatology. Parallel with the traditional data (text) graph mining studies ways to extract patterns, infer behavior, retrieve rules, querying predict links, finding communities and many other things. The course is intended to provide an introduction to the broad topic of graph mining, with the focus on challenges, algorithmic solutions and new problems.

Prerequisites:

Data Mining, Probability, Linear Algebra, Graphs, Design and Analysis of Algorithms.

Course Objectives:

The objectives of this course are to:

1. To provide the basic concepts and important properties of graphs.
2. To learn and explore several methods on algorithms such as graph traversal, shortest path finding.
3. To introduce students to the field of graph mining and its application in various domains.
4. To give the students an opportunity to obtain hands-on experience on applications of graph mining.

Course Outcomes:

On successful completion of this course; the student will be able to:

1. Understand of the graph theory and graph mining foundations.
2. Analyze the graph mining algorithms.
3. Formulate and solve graph-related real world problems.
4. Apply graph mining algorithms to analyze large-scale datasets on various domains.

Course Content:

UNIT I **[10 Hours]**

Introduction to graphs: Introduction to graphs and basic terminology, Representations of a graph, types of graphs, Graph theory-matchings, Graph theory- Connectivity, Graph Decomposition-Perfect matching decomposition, Hamiltonian Cycles, Cycle and Hamilton cycle decomposition, Spanning and Minimum spanning trees

UNIT II **[10 Hours]**

Graph algorithms: Graph traversal Techniques, Single source shortest path (Dijkstra's shortest path) algorithm, Graph colouring, Multi-stage graph

Graph Mining: Motivation of Graph Mining, Mining Frequent Subgraphs –Transactions, BFS/Apriori Approach (FSG and others), DFS Approach (gSpan and others),

UNIT III **[10 Hours]**

Diagonal and Greedy Approaches, Constraint-based mining and new algorithms, Mining Frequent Subgraphs-single graph.

Applications of Graph Mining: Web mining, social network analysis, Link analysis algorithms, graph clustering Analysis

UNIT IV **[10 Hours]**

Node classification in social networking, Influence maximization in social networking, Geo-social networking and location based networks.

Graph Neural Networks: Introduction to Graph Neural Networks, Graph Convolutional Network, Types of Graph Neural Networks

Note: Practical based assignments to be given on applications of GNN / Case study on Recommenders & NLP

Text books:

1. AnanyLevitin, "Introduction to the Design and Analysis of Algorithms", Pearson Education, 3rd Edition, Copyright © 2012.
2. Diestel, R. (2010).Graph Theory, 4th ed.Springer-Verlag, Heidelberg

3. J. Han and M. Kamber, Data minining–Concepts and Techniques, 2ndEdition, Morgan kaufmanPublishers, 2006

4. Bing Liu, Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, Springer publishing, 2009

5. Jure Leskovec, Anand Rajaraman, Jeff Ullman. Mining of Massive Datasets. Book 2nd edition. Cambridge University Press

References:

1. T. Washio and H. Motoda, "State of the art of graph-based data mining", SIGKDD Explorations, 5:59-68, 2003

2. X. Yan and J. Han, "gSpan: Graph-Based Substructure Pattern Mining", ICDM'02

3. X. Yan and J. Han, "CloseGraph: Mining Closed Frequent Graph Patterns", KDD'03

Reference Links:

1. Graph Mining and Exploration at Scale (prof. Danai Koutra)
   - http://web.eecs.umich.edu/~dkoutra/courses/F15_598/
2. Data Mining meets Graph Mining (prof. Leman Akoglu)
   - http://www3.cs.stonybrook.edu/~leman/courses/14CSE590/index.htm

M21DGS313	**Cloud Analytics**	**L**	**T**	**P**	**C**
Duration: 40 Hrs		2	1	0	3

Course Description

This course is helps students to understand the concepts of Data Analytics, Cloud Computing and advantages of deployment of cloud in Analytics process.

Prerequisites:

Basic knowledge of Data Base Techniques, NoSQL Databases, Cloud computing, Data Analytics.

Course Objectives:

The objectives of this course are to:

1. To provide an insight into the processes of approach to data science and big data analytics projects.

2. To understand cloud computing technologies in terms of hardware, software, architectures, limitations, advantages and disadvantages, issues, constraints, and security problems on data content that has been exchanged.
3. To develop skills to analyze data using different analytics techniques for useful business applications.
4. To develop skills to identify appropriate cloud player for Analytics process.

Course Outcomes:

On successful completion of this course; the student will be able to:

1. Understand the terminologies and concepts in Big Data Analytics.
2. Compare the strengths and limitations of cloud computing and Identify the architecture, infrastructure and delivery models of cloud computing.
3. Understand the process of analyzing big data using cloud platforms.
4. Illustrate tools such as Google Cloud, AWS, Azure, IBM Cognos. (Application).

Course Content:

UNIT I – Cloud Computing [10 Hours]

Cloud Computing: Introduction to Cloud Computing, Cloud Deployment Models, Types of Cloud service delivery models, Risks and Challenges of Cloud Computing.

Data Lakes – Introduction, Need of data lakes, Challenges, Data lake Vs Lake house Vs Data Warehouse

Cloud Analytics : Introduction, Types of Cloud Analytics, Benefits of Cloud Analytics, Analytics for Cloud, Analytics on Cloud,

UNIT II – Cloud Analytics Platforms [10 Hours]

Selecting a Modern Cloud Data Platform, Comparing Cloud Data Platforms, Data sources, Data models, processing applications, Computing power, Analytic models, Sharing and Collaboration, Cost Reduction, Scalability, Data Consolidation, Data sharing and storage, Challenges.

UNIT III – Cloud Analytics with Google Cloud Platform [10 Hours]

Google Cloud Platform: Compute Engine, Storage and Databases, Networking, Bigdata, Data Transfer, Cloud AI, Internet of things, Management Tools; Machine Learning, Deep Learning, and AI on GCP; Business Use Cases - Smart Parking Solution by Mark N Park

UNIT IV – Cloud Analytics with Microsoft Azure **[10 Hours]**

Introduction to analytics on Azure: The power of data, Big data analytics, Data Ops, Azure Synapse Analytics; Processing and visualizing data - Power BI and Azure Synapse Analytics, Machine learning on Azure, Azure Machine Learning and Azure Synapse Analytics

Case Study: Real-time customer insights with Azure Synapse Analytics / Using advanced analytics on Azure to create a smart airport

Note: Additional Case studies can be given as assignments and seminar

Text books:

1. Cloud Analytics with Google Cloud Platform by Sanket Thodge, April 2018, Publisher(s): Packt Publishing, ISBN: 9781788839686
2. Cloud Analytics with Microsoft Azure - Second Edition, by Has Altaiar, Jack Lee, Michael Pena,January 2021, Publisher(s): Packt Publishing, ISBN: 9781800202436

References:

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
2. Judith Hurwitz, Alan Nugent, Dr. Fern Halper,and Marcia Kaufman, Big Data for Dummies, Wiley publications, 2013
3. David Baum, Cloud Data Analytics For Dummies®, Snowflake Special Edition, 2020
4. Toby Velte, Anthony Velte, Robert Elsenpeter, “Cloud Computing, A Practical Approach”, TMH,2009.
5. George Reese, “Cloud Application Architectures: Building Applications and Infrastructure in The cloud, O Reilly.
6. Bill Franks, “Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics”, John Wiley & Sons, 2012.
7. Glenn J. Myatt, “Making Sense Of Data”, John Wiley & Sons, 2007
8. Pete Warden, “Big Data Glossary”, O’Reilly, 2011.
9. https://www.databricks.com/discover/data-lakes/introduction#why-would

M21DGS321	Time Series Analysis and Forecasting	L	T	P	C
Duration: 40 Hrs		2	1	0	3

Course Description

This course introduces the basic time series analysis and forecasting methods. Topics include stationary processes, ARMA models, spectral analysis, model and forecasting using ARMA models, nonstationary and seasonal time series models, multivariate time series, state-space models, and forecasting techniques.

Prerequisites:

Knowledge of Mathematics, Analytics, Machine Learning concepts

Course Objectives:

The objectives of this course are to:

1. learn about important time series models and their applications in various fields.
2. formulate real life problems using linear process time series models.
3. Predict the linear stationary and non - stationary process models using forecasting principles
4. Analyze the multivariate time series analysis.

Course Outcomes:

On successful completion of this course; the student will be able to:

1. Describe the concepts of time series and their application.
2. Discuss the underlying concepts of Linear stationary time series models and forecasting.
3. Analyze the Non Linear stationary time series models and forecasting.
4. Understand the multivariate time series analysis and Forecasting of VARMA process.

Course Content:

UNIT I **[10 Hours]**

Introduction: Objectives of Time Series Analysis - A General Approach to Time Series modeling - Stationary Models and the Autocorrelation Function: The Sample Autocorrelation Function - Estimation and Elimination of Both Trend and Seasonal components - Testing the Estimated Noise Sequence.

Stationary Processes - Basic Properties - Linear Process - Introduction to ARMA Processes - Properties of the Sample Mean and Autocorrelation Function - Forecasting Stationary Time Series.

UNIT II **[10 Hours]**

ARMA Models - ARMA(p, q) Processes - The ACF and PACF of an ARMA(p, q) Process - Calculation of the ACVF - The Autocorrelation Function - The Partial Autocorrelation Function - Forecasting ARMA Processes

Spectral Analysis - Spectral Densities - The Periodogram - Time-Invariant Linear Filters - The Spectral Density of an ARMA Process.

Modeling and Forecasting with ARMA Processes - Preliminary Estimation : Yule–Walker Estimation - Burg's Algorithm - The Innovations Algorithm - The Hannan–Rissanen Algorithm - Maximum Likelihood Estimation - Diagnostic Checking : The Graph of $\{R_t, t = 1, \ldots, n\}$ - The Sample ACF of the Residuals - Tests for Randomness of the Residuals – Forecasting - Order Selection : The FPE Criterion - The AICC Criterion

UNIT III **[10 Hours]**

Linear Nonstationary Models : Autoregressive Integrated Moving Average Processes: Nonstationary First-Order Autoregressive Process, General Model for a Nonstationary Process Exhibiting Homogeneity, General Form of the ARIMA Model - Three Explicit Forms for the ARIMA Model: Difference Equation Form of the Model, Random Shock Form of the Model, Inverted Form of the Model - Integrated Moving Average Processes : Integrated Moving Average Process of Order (0, 1, 1), Integrated Moving Average Process of Order (0, 2, 2), General Integrated Moving Average Process of Order (0, d, q).

Forecasting: Minimum Mean Square Error Forecasts and Their Properties : Derivation of the Minimum Mean Square Error Forecasts, Three Basic Forms for the Forecast - Calculating Forecasts and Probability Limits : Calculation of ψ Weights, Use of the ψ Weights in Updating the Forecasts, Calculation of the Probability Limits at Different Lead Times, Calculation of Forecasts Using R - Use of State-Space Model Formulation for Exact Forecasting: State-Space Model Representation for the ARIMA Process, Kalman Filtering Relations for Use in Prediction, Smoothing Relations in the State Variable Model.

UNIT IV **[10 Hours]**

Multivariate Time Series Analysis: Stationary Multivariate Time Series: Cross-Covariance and Cross-Correlation Matrices, Covariance Stationarity, Vector White Noise Process, Moving Average Representation of a Stationary Vector Process.

Vector Autoregressive - Moving Average Models: Stationarity and Invertibility Conditions, Covariance Matrix Properties of VARMA Processes, Non uniqueness and Parameter Identifiability for VARMA Models, Model Specification for VARMA Processes, Estimation and Model Checking for VARMA Models, Relation of VARMA Models to Transfer Function and ARMAX Models.

Forecasting for Vector Autoregressive - Moving Average Processes: Calculation of Forecasts from ARMA Difference Equation, Forecasts from Infinite VMA Form and Properties of Forecast Errors, State-Space Form of the VARMA Model.

Note: Hands-on sessions to be conducted and practical based assignments to be given.

Text books:

1. Brockwell, Peter J. and Davis, Richard A. (2002). Introduction to Time Series and Forecasting, 2nd edition. Springer-Verlag, New York. (Unit 1 & 2)
2. Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. (1994). Time Series Analysis: Forecasting and Control, 3rd Edition, Prentice Hall, New Jersey (Unit 3 & 4)

References:

1. Shumway, R.H., Stoffer, D.S. (2006). Time Series Analysis and Its Applications (with R examples). Springer-Verlag, New York.
2. Chatfield, C. (2004). The Analysis of Time Series. Chapman & Hall/CRC, Boca Raton, FL.
3. James D. Hamilton (1994). Time Series Analysis, 1st Edition, Princeton University Press,
4. Galit Shmueli and Kenneth C. Lichtendahl Jr (2016). Practical Time Series Forecasting with R: A Hands-On Guide, 2nd Edition, Axelrod Schnall Publishers.

M21DGS322	**Multivariate Methods for Data Analysis**	**Course Type**	**L**	**T**	**P**	**C**
Duration : 40 Hrs		SC	2	1	0	3

Course Description

Large amount of data is collected on many different variables across disciplines in order to understand the underlying process (es). The multivariate analysis of data deals with examining interrelationship between three or more equally important variables or explaining of variation in, usually one (or more than one) dependent variable(s) on the basis of two or more independent (explaining) variables. With the availability of inexpensive, fast and efficient computing resources and statistical packages there has been a growth in the application of these techniques. This course introduces the student to various multivariate data analysis tools.

Prerequisites:

Linear Algebra, Multivariate Calculus, and Mathematical Statistics

Course Objectives:

The objectives of this course are to:

1. Cover differential, integral and vector calculus for functions of more than one variable.
2. Reduction in data or simplification of the structure

3. Grouping & Sorting the data
4. Establishing a connection between the variables

Course Outcomes:

On successful completion of this course; the student will be able to:

1. Understand of the analysis of distributed contents.
2. Data is verified based on the variables
3. Apply Matrices and Vectors on free-body diagrams and Construct free-body diagrams.
4. Testing and construction of hypothesis

Course Content:

UNIT– I **[10 Hours]**

System of Linear Equations: Matrices, Matrices Operations, Related Matrices, Determinants, Properties of Determinants, Rank of Matrix and consistency, Solution of Linear System of Equations, Gauss Elimination method, Guass Jordan method, Gauss Seidel method.

UNIT– II **[10 Hours]**

Partial Differentiation and its Applications: Functions of Two or More Variable, Partial Derivatives, Homogeneous Functions, Total Derivative, Geometrical Interpretation, Taylor's Theorem for functions of Two Variables, Maxima and Minima of Functions of Two Variables, Lagrange's Method of Undetermined Multipliers.

UNIT– III **[10 Hours]**

Vectors: Vectors, Scalar or Dot Product, Vector or Cross product, Scalar Product of Three Vectors, Vector Product of Three Vectors, Differentiation of Vectors, Velocity and Acceleration. Scalar and Vector Point Functions, Del Applied to Scalar Point Functions – Gradient, Del applied Twice to Point Functions, Del Applied to Products of Point Functions, Solenoidel, Curl and irrotational.

UNIT– IV **[10 Hours]**

Double Integrals and Triple integrals: Double Integrals, Change of Order of Integration, Double Integrals in Polar Coordinates; Area enclosed by Plane Curves, Triple Integrals, Volumes of Solids, Change of Variables.

Text Book:

1. B S Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd Edition, 2015, ISBN No: 978-81-7409-195-5

References:

1. ErwinKreyszig, "Advanced Engineering Mathematics", 9th edition Wiley Publications, 2013.
2. B.V. Ramana, "Higher Engineering Mathematics", 19th Reprint edition, Tata McGraw Hill Publications, 2013.
3. R.K.Jain and S.R.K.Iyengar, "Advanced Engineering Mathematics", 4th edition, Narosa Publishing House, 2016.
4. Calculus, Early Transcedentals Plus New May Math Lab by William Briggs, Lyle Cochran, and Gillet Pearson, Addison-Wesley, 2014.
5. Edwards, Henry C., and David E. Penney, Multivariable Calculus. 6th ed. Lebanon, IN: Prentice Hall, 2002. ISBN: 9780130339676.

M21DGS323	Recommender Systems	L	T	P	C
Duration: 4 Hrs		2	1	0	3

Course Description

This course covers the basic concepts of recommender systems, including personalization algorithms, evaluation tools, and user experiences. We will discuss how recommender systems and user models are deployed in e-commerce sites, social networks, and many other online systems, with readings from current and past research in the field

Prerequisites:

Knowledge of Mathematical foundations, Programming concepts, Machine Learning concepts

Course Objectives:

The objectives of this course are to:

1. To provide students with basic concepts and its application in various domain.
2. To make the students understand different techniques that a data scientist needs to know for analyzing big data.
3. To design and build a complete machine learning solution in many application domains

Course Outcomes:

On successful completion of this course; the student will be able to:

1. Identify and describe a recommender system in practical use.
2. Design, train and evaluate a recommendation algorithm.
3. Understand the work needed to go from a recommendation model to a live system with users.
4. Use data collected from a recommender system to understand user preferences and/or behavior.
5. Read current research on recommender systems, understand what it contributes to knowledge, and apply it to new settings

Course Content:

UNIT I [10 Hours]

Introduction: Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.

Collaborative Filtering: User-based nearest neighbor recommendation, Item-based nearest neighbor recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems

UNIT II [10 Hours]

Content-based recommendation: High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles,

Similarity based retrieval, Classification algorithms.

Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders.

UNIT III [10 Hours]

Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.

Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centred metrics.

UNIT IV [10 Hours]

Recommender Systems and communities: Communities, collaboration and recommender systems in personalized web search, Social tagging recommender systems, Trust and recommendations, Group recommender systems.

Tutorial Work: To implement algorithms and techniques given above using relevant tools or high-level language. To design recommendation system for a particular application domain.

Note: Assignments to be given based on practical implementation of recommender systems for E-Commerce website or Social Networking site etc.

Text books:

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press(2011), 1st ed.
2. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer(2011), 1st ed.
3. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer (2013), 1st ed

References:

1. C.C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
2. F. Ricci, L Rokach, B. Shapira and P.B. Kantor, Recommender systems handbook, Springer 2010.

* Open Elective:

M21DGO301	Digital Marketing	L	T	P	C
Duration: 52 Hrs		4	0	0	4

Course Description

This is a four-credit course that sets out essential concepts and skills relating to the fundamentals of digital marketing. This syllabus offers the students a mixture of theoretical knowledge and practical experience required to understand the concepts and guide them for career opportunities.

Prerequisites:

Knowledge about the fundamentals of internet.

Course Objectives:

The objectives of this course are to:

1. Develop industry background knowledge to navigate Digital Marketing topics including online advertising, SEO, social media, and to secure customer data.
2. Evaluate an experiment quantitatively and qualitatively to measure the effectiveness of business decisions and online advertising effectiveness in particular.
3. Design and implement digital marketing campaign.
4. Apply best practices of social media marketing.

Course Outcomes:

On successful completion of this course; the student will be able to:

1. Assess the impact of digital technology and search engines on the practice of marketing.
2. Analyse the use of different forms of digital marketing to efficiently improve the online presence.
3. Integrate social media tools into a marketing communications strategy.
4. Illustrate the ways of advertising through mobiles and monitoring the performance of different digital marketing aspects.

Course Content:

UNIT I **[13 Hours]**

An introduction to digital marketing: Start with customer and work backward, 3i principles.

Search Engine optimization: Introduction, Search Engine Result Pages, Search behavior, four stages- Goals, On-page optimization, Off-page optimization, Analyze.

UNIT II **[13 Hours]**

Pay Per Click: Introduction, four stages: Goals, Setup, Manage, Analyze.

Digital Display Advertising: Introduction, industry overview, four stages: Define, Format, Configure, Analyze.

UNIT III **[13 Hours]**

Email marketing: Introduction, four stages: Data-Email marketing process, Design and content, Delivery, Discovery.

Social media marketing: Introduction, four stages: Goals, Channels, Implementation, Analyze.

UNIT IV **[13 Hours]**

Mobile marketing: Introduction, four stages: Opportunity, Optimize, Advertise, Analyze.
Analytics: Introduction, four stages: Goals, Setup, Monitor, Analyze.

Text books:

1. Ian Dodson, "THE ART OF DIGITAL MARKETING: The Definitive Guide to Creating Strategic, Targeted and Measurable Online Campaigns",1st Edition, Wiley Publications, 2016.

References:

1. Damian Ryan, "UNDERSTANDING DIGITAL MARKETING: Marketing Strategies for engaging the digital generation" 4th Edition, Kogan Page, 2017.
2. Alan Charlesworth, "DIGITAL MARKETING: A Practical Approach", 2nd Edition, Routledge, 2009.
3. Puneet Singh Bhatia, "Fundamentals of digital marketing" Pearson edition, 2017.

M21DG0303	**Minor Project Using R /Python/Java**	**L**	**T**	**P**	**C**
Duration: 14 Weeks		**2**	**0**	**4**	**6**

Prerequisites:

Programming and logical skill set

Course Objectives:

To carry out the research under the guidance of supervisor and in the process learn the techniques of research.

Course Outcomes:

On successful completion of the project, the student shall be able to:

1. Familiarize with literature search
2. Conduct the experiments related to research and formulate computational techniques
3. Interpret the primary data.
4. Write report and defend the research findings.

PROJECT:

Each student or a group of maximum of 3 students will choose the topic of research and work under the guidance of allocated faculty member. The project shall preferably be application oriented or industry need based that could be useful to the society. In case of industry need based project or R & D project, the student may opt co-supervisor from the concerned industry / research institution as the case may be. The student will have to make a preliminary survey of research done in broad area of his/her area of interest and decide on the topic in consultation with his/her supervisor(s). The project work floated should be completed within 16 weeks and project report has to be submitted within the stipulated date by the University/ within 18 weeks whichever is earlier. The student has to meet the concerned supervisor(s) frequently to seek guidance and also to produce the progress of the work being carried out. The student should also submit progress report during 5^{th} week and 10^{th} week of the beginning of the semester and final draft report with findings by 15^{th} week. After the completion of the project the student shall submit project report in the form of dissertation on a specified date by the School.

FOURTH SEMESTER

SL. No	Course Code	Title of the Course	Credit Pattern L:T:P	Credits
1	M21DG0401	Research/Technical paper	0:0:2	2
2	M21DG0402	Internship/ Certification	0:0:4	4
3	M21DG0403	Major Project	0:0:10	10
Total Credits				**16**

*** Note:**

1. Project Work and Dissertation will be mandatory of 12 Credits

2. The student can select either Internship (4 weeks) or Certification Course for 4 Credits.

3. All final year project students must write & publish a technical/Research paper based on their area of interest that carries 2 credit.

CAREER DEVELOPMENT AND PLACEMENT

Having a degree will open doors to the world of opportunities for you. But Employers are looking for much more than just a degree. They want graduates who stand out from the crowd and exhibit real life skills that can be applied to their organizations. Examples of such popular skills employers look for include:

1. Willingness to learn
2. Self motivation
3. Team work
4. Communication skills and application of these skills to real scenarios
5. Requirement of gathering, design and analysis, development and testing skills
6. Analytical and Technical skills
7. Computer skills
8. Internet searching skills
9. Information consolidation and presentation skills
10. Role play
11. Group discussion, and so on

REVA University therefore, has given utmost importance to develop these skills through variety of training programs and such other activities that induce the said skills among all students. A full-fledged Career Counseling and Placement division, namely Career Development Center (CDC) headed by well experienced senior Professor and Dean and supported by dynamic trainers, counselors and placement officers and other efficient supportive team does handle all aspects of Internships and placements for the students of REVA University. The prime objective of the CDC is to liaison between REVA graduating students and industries by providing a common platform where the prospective employer companies can identify suitable candidates for placement in their respective organization. The CDC organizes pre-placement training by professionals and also arranges expert talks to our students. It facilitates students to career guidance and improves their employability. In addition, CDC forms teams to perform mock interviews. It makes you to enjoy working with such teams and learn many things apart from working together in a team. It also makes you to participate in various student clubs which helps in developing team culture, variety of job skills and overall personality.

The need of the hour in the field of Computer Science is not only knowledge in the subject, but also the skill to do the job proficiently, team spirit and a flavour of innovation. This kept in focus, the CDC has designed the training process, which will commence from second semester along with the curriculum. Special coaching in personality development, career building, English proficiency, reasoning, puzzles, and communication skills to every student of REVA University is given with utmost care. The process involves continuous training and monitoring the students to develop their soft skills including interpersonal skills that will fetch them a job of repute in the area of his / her interest and March forward to make better career. The School of Computer Science and Applications also has emphasised subject based skill training through lab practice, internship, project work, industry interaction and many such skilling techniques. The students during their day to day studies are made to practice these skill techniques as these are inbuilt in the course curriculum. Concerned teachers also continuously guide and monitor the progress of students.

The University has also established University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director to facilitate skill related training to REVA students and other unemployed students around REVA campus. The center conducts variety of skill development programs to students to suite to their career opportunities. Through this skill development centre the students shall compulsorily complete at least two skill / certification based programs before the completion of their degree. The University has collaborations with Industries, Corporate training organizations, research institutions and Government agencies like NSDC (National Skill Development Corporation) to conduct certification programs. REVA University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana.

The University has also signed MOU’s with Multi-National Companies, research institutions, and universities abroad to facilitate greater opportunities of employability, students’ exchange programs for higher learning and for conducting certification programs.

Programme Regulations

Summary of REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Post Graduate Degree Program

1.0 Teaching and Learning Process

The teaching and learning process under CBCS-CAGP of education in each course of study will have three components, namely-

(i) L= Lecture (ii) T= Tutorial (iii) P= Practice, where:

L stands for **Lecture** session consisting of classroom instruction.

T stands for **Tutorial** session consisting participatory discussion / self-study/ desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.

P stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies that equip students to acquire the much required skill component.

2.0. A course shall have either or all the three components. That means a course may have only lecture component, or only practical component or combination of any two or all the three components.

2.1. Various course of s**tudy** are labeled and defined as: (i) Core Course (CC) (ii) Hard Core Course

(HC), (iii) Soft Core Course (SC), (iv) Foundation Core Course (FC) and (v) Open Elective Course (OE).

(i) **Core Course:** A course which should compulsorily be studied by a candidate as a core-requirement is termed as a Core course.

(ii) **Foundation Course (FC):**

The foundation Course is a core course which should be completed successfully as a part of graduate degree program irrespective of the branch of study.

(iii) **Hard Core Course (HC):**

The **Hard Core Course** is a Core Course in the main branch of study and related branch (es) of study, if any that the candidates have to complete compulsorily.

(iv) **Soft Core Course (SC):**

A Core course may be a **Soft Core** if there is a choice or an option for the

candidate to choose a course from a pool of courses from the main branch of study or from a sister/related branch of study which supports the main branch of study.

(v) O**pen Elective Course:**

An elective course chosen generally from other discipline / subject, with an intention to seek exposure is called an O**pen Elective Course.**

2.2. Project Work:

Project work is a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem.

2.3. Minor Project:

A project work up to **Six to Eight credits** is called **Minor Project** work. A Minor Project work may be a hard core or a Soft Core as decided by the BOS / concerned.

2.4. Major Project / Dissertation:

A project work of **EIGHT, TEN, TWELVE, SIXTEEN or TWENTY** credits is called **Major Project** work. The Major Project / Dissertation shall be Hard Core.

3.0. Minimum Credits to be earned:

3.1. A candidate has to earn 90 credits for successful completion of M.S in Computer Science degree with a distribution of credits for different courses as prescribed by the university.

3.2. A candidate can enroll for a maximum of 32 credits per Semester. However he / she may not successfully earn a maximum of 32 credits per semester. This maximum of 32 credits does not include the credits of courses carried forward by a candidate.

3.3. Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to IV semester and complete successfully 90 credits in 4 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and are eligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities.

4.0. Add- on Proficiency Certification:

In excess to the minimum of 90 credits for the M.S in Computer Science program, a candidate can opt to complete a minimum of 4 extra credits either in the same discipline/subject or in different discipline / subject to acquire **Add on Proficiency Certification** in that particular discipline / subject along with the M.S in Computer Science degree.

4.1. Add on Proficiency Diploma:

In excess to the minimum of 90 credits for the M.S in Computer Science program, a candidate can opt to complete a minimum of 18 extra credits either in the same discipline/subject or in different discipline / subject to acquire Add on Proficiency Diploma in that particular discipline / subject along with the M.S in Computer Science. The A**dd -on Proficiency Certification / Diploma** so issued to the candidate contains the courses studied and grades earned.

5. Scheme of Assessment & Evaluation

5.1.The Scheme of Assessment and Evaluation will have **TWO PARTS**, namely;

i. Internal Assessment (IA); and
ii. Semester End Examination (SEE)

5.2. Assessment and Evaluation of each Course shall be for 100 marks. The Internal Assessment (IA) and Semester End Examination (SEE) of PG programs shall carry 50 marks each (i.e., 50 marks internal assessment; 50 marks semester end examination).

5.3. The 50 marks of Internal Assessment (IA) shall comprise of:

Internal Test	= 30 marks
Assignments	= 10 marks
Presentations / Quizzes / Case studies	= 10 marks

5.4. There shall be two internal tests conducted as per the schedule given below. The students have to attend all the two tests compulsorily.

- 1st test for 15 marks at the end of 8th week of the beginning of the Semester; and
- 2nd test for 15 marks at the end of the 16th week of the beginning of the Semester; and

5.5. The coverage of syllabus for the said three tests shall be as under:

- For the 1st test syllabus shall be 1st and 2nd unit of the course;
- For the 2nd test it shall be 3rd and 4th unit;

5.6. There shall be two Assignments and two Presentations / Quizzes / Case studies each carrying 5 marks. Hence two assignments carry 10 marks (5+5 marks) and two Presentations / Quizzes / Case studies carry 10 marks (5+5 marks) as stated at Sl.No.5.3 above. In place of assignments and seminars, there shall be model designs or some task based activity wherein the number of designs/ activity the marks each design / activity carries shall be decided by the respective School Board. However such decision shall be done well in advance and it should be announced before commencement of the Semester after communicating the same to the Registrar and Registrar (Evaluation) to avoid ambiguity and confusion among students and faculty members.

5.8. The Semester End Examination for 50 marks shall be held during 19th and 20th week of the beginning of the semester and **the syllabus for the semester end examination shall be entire 4 units**.

5.9. The **duration of the internal test shall be 75 minutes and for semester end examination the duration shall be 3 hours.**

5. 10 Evaluation of Foundation Course - Tree Plantation in Tropical Region: Benefits and Strategic Planning:

Note:

1. Tree plantation activity shall start in first semester; conduction of classes and evaluation is done in second semester.

2. Successful maintenance of tree is considered to be one of the eligibility criterions for the award of university degree.

Summary of Internal Assessment and Evaluation Schedule

Sl. No.	Type of Assessment	When	Syllabus Covered	Max Marks	Reduced to	Date by which the process must be completed
1	Test-1	During 8th Week	First 50%	25	12.5	8th week
2	Test -2	During 15th Week	Remaining 50%	25	12.5	15th Week
3	SEE	18th to 20th Week	100%	50	25	20th Week

5.11. There shall be double evaluation, viz, first valuation by the internal teachers who have taught the subject and second evaluation shall be the external examiner.

5.12. The average of the two evaluations (internal examiner & external examiner) shall be the marks to be considered for declaration of results.

Summary of Continuous Assessment and Evaluation Schedule

Type of Assessment	Period	Syllabus	Marks	Activity
First Test	8th Week	1st and 2nd Units	15	Consolidation of 1st and 2nd Unit
Allocation of Topics for Assignments	-	First Unit and second unit		Instructional process and Continuous Assessment
Submission of Assignments	-	First Unit and second unit	5	Instructional process and Continuous Assessment
Presentations / Quizzes/Case studies	-	First Unit and second unit	5	Instructional process and Continuous Assessment
Second Test	16th Week	Third unit and Fourth unit	15	Consolidation of 3rd and 4th Unit
Allocation of Topic for 2nd Assignment	-	2nd half of second unit and 3rd Unit		Instructional process and Continuous Assessment

Submission of Assignments	-	2nd half of second unit and 3rd Unit	5	Instructional process and Continuous Assessment
Presentations / Quizzes / Case studies	-	2nd half of second unit and 3rd Unit	5	Instructional process and Continuous Assessment
Semester End Practical Examination	17th Week	Entire syllabus	50	Conduct of Semester - end Practical Exams
Preparation for Semester–End Exam	16th & 17th Week	Entire Syllabus		Revision and preparation for semester–end exam
Semester End Theory Examination	18th Week & 19th Week	Entire Syllabus	50	Evaluation and Tabulation
	End of 20th Week			Notification of Final Grades

Note:

1. **As per the model making is concerned, the School shall decide about the Marks and the Number of Model Designs and as well the schedule of allocation and presentation of model design(s). If the model design carries 5 marks, there shall be two model designs; and in case of 10 marks, there shall be one model design. However, the decision of the School should be announced in the beginning of the Semester for students to avoid ambiguity and confusion.*

2. Examination and Evaluation shall take place concurrently and Final Grades shall be announced latest by 5 day after completion of the examination.

3. Practical examination wherever applicable shall be conducted after 2nd test and before semester end examination. The calendar of practical examination shall be decided by the respective School Boards and communicated well in advance to the Registrar (Evaluation) who will notify the same immediately.

6. Assessment of Performance in Practicals

6.1. The performance in the practice tasks / experiments shall be assessed on the basis of:

a) Knowledge of relevant processes;

b) Skills and operations involved;

c) Results / products including calculation and reporting

6.2. The 50 marks meant for continuous assessment of the performance in carrying out practical shall further be allocated as under:

i	Conduction of regular practical / experiments throughout the semester	20 marks
ii	Maintenance of lab records	10 marks
iii	Performance of mid-term test (to be conducted while conducting second test for theory courses); the performance assessments of the mid-term test includes performance in the conduction of experiment and write up about the experiment.	20 marks
	Total	**50 marks**

6.3. The 50 marks meant for Semester End Examination, shall be allocated as under:

i	Conduction of semester end practical examination	30 marks
ii	Write up about the experiment / practical conducted	10 marks
iii	Viva Voce	10 marks
	Total	**50 marks**

6.4. The duration for semester-end practical examination shall be decided by the concerned School Board.

7. Evaluation of Minor Project / Major Project / Dissertation:

Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the supervisor. At the end of the semester, the candidate has to submit final report of the project / dissertation, as the case may be, for final evaluation. The components of evaluation are as follows:

i	Periodic Progress and Progress Reports (25%)
ii	Results of Work and Draft Report (25%)
iii	Final Evaluation and Viva-Voce (50%). Evaluation of the report is for 30% and the Viva-Voce examination is for 20%.

8. Provision for Appeal

If a candidate is not satisfied with the evaluation of Internal Assessment components (Mid-term Tests and Assignments), he/she can approach the grievance cell with the written submission together with all facts, the assignments, test papers etc, which were evaluated. He/she can do so before the commencement of respective semester-end examination. The grievance cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the university on the candidate if his/her submission is found to be baseless and unduly motivated. This cell may recommend taking

disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the grievance cell is final.

For every program there will be one grievance cell. The composition of the grievance cell is as follows:-

- The Registrar (Evaluation) - Ex-officio Chairman / Convener
- One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the school / department/discipline and/or from the sister schools / departments/sister disciplines – Member.
- One Senior Faculty Members / Subject Experts drawn from outside the University school / department – Member

9.0 Eligibility to Appear for Semester - end Examination.

Only those students who fulfill a minimum of 75% of attendance in aggregate of all courses including practical courses / field visits etc, as part of the program shall be eligible to appear for Semester End Examination.

10. Requirements to Pass a Course / Semester and Provision to Drop / withdraw Course

10.1 **Requirements to Pass a Course**

A candidate's performance from IA and SEE will be in terms of scores, and the sum of IA and SEE scores will be for a maximum of 100 marks (IA = 50 + SEE = 50) and have to secure a minimum of 40% to declare pass in the course. However, a candidate has to secure a minimum of 25% (12 marks) in Semester End Examination (SEE) which is compulsory.

10.2. **Requirements to Pass a Semester**

To pass the semester, a candidate has to secure minimum of 40% marks in each subject / course of study prescribed in that semester.

10.3. **Provision to Carry Forward the Failed Subjects / Courses:**

A student who has failed in a given number of courses in odd and even semesters shall move to next semester of immediate succeeding year and final year of the study. However, he / she shall have to clear all courses of all semesters within the double duration, i. e., within **four years** of admission of the first semester failing which the student has to re-register to the entire program.

10.4. **Provision to Withdraw Course:**

A candidate can withdraw any course within ten days from the date of notification of final results. Whenever a candidate withdraws a course, he/she has to register for the same course in case it is hard core course, the same course or an alternate course if it is Soft Core Course or Open Elective Course.

A DROPPED course is automatically considered as a course withdrawn.

11. Re-Registration and Re-Admission:

11.1. A candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University and is considered as dropped the semester and is not allowed to appear for Semester End Examination (SEE) shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

11.2 In such a case where in a candidate drops all the courses in a semester due to personal reasons, it is considered that the candidate has dropped the semester and he / she shall seek re-admission to such dropped semester.

12. Attendance Requirement:

a. All students must attend every lecture, tutorial and practical classes.

b. In case a student is on approved leave of absence (e g:- representing the university in sports, games or athletics, placement activities, NCC, NSS activities and such others) and / or any other such contingencies like medical emergencies, the attendance requirement shall be minimum of 75% of the classes taught.

c. Any student with less than 75% of attendance in a course in aggregate during a semester shall not be permitted to appear to the end semester (SEE) examination.

d. Teachers offering the courses will place the above details in the School / Department meeting during the last week of the semester, before the commencement of SEE, and subsequently a notification pertaining to the above will be brought out by the Head of the School before the commencement of SEE examination. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

13. **The Grade and the Grade Point:**

The Grade and the Grade Point earned by the candidate in the subject will be as

given below.

Marks P	Grade G	Grade Point (GP=V x G)	Letter Grade
90 >100	10	v*10	O
80 > 90	9	v*9	A+
70 > 80	8	v*8	A
60 > 70	7	v*7	B+
55 > 60	6	v*6	B
50 > 55	5.5	V*5.5	C+
40 > 50	5	v*5	C
0-40	0	v*0	F
ABSENT			AB

O - Outstanding; A+-Excellent; A-Very Good; B+-Good; B-Above Average; C+-Average; C-Satisfactory; F – Unsatisfactory.

Here, P is the percentage of marks (P=[IA + SEE]) secured by a candidate in a course which is **rounded to nearest integer**. V is the credit value of course. G is the grade and GP is the grade point.

14. **Provisional Grade Card:**

The tentative / provisional Grade Card will be issued by the Registrar (Evaluation) at the end of every Semester indicating the courses completed successfully. The provisional grade card provides **Semester Grade Point Average** (SGPA). This statement will not contain the list of DROPPED / WITHDRAWN courses.

14.1 Computation of SGPA

The Following procedure to compute the Semester Grade Point Average (SGPA)

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in a given semester, i.e : **SGPA (Si) = ∑(Ci x Gi) / ∑Ci** where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

15. **Challenge Valuation:**

A student who desires to apply for challenge valuation shall obtain a Xerox copy of the

answer script by paying the prescribed fee within 10 days after the announcement of the results. He / She can challenge the Grade awarded to him/her by surrendering the Grade Card and by submitting an application along with the prescribed fee to the Registrar (Evaluation) within 10 days after the announcement of the results. **This challenge valuation is only for Semester End Examination (SEE) component.**

b. The answer scripts for which challenge valuation is sought for shall be evaluated by another external examiner (third examiner) who has not involved in the first evaluation. The higher of two marks from the average of first two valuations and challenge valuation shall be the final.

16. Final Grade Card:

Upon successful completion of M.S in Computer Science / M.S in Computer Science with Specialization in Data Science and Analytics degree a Final Grade card consisting of Grades / CGPA of all courses successfully completed by the candidate shall be issued by the Registrar (Evaluation).

16.1.Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (90) for M.S in Computer Science degree is calculated taking into account all the courses undergone by a student over all the semesters of a program, i.e.,

CGPA = $\sum$(Ci x Si) / $\sum$Ci Where Si is the SGPA of the i^{th} semester and Ci is the total number of credits in that semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

CONVERSION OF GRADES INTO PERCENTAGE:

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10

Illustration: CGPA Earned 8.93 x 10=89.30

17. Classification of Results

The final grade point (FGP) to be awarded to the student is based on CGPA secured by the candidate and is given as follows.

CGPA	Grade (Numerical Index) G	Letter Grade	Performance	FGP Qualitative Index
9 >= CGPA 10	10	O	Outstanding	Distinction
8 >= CGPA < 9	9	A+	Excellent	
7 >= CGPA < 8	8	A	Very Good	First Class
6 >= CGPA < 7	7	B+	Good	
5.5> = CGPA < 6	6	B	Above average	Second Class
> 5 CGPA < 5.5	5.5	C+	Average	
> 4 CGPA <5	5	C	Satisfactory	Pass

Overall percentage=10*CGPA

18. With regard to any specific case of ambiguity and unsolved problem, the decision

of the Vice-Chancellor shall be final.

Faculty List

Sl.No	Name	Designation	Contact No.
1	Dr. Senthil	Professor & Director	**8884750100/ 73497 97355**
2	Dr. M Vinayaka Murthy	Professor	9448809443
3	K. Vijaya Lakshmi	Assoc. Professor	9740388711
4	Dr . Rajeev Ranjan	Assoc. Professor	9108898284
5	Dr. Anand R	Assoc. Professor	9944301453
6	Dr. Hemanth K S	Assoc. Professor	9986257582
7	Dr. Sasikala G	Assoc. Professor	7259176911
8	Dr. Ambili P S	Assoc. Professor	9446503903
9	Dr. Vijayalakshmi A Lepakshi	Assoc. Professor	9742138440
10	Dr. Devi A	Assoc. Professor	9945270104
11	Dr. Lakshmi K	Associate Prof.	9844144380
12	Dr. N Thrimoorthy	Asst. Professor	9060967911
13	Dr. Thontadari	Asst. Professor	9844573076
14	Dr. A P Bhuveneswari	Asst. Professor	9148445592
15	Dr. Deeba K	Asst.Professor	9003516146
16	Dr. Setturu Bharath	Asst.Professor	9483832144
17	Prof. Lokesh C K	Asst. Professor	9448295877
18	Prof. Ravi Dandu	Asst. Professor	9379772672
19	Prof. R Pinaka Pani	Asst. Professor	9972254146
20	Prof. Vijaya Kumar H	Asst. Professor	9663887148
21	Prof. Vijayalaxmi. P. Chiniwar	Asst. Professor	9611345300
22	Prof. Deepa B G	Asst. Professor	8105095047
23	Prof. Vidya S	Asst. Professor	9902989134
24	Prof. Krishnamurthy R	Asst. Professor	9480050433
25	Prof. Md Abdul Khader Jailani	Asst. Professor	9790521466
26	Prof. Shobhana Saxena	Asst. Professor	9341261151
27	Prof. P Sree Lakshmi	Asst. Professor	9731068437
28	Prof. Shreetha Bhat	Asst. Professor	9743002419
29	Prof.Sneha N	Asst. Professor	9538589009
30	Prof. Vinay G	Asst. Professor	8310899551
31	Prof.Abhay Kumar Srivastav	Asst. Professor	9611364430
32	Prof.Aryamol	Asst. Professor	9986628052
33	Prof.Kusha K R	Asst. Professor	9738462560
34	Prof.Aditya V	Asst. Professor	9886430728
35	Prof. Manju B	Asst. Professor	9591450920
36	Prof. Jesla	Asst. Professor	9447964223
37	Prof. Komala R	Asst. Professor	9844551833

38	Prof. Pradeepa D	Asst. Professor	9513873344
39	Prof. Pradeep Udupa	Asst. Professor	8618109452
40	Prof. Apoorva M C	Asst. Professor	7760114305
41	Prof. Nagaraju S	Asst. Professor	9036737368
42	Prof. Shuaib Ahmed Shariff	Asst. Professor	8971104643
43	Prof. Anjali Surendran	Asst. Professor	9562227630
44	Prof. Manjunath B	Asst. Professor	9845265965
45	Prof. Anitha Rani K S	Asst. Professor	8971534442
46	Prof. Archana Bhaskar	Asst. Professor	9916510899
47	Prof. Farhanaaz	Asst. Professor	9902329068
48	Prof. B Hemalatha	Asst.Professor	7904051721
49	Prof. Rajib Guha Thakurta	Asst.Professor	7980031252 9831972166
50	Prof. Sunit Navneet Jha	Asst.Professor	9724478310
51	Prof. Mohammed Mueen Pasha	Asst.Professor	9845225993
52	Prof. Sherin	Asst.Professor	9742854395
53	Prof. Sowmya P D	Asst.Professor	7204909639
54	Prof. Divyashree D	Asst.Professor	7349189651
55	Prof. Sheela D V	Asst.Professor	9620341850