REVA UNIVERSITY
Bengaluru, India

School of CSA

Master of Science in Computer Science (MS-CS)

HANDBOOK
2019-2020

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

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF COMPUTER SCIENCE AND APPLICATIONS

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Rukmini Educational
Charitable Trust

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Chancellor's Message

"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. S. Y. Kulkarni
Vice-Chancellor, 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 (Computer 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 computer science. There are ample number of courses providing knowledge in specialized areas of network security, python programming and cloud computing etc. facilitating students to choose specialized areas of their interest. Adequate attention is given to provide students the basic concepts in computer applications.

The program is designed to expose students to various subjects having applications in computers, IT and electronics related industries through outcome based teaching and learning process which emphasizes practical exposure rather than memorization. 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 (Computer Science) program are:

- Flexibility to choose various fields upon graduation.
- Opportunity to work on live problems.
- Opportunity to work on environmental related technologies.
- Opportunity for programmers to develop software for varied applications in different sectors.

Students after successful completion of MS (Computer Science) program:

- Can start-up their career in either government sector or private sector since there are ample employment opportunities in these sectors.

- Can also start their career as software programmers / engineers, testing engineers, data base administers, system and network administrators, multimedia / web programmers, web designers etc.,
- Can seek placements in diversified fields like banking, e-commerce, insurance, entertainment, and such others.
- The computer application trained graduates are sought after by varied firms for their software based skills.
- Can opt for higher studies in computer science, IT, business management and so on.

The curriculum caters to and has relevence to local, reginal, natinal and global development needs. All courses are focussed on building skill, employability and entrepreneurship of students. Maximum number of courses are integrated with cross cutting issues with relevant to professional ethics, gender, human values, environment and sustainability.

I am sure the students choosing MS (Computer 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 centre, 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 so as 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 into 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 top most 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 recognised 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 facilitates 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 Defence Dr. Sathish Reddy, Scientific Advisor, Ministry of Defence, 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 organises 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 REVAMP 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 Shubha Vidaaya, - 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. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognised by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga classes everyday 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 honoured 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".

Misson

- 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, experiencedand highly committed faculty. The state-of-the-art infrastructure digital classrooms, well equippedadvanced computer laboratory, conference rooms and the serene academic atmosphere at REVAUniversity will enhance the transfer as well as creation of knowledge. The School offers BCA,B. Sc. (Honors) in Computer Science with specialization in Cloud Computing and Big Data,MCA and MS (Computer Science) programs. The School also has research program leading todoctoral degree. The curriculum of both graduate and post graduate degree programs have beendesigned 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 invarious core subjects / courses offered within the program. Further the school provides aninteractive, collaborative peer tutoring environment that encourages students to break downcomplex problems and develop strategies for finding solutions across a variety of situations anddisciplines. The school aims to develop a learning commUNITy of critical thinkers who serve asmodels of innovative problems solving in the university environment to enrich their academic andprofessional careers.

VISION

To transform students into good human beings, responsible citizens and competent professionals, focusing on assimilation, generation and dissemination of knowledge in the area of Computer 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 BOARD

SL. No	Name and Affiliation
1	Dr. Anand Kumar Professor and Dean-Academics, MCA Department, M.S Engineering College
2	Dr. Muralidhar B.L Professor and Coordinator, MCA Programme, Bangalore University
3	Dr. Dharani Dhamre Professor, Dept of MCA, RVCE
4	Mr. ManikantanMohanavelu Head Training Tower-India, HP
5	Mr. Madusudan R Practice Lead, Engagement & System Operations-IBM
6	Mr. DharshanMaheshbhai Project Lead- Cognizant Technology Pvt Ltd
7	Mr. Ashish Tanwar, University Relations Manager-India, Dell

MASTER OF SCIENCE in COMPUTER SCIENCE (MS-CS) PROGRAM

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 career opportunities for Master of Science in computer science graduates are plenty and growing. Programming and software development, Information systems operation and management, telecommunications and networking, computer science research, web and Internet, graphics and multimedia, training and support, and computer industry specialists are some of the areas where the graduates find opportunities.

The School of Computer Science and Applications at REVA UNIVERSITY is offering Master of Science in Computer Science (MS) –a two year postgraduate programme. The aim of the programme is to create motivated, innovative, creative thinking graduates to fill in the roles of Software Engineers who can conceptualize, design, analyze and develop computer software to meet the modern day industry requirements.

This MS programme in Computer Science is offered by **School of Computer Science and Applications at REVA UNIVERSITY in collaboration with University of Alabama in Huntsville (UAH), USA. The students of this programme who completes first year of study successfully at REVA University has a choice either to pursue their second year of study at UAH or continue in REVA.**

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 security; Data warehousing and Data mining; mobile application development and cloud computing.

Program Educational Objectives (PEO's)

The aim of the programme is to produce postgraduates with advanced knowledge and understanding of Computer 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 Programme Educational Objectives are to prepare the students to:

PEO-1	Be skilled Computer Application Developers, Use existing algorithms to develop computer applications, Provide computer based solutions for real life problems, Design, develop and test software /computer applications for specific needs
PEO-2	Understand the concepts and theories behind computer 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 a 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.

School of Computer Science and Applications

Master of Science in Computer Science – MS (CS) Programme

Scheme of Instructions – 2019 Batch

FIRST SEMESTER

Sl. No	Course Code	Course Title	HC/SC/FC	Credit Pattern			Credits	Working Hrs
				L	T	P		
1	M19MS1010	Big Data Analytics	HC	3	0	1	4	5
2	M19MS1020	OOP with JAVA	HC	4	0	0	4	4
3	M19MS1030	Data Mining and Knowledge Discovery	HC	4	0	0	4	4
4	M19MS1040	Advanced Computer Networks	HC	4	0	0	4	4
5	M19MS1050	Probability & Statistics	HC	4	0	0	4	4
6	M19MS1061	Advanced Operating Systems	SC	2	1	0	3	4
	M19MS1062	Advanced DBMS						
7	M19MS1070	Sports/Yoga/Music/Dance/Theatre	RULO	2	0	0	2	2
8	M19MS1080	JAVA Lab	HC	0	0	2	2	4
9	M19MS1090	Data Mining LAB	HC	0	0	2	2	4
Total Credits				**23**	**1**	**5**	**29**	**35**

SECOND SEMESTER

Sl. No	Course Code	Course Title	HC/SC FC	Credit Pattern			Credits	Working Hrs
				L	T	P		
1	M19MS2010	Machine Learning using Python	HC	4	0	0	4	4
2	M19MS2020	Linear Algebra	HC	3	1	0	4	5
3	M19MS2030	Big Data with NoSQL	HC	4	0	0	4	4
4	M19MS2041	System Modelling and Simulation	SC	2	1	0	3	4
	M19MS2042	Internet of Things						
5	M19MS2051	Pattern Recognition	SC	2	1	0	3	4
	M19MS2052	Social Network analysis						
6	M19MS2061	Service Oriented Architecture	SC	2	1	0	3	4
	M19MS2062	Business Intelligence						
7	M19MS2070	Soft Skill	RULO	2	0	0	2	2
8	M19MS2080	Python lab	HC	0	0	2	2	4
9	M19MS2090	Big Data and NoSQL Lab	HC	0	0	2	2	4
Total Credits				19	4	4	27	35

THIRD SEMESTER

Sl. No	Course Code	Course Title	HC/SC FC	Credit Pattern			Credits	Working Hrs
				L	T	P		
1	M19MS3010	Cloud Computing	HC	4	0	0	4	4
2	M19MS3021	Mobile Computing and APP store Management	SC	2	1	0	3	4
	M19MS3022	Deep Learning Techniques						
3	M19MS3031	Multivariate Methods for Data Analysis	SC	2	0	1	3	4
	M19MS3032	Advanced Web Technologies						
4	M19MS3040	Open Elective	OE	4	0	0	4	4
5	M19MS3050	Soft Skill	RULO	2	0	0	2	2
6	M19MS3060	Minor Project	HC	3	0	3	6	9
7	M19MS3070	MOOC/SWAYAM	RULO	4	0	0	4	4
Total Credits				**21**	**1**	**4**	**26**	**31**

FOURTH SEMESTER

Sl No	Course Code	Title of the Course	Credit Pattern L:T:P	Credits	Working Hrs
1	M19MS4010	Internship/ Certification	2:0:2	4	6
2	M19MS4020	Major Project	0:0:10	10	20
		Total Credits	**2:0:12**	**14**	**26**

*** Note:**

1. Project Work and Dissertation will be mandatory of 10 Credits

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

CREDIT SUMMARY

Semester	Credits
First	29
Second	27
Third	26
Fourth	14
Total	**96**

CREDIT DISTRIBUTION

Semester	Hard Core(HC)	Foundation Course(FC)	Softcore Course(SC)	Open Elective(OE)	Others	Total Credits
First	24	-	3	-	2	29
Second	16	4	9	-	2	27
Third	10	-	6	4	6	26
Fourth	14	-	-	-	-	14
Total Credits for Programme						**96**

MS in Computer Science

DETAILED SYLLABUS – 2019

FIRST SEMESTER

M19MS1010	Big Data Analytics	L	T	P	C
Duration: 60 Hours		3	0	1	4

Course Objectives:

The objectives of this course are to:

- Analyze the basic challenges in handling big data.
- Explore the fundamental concepts of big data analytics
- Compare the types of Data analytics
- Discover the challenges in Big data processing for analytics using R

Course Outcomes:

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

- Determine the challenges in working with big data platform
- Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
- Analyse the fundamentals of various big data analysis techniques.
- Demonstrate Map Reduce Concepts in Big Data processing

Course Content:

UNIT I Introduction to Big Data **15 Hours**

Introduction to BigData and its importance, Understanding the Characteristics of Big Data-The Vs,

Types of Data- Examples of structured, unstructured and Semi-structured data. Understanding the Waves of managing Data, Big Data architecture, Big Data Technology Components.
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.

UNIT II Data Science and BigData Analytics 15 Hours

Data Science: Business Intelligence vs Data Science. Role of a Data scientist, Profile of a Data Scientist.

Big Data Analytics- Importance, Types of Big data Analytics: Diagnostic, Descriptive, Predictive and Prescriptive analytics. Data Analytics Life cycle –the six Phases Viz. Discover, Data Preparation, Model Planning, Model Building, Communicate Results, Operationalize.Analysis Vs Reporting, Modern Data Analytic Tools.

UNIT III Data Analytics process and Hadoop Related Tools 15 Hours

Advanced clustering: K means, Regression, Regression models, Text Analytics, Analytics for Unstructured data.

Technologies and tools: Introduction to distributed computing, Hadoop and Hadoop Eco system, cloud and big data, Introducing Map Reduce. Examples of Map Reduce.

UNIT IV R Programming and Data Analytics 15 Hours

Using R for analytics: Introduction to R, Analyzing and exploring data, methods for model building and Evaluation.

Data Visualization: data Visualization techniques and methods, problems and Case Studies.

Use cases– Text analytics, Web analytics

Text Books:

1. 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.
2. Judith Hurwitz, Alan Nugent, Dr. Fern Halper, and Marcia Kaufman, Big Data For Dummies, Wiley,2013
3. Data Science and Big Data analytics, EMC2 Educational services, Wiley,2015
4. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams

with Advanced Analytics", 1st Edition, Wiley and SAS Business Series, 2012.

5. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.

Reference Books:

1. Chris Eaton, Dirk Deroos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics For Enterprise Class Hadoop And Streaming Data", Mcgrawhill Publishing, 2012
2. Glenn J. Myatt, "Making Sense Of Data", John Wiley & Sons, 2007
3. Pete Warden, "Big Data Glossary", O'Reilly, 2011.

Unit Wise Text Books:

UNIT-I:

Text 2:Big Data For Dummies Part I and II
Text 1:Chapters 1 and 2

UNIT-II:

Text Book 3: Chapter 1
Text Book 2: Part IV

UNIT-III:

Text book 3: Chapter 2

UNIT-IV:

Text book 4: Chapter1, 2

R PROGRAMMING LAB

Course Content:

Lab Exercises

1. Program to Perform the following Statistical operations in the vector sequence
   a. Sum
   b. Length
   c. Median
   d. Standard Deviation
   e. Variance
   f. Summary
   g. Min
   h. Max
2. Program to import data set and perform the various statistical operations
3. Program to perform matrix operations

4. Program to perform t test
5. Program to Perform Linear Regression
6. Program to perform Logistic Regression
7. Program to perform Polynomial regression
8. Program to merge the dataset
9. Program to perform Scatter Plot
10. Program to plot 3D Graphs.

M19MS1020	OOP with JAVA	L	T	P	C
Duration:60 Hours		4	0	0	4

Course Objectives:

The objectives of this course are to:

- Understand fundamentals of object-oriented programming in Java, including defining Classes, invoking methods, using class libraries, exception handling etc.
- Solve problems using object-oriented paradigm
- Develop applications using threads and applet programming.
- Understand Java Database Connectivity.

Course Outcomes:

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

- Implement Java classes from specifications.
- Effectively create and use objects from predefined class libraries.
- Use interfaces, inheritance, and polymorphism as programming techniques.
- Use exceptions and multithreading.
- Use applets and GUI based controls.

Course Content:

Unit I Introduction to JAVA Programming **15 Hours**

An Overview of Java - Data Types – Variables – Arrays – Operators - Control Statements. Introducing Classes - Overloading Methods- Introducing Access Control- Introducing final. String Handling: The String Constructors- Special String Operations- String Comparison -StringBuffer.

Unit II Inheritance, Packages & Interfaces, Exception Handling: 15 Hours

Inheritance: Inheritance Basics-using super - Method Overriding- Using Abstract Classes – using final with Inheritance. **Packages and Interfaces:** Packages – importing packages – interfaces. **Exception Handling:** Fundamentals – types – Uncaught Exceptions – Using try and catch – throw-throws-finally –Builtin Exceptions.

Unit III Multithreaded Programming,Applets, AWT & Event Handling 15 Hours

Multithreaded Programming: The Java Thread Model - The Main Thread - Creating a Thread/multiple threads – Interthread Communication. **Applet class:** Applet Basics - An Applet Skeleton - Simple Applet Display Methods. **Introducing the AWT:** AWT Classes- Window Fundamentals - Working with Graphics. **Event Handling:** Event Handling mechanisms - The Delegation Event Model - Event Classes - Event Listener Interfaces –Adapter classes.

UNIT IV Advanced Java 15 Hours

Java Beans : what is a Java Bean? – Advantages of Java Beans – Developing a simple Bean using the BDK - The Java Beans API. **A tour of Swing**:JApplet – Icons and Labels – Text Fields – Buttons – Combo Boxes. **Servlets**:Life cycle of a Servlet – Servlet API – javax.servlet Packages. **Accessing Databases with JDBC:** Introduction – SQL – Creating Database – Manipulating Databases with JDBC.

Text Book:

1. Herbert Schildt, Java 2: The Complete Reference. 5th Edition, McGraw-Hill Education Group.(Chapter 2,3,4,5,6,7,8,9,10,11,13,19,20,21,25,26,27)
2. Deitel and Deitel, Java How to Program, 9th Edition, PHI publisher,2013. (Chapter 28).

Reference Book:

1. Kassem, Nicholas, and Enterprise Team. Designing enterprise applications: Java 2 platform. Addison-Wesley Longman Publishing Co., Inc., 2000. Unit 4
2. Herbert Schildt, Java™: The Complete Reference, 2014, 9th Edition, Oracle Press.
3. Aaron Walsh and John Fronckowick, "Java Bible, Programming Version 2", IDG Books Worldwide, Inc. 2000.

M19MS1030	Data Mining and Knowledge Discovery	L	T	P	C
Duration: 60Hours		4	0	0	4

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 will 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.
- Evaluation of Association Patterns and compact representation of frequent item sets.

Course Content:

UNIT I Introduction to Data Mining **15 Hours**

Introduction to Data mining – Getting to Know about the Data. **Data Pre-processing:** An Overview – Data Cleaning – Data Integration – Data Reduction – Data Transformation and Discretization.

UNIT II Classification **15 Hours**

Basic Concepts – Decision Tree Induction – Bayes Classification Methods- Rule Based Classification – Techniques to Improve Classification Accuracy. Advanced Methods: Classification by Back Propagation - Support Vector Machines – k- NN Classifiers.

UNIT III Clustering **15 Hours**

Cluster Analysis: Basic Concepts and Methods: Cluster Analysis - Partitioning Methods –

Hierarchical methods – Density-Based Methods – Grid-Based Methods. **Advanced Cluster Analysis:**Probabilistic Model-Based Clustering – Clustering High- Dimensional Data – Clustering with Constraints – Outlier Analysis.

UNIT IV Association Analysis **15 Hours**

Basic Concepts and algorithms : Problem Definition – Frequent Itemset Generation –Rule Generation –Compact representation of Frequent itemsets – Alternative methods for generating Frequent Itemsets- FP- growth Algorithm –Evaluation of Association Patterns.

Text Book:

1. Jiawei Han and Micheline Kamber, "Data Mining - Concepts and Techniques", Third Edition, Elsevier, 2012.(Unit I, II & III)
2. Pang-Ning Tan, Michael Steinbach, Vipin Kumar: Introduction to Data Mining, Addison Wesley, 2006.(Unit IV)

Reference Books:

1. Daniel. T. Larose Knowledge discovery, An Introduction to Data Mining, Wiley Publishers, 2014
2. Margaret H.Dunham, "Data mining introductory and advanced topics", Pearson education, 2003.
3. G. K. Gupta: Introduction to Data Mining with Case Studies, 3rd Edition, PHI, New Delhi, 2009.

M19MS1040	**Advanced Computer Networks**	**L**	**T**	**P**	**C**
Duration: 60 Hours		**4**	**0**	**0**	**4**

Course Objectives:

The objectives of this course are to:

- Make students build an understanding of the fundamental concepts of computer networking;
- Make students to become Familiar with the basic taxonomy and terminology of the computer networking area;

- Introduce the students to advanced networking concepts, preparing the student for entry Advanced courses in computer networking;
- Allow the students to gain expertise in some specific areas of networking such as the design and maintenance of individual networks.

Course Outcomes:

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

- Understand and explain Data Communications System and its components;
- Enumerate the layers of the OSI model and TCP/IP and apply the function(s) of each layer on network applications;
- Identify the different types of network devices and their functions within a network and identify the new protocols for the same;
- Illustrate of environmental parameters measurement and 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 **15 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 **15 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 **15 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 **15 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

Textbook

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 McGraw Hill,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.

M19MS1050	Probability and Statistics	L	T	P	C

Duration: 60 Hours		**4**	**0**	**0**	**4**

Course Objectives:

The objectives of this course are to:

- Know the different Sampling Techniques used in Big data and related areas
- Introduce Random variables and Probability distributions
- Learn the statistical procedures most often used by practicing engineers.
- Understand apply for business applications.

Course Outcomes:

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

- Classify variables as quantitative or categorical, create appropriate numerical and graphical summaries for each type, and use these to explain/identify relationships between variables.
- Understand, apply and examine the goodness-of-fit test, test for independence, and coefficient of correlation for bivariate data.
- Illustrate and apply the concepts of discrete and continuous random variables, the discrete and continuous probability distributions and the joint probability distributions and solve real world problems in appropriate contexts by using standard techniques.
- Recognize and compute the single and multi-sample tests for m descriptive and inferential statistics in many different fieldsstatistics in many different fields.

Course Content:

UNIT I **15 Hours**

Descriptive Statistics

Introduction meaning and scope of Statistics - Data classification, Tabulation, Frequency and Graphic representation - Measures of central Tendency - Arithmetic mean, Mode, Partition Values - Median, Quartiles, Deciles, Percentile - Measures of Dispersion – Range, Quartile deviation, Mean deviation,

standard deviation, coefficient of Variance, Measure of Skewness, Moments & Kurtosis.

UNIT II **15 Hours**

PREDICTIVE ANALYTICS

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

UNIT III **15 Hours**

RANDOM VARIABLE AND PROBABILITY DISTRIBUTION

Introduction probability and its property, Random variable, its types DRV, CRV and its distributions, two dimensional R V, joint probability function, marginal density function. Some special probability distribution - Binomial, Poison, Uniform, Exponential and Normal Distribution.

UNIT IV **15 Hours**

HYPOTHESIS TESTING 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 10 edition , Sultan Chand and sons, 2010
2. Larsen, Richard J., and Morris L. Marx. An introduction to mathematical statistics and its applications. Vol. 5. Pearson, 2017.

References Books:

1.Berenson and Levine, Basic Business Statistics, Prentice- Hall India (1996, 6thedition)

2. S.P.Gupta, "Statistical methods"- Sultan Chand & Sons, New Delhi, 2012 Edition

3. Ross Sheldon, A First Course in Probability, Macmillan , (6th edition)

4. Medhi.J, "Statistical methods - An introductory text", new age publications, 2009 edition.

5. D.C. Montogomery and G.C.Runger, "Applied Statistics and Probability for engineers", New Jersey,John Wiley and Sons, 3rd edition, 2003.

6. P K Srimani and M Vinayaka Murthy, "Probability and Statistics", Subhas Stores, 2000

7. W.N. Venables, D.M Smith, "An introduction to R"

8. S M Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Academic Foundation, 2011

9. http://cran.r-project.org/doc/manuals/R-intro.html

M19MS1061	Advanced Operating Systems	L	T	P	C
Duration: 60 Hours		2	1	0	3

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 successful 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 **14 Hours**

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

UNIT III Multimedia Operating Systems **14 Hours**

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 System **14 Hours**

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.

Textbooks

1. "Modern Operating System" By Andrew S Tanenbaum, 3rd ed (chapter 7, 8)
2. Tanenbaum, Andrew S. Distributed operating systems. Pearson Education India, 1995. (chap 1 , 2)

Reference Books:

1. "Operating Systems" Internals and design Principles By William Stallings ,6th edition.
2. Springer, Springer transaction for advance in Distributed computing and middleware.

M19MS1062	Advanced DBMS	L	T	P	C
Duration: 60Hours		2	1	0	3

Course Objectives:

The objectives of this course are to:

- learn the modeling and design of databases
- acquire knowledge on parallel and distributed databases and its applications
- study the usage and applications of Object Oriented database
- understand the usage of advanced data models
- acquire inquisitive attitude towards research topics in databases.

Course Outcomes:

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

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

Course Content:

UNIT I Overview of Storage and Indexing 12 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

18 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 18Hours

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 12 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

M19MS1070	SPORTS/ YOGA/ MUSIC /DANCE/ THEATRE	L	T	P	C
Duration: 30 Hours		2	0	0	2

Course Objectives:

Note: Music, Dance, and Theater courses are offered by the School of Performing Arts, whereas the Sports and Yoga courses are offered by the Department of Physical Education. The students have to choose any **ONE** of these courses.

A. YOGA FOR HEALTH

Course Objectives:

Following are the Course Objectives.

- To prepare the students for the integration of their physical, mental and spiritual faculties;
- To enable the students to maintain good health;
- To practice mental hygiene and to attain higher level of consciousness;
- To possess emotional stability, self control and concentration; and
- To inculcate among students self discipline, moral and ethical values.

Course Outcomes:

On completion of the course learners will be able to:

- Practice yoga for strength, flexibility, and relaxation.
- Learn techniques for increasing concentration and decreasing anxiety
- Become self disciplined and self-controlled
- Improve physical fitness and perform better in studies
- Gain self confidence to face the challenges in the society with commitment to serve the society

Course Content:

UNIT I

Yoga: Introduction, Tips from Sage Patanjali's Yoga Sutras

Surya Namaskara:- 10 counts,12 counts,16 counts

UNIT II

Asanas: Sitting-Vajrasana, Dandasana, Padmasana, Matsyasana, Ardha Matsyendrasana, Suptavajrasana, Paschimottasana, Bakasana, Simhasana, Shirasasana.

Asanas: Standing-Tadasana, Trikonasana, Parshwa konasana, Veerabadrasana, Parivrutta trikonasana.

UNIT III

Asanas:Prone Position-Bhujangasana, Dhanurasana, Shalabhasana.**Asanas: Supine Position-**Sarvangasana, Sethubandha sarvangasana, Halasana,Karnapeedasana.

Mudras- Dhyana mudra, Chinmaya mudra, Namaste mudra, Nasika mudra

UNIT IV

Pranayams:- Ujjayi, Nadi Shodhana, Anuloma – Viloma, Basthrika, Bhramari, Sheethali

Dhyana & its types Competition format, Rules and their interpretations

B. VOLLEYBALL

Course Objectives:

- To learn the rules, fundamental skills, and strategies of volleyball.
- To develop skills in passing, setting, serving, spiking, and blocking.
- To learn basic offensive and defensive patterns of play.
- To develop a positive attitude towards volleyball as a lifetime sport and to improve physical fitness through participation in volleyball.

Course Outcomes:

On completion of the course learners will be able to:

- Learn basic skills and knowledge associated with volleyball.
- Apply these skills while playing volleyball and exhibit improved performance
- Improve physical fitness and practice positive personal and lifestyle.
- Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Course Content:

UNIT I

1. Introduction about Volleyball
2. Players Stance, Receiving and passing
3. The Volley (Overhead pass), The Dig (Underhand pass), Service Reception

UNIT II

1. Service- Under Arm Service, Tennis Service, Side Arm Spin Service, Round Arm Service, High spin service, Asian serve / American serve (floating)
2. Setting the ball- Set for attack, Back set, Jump set

UNIT III

1. Smash/Spike- Straight smash, Body turn smash, Wrist outward smash, Wrist inward smash
2. Block- Single block, Double block, Three-man block
3. Rolls- Overhead pass & back rolling, One hand underhand pass with side rolling, Forward dive

UNIT IV

1. Attack Combination, Defense Systems, Libero play
2. Court marking, Rules and their interpretations and Duties of officials

C. **BASKETBALL**

Course Objectives:

- To learn the rules, fundamental skills, and strategies of Basketball
- To develop technical skills in passing, in ball handling, individual offense, individual defense, rebounding, screen, team offense, team defense and fast break.
- To learn basic offensive and defensive strategies of play.
- To develop a positive attitude towards Basketball as a lifetime sport and to improve physical fitness through participation in Basketball.
- To develop positive understanding and appreciation of the basketball game

Course Outcomes:

On completion of the course learners will be able to:

- Learn basic skills and knowledge associated with basketball.
- Apply these skills while playing basketball and exhibit improved performance
- Improve physical fitness and practice positive personal and lifestyle.

- Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork

Course Content:

UNIT I

1. Basketball: Introduction
2. Grip; Player stance- Triple threat stance and Ball handling exercises
3. Passing (Two hand/one hand)- Chest pass, Bounce Pass, Over head pass, Underhand pass, Hook Pass, Behind the back pass, Baseball pass, Side arm pass and passing in running.
4. Receiving-Two Hand receiving, One hand receiving, Receiving in stationary position, Receiving while jumping, Receiving while running.

UNIT II

1. Dribbling- How to start dribble, How to stop dribble, High / Low dribble with variations
2. Shooting- Layup shot and its variations, One hand set shot, One hand jump shot, Free throw, Hook shot, Tip-in shot.
3. Stopping- Stride/Scoot, Pivoting and Faking /Feinting footwork.

UNIT III

1. Rebounding- Defensive rebound, Offensive rebound, Box out, Rebound Organization.
2. Individual Defensive- Guarding the man with the ball and without the ball.
3. Offensive drills, Fast break drills, Team Defense/Offense, Team Tactics

UNIT IV

1. marking, Rules and their interpretations

D. **FOOTBALL**

Course Objectives:

- To learn the rules, fundamental skills, and strategies of football.
- To develop skills in passing, receiving, controlling the ball, dribbling, shielding, shooting, tackling, beating a defender and heading in football.

- To learn basic offensive and defensive patterns of play
- To use different parts of the body in utilizing the above skills while playing football
- To develop a positive attitude towards football as a lifetime sport and to improve physical fitness through participation in football.

Course Outcomes:

On completion of the course learners will be able to:

- Learn basic skills and knowledge associated with football.
- Apply these skills while playing football and exhibit improved performance
- Use the knowledge and understanding to perform, refine and adapt the above skills and related skills with precision, accuracy, fluency and clarity in any situation.
- Improve physical fitness and practice positive personal and lifestyle.
- Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Course Content:

UNIT I

Football: Introduction

1. Kicks- Inside kick, Instep kick, Outer instep kick, Lofted kick, Chipping, Volley, Half Volley
2. Trapping- Trapping rolling the ball, Trapping bouncing ball with sole

UNIT II

1. Dribbling- With instep and outer instep of the foot.
2. Heading- From standing, running and jumping.
3. Feinting- With the lower limb and upper part of the body.

UNIT III

1. Tackling- Simple tackling, Slide tackling.

2. Throw-in- Standing and Sliding
3. Goal Keeping- Collection of balls, Ball clearance, throwing and deflecting.

UNIT IV

1. Ground marking, Rules and their interpretations

E. ATHLETICS (TRACK AND FIELD)

Course Objectives:

- To teach students the skilled techniques in sprints, relay running, hurdles, long jump, high jump, and shot put and practice them.
- To develop competence among students in demonstrating all the techniques covered in the course.
- To make students understand some of the scientific and empirical principles and their rationale underlying the development of skilled performance.
- To inculcate among students the habit of team work and cooperative learning and develop competence in detecting / correcting technique errors.
- To develop a positive attitude towards sports in general and athletics in particular and to improve physical fitness through participation in various athletic games / sports activities.

Course Outcomes:

On completion of the course learners will be able to:

- Display competencies in executing basic techniques and skills associated with select track and field events.
- Develop basic skills and techniques to improve one's running posture and take-off position for different jumps.
- Learn regular practice of select track and field events and improve physical fitness
- Appreciate track and field events by applying sports science knowledge to explain the execution of the events.

Course Content:

UNIT I

1. Athletics: Introduction
2. Track Events - Steeple Chase, Race Walking, Middle and Long distance races
3. Race walking - Technique, Faults and Officiating.
4. Middle and Long distance races – Technique and Training

UNIT II

1. Jumping Events - High Jump and Triple Jump: Basic Skills and techniques
2. High Jump - Straddle Roll & Flop Technique, Approach, Take-off, Technique in the air, Clearance over the bar & Landing
3. Triple Jump – Hop, Step and Jump Technique, Approach, Take-off & Landing

UNIT III

1. Throwing Events - Discus Throw and Hammer Throw: Basic Skills and techniques
2. Discus Throw -Standing and Rotatory techniques,Grip, Stance, Rotation Technique, Power stance, Release and Reverse (Follow through)
3. Hammer Throw - Grip, Swings, Rotation foot work, Release and Follow through

UNIT IV

1. Rules, Officiating and Marking - Ground / Sector Marking, Interpretation of Rules.

Reference books and manual for Athletics Specialization

(Athletics Part-I and Athletics Part-II)

1. Arthur E. Ellison (ed) (1994). Athletic Training and Sports Medicine.
2. Ballisteros, J.M. (1998). Hurdles Basic Coaching Manual, IAAF.
3. Bosen K.O. (1993). Teaching Athletics Skills and Technique.
4. Bosen K.O. (1990). Study Material on Hurdles for the Regular Course Students.
5. Doherty K. (1995). Track and Field Omni book.
6. Martin, David E. Peter N. Coe (1991). Training Distance Runner.
7. Howard S. (1981). Science of Track and Field Athletics.
8. Briggs Graeme (1987). “Track and field coaching Manual”, Australian Track and Field Coaches Association. Rothmans Foundation National Sports Division.
9. Carr, Gerry (1999). “Fundamentals of Track and Field. Track Athletics 1 Title G.V. 1060 5.e. 368.
10. I.A.A.F. Level-II (2001). Text Book on Jumping Event.

11. Jarver, Jesse (1987). “The Jumps”, Track and Field Coaching Manual Australia.

M19MS1080	JAVA Lab	L	T	P	C
Duration: 30Hours		0	0	2	2

Course Objectives:

The objectives of this course are to:

- Understand fundamentals of object-oriented programming in Java Programming, including defining Classes, invoking methods, using class libraries, exception handling etc.
- Solve Programming problems using object-oriented paradigm
- Develop applications using threads and applet programming.
- Understand Java Database Connectivity with Programming

Course Outcomes:

- On successful completion of this course, the student will be able to:
- Implement Java classes from specifications.
- Effectively create and use objects from predefined class libraries with Programming.
- Use interfaces, inheritance, and polymorphism as programming techniques.
- Use applets and GUI based controls.

List of Experiments:

1	Program to define a structure of a basic JAVA program
2	Program to define the data types, variable, operators, arrays and control structures.
3	Program to define class and constructors. Demonstrate constructors.
4	Program to define class, methods and objects. Demonstrate method overloading.
5	Program to define inheritance and show method overriding.
6	Program to demonstrate Packages.
7	Program to demonstrate Exception Handling.
8	Program to demonstrate Multithreading.
9	Program to demonstrate I/O operations
10.	Program to demonstrate Applet structure and event handling.
11	Program to demonstrate Layout managers.

M19MS1090	**Data Mining Lab**	**L**	**T**	**P**	**C**
Duration: 30Hours		**0**	**0**	**2**	**2**

Course Objectives:

The objectives of this course are to:

- Learn data analysis techniques through Data Mining Programming.
- Understand Data mining techniques and algorithms with Programs.
- Comprehend the data mining environments and applications.
- Understand the process of Knowledge discovery program

Course Outcomes:

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

- Compare various conceptions of data mining as evidenced in research, Programming and applications.
- Characterize the various kinds of patterns that can be discovered by association rule mining.
- Evaluate Programming methods underlying the effective application of data mining.

List of Experiments

1	Build Data Warehouse and Explore WEKA.
2	Create data-set in .arff file format. Demonstration of preprocessing on WEKA data-set.
3	Demonstrate performing association rule mining on data sets(contact lenses.arff /supermarket using apriori algorithm.)
4	Demonstration of classification rule process on WEKA data-set using j48 algorithm.
5	Demonstration of classification rule process on WEKA data-set using Naive Bayes algorithm.
6	Demonstrate performing clustering on data sets(data-set iris.arff using simple k-means).
7	Demonstrate performing Regression on data sets.
8	Write a program of Naive Bayesian classification using C.
9	Write a program of cluster analysis using simple k-means algorithm using any programming language.
10.	Write a program of Apriori algorithm using any programming language.

SECOND SEMESTER

M19MS2010		L	T	P	C
Duration: 60 Hours	Machine Learning using Python	4	0	0	4

Course Objectives:

The objectives of this course are to:

- Describe the basic components of Machine Learning with concepts of Python
- Differentiate broad categories of Machine learning
- Compare different types of algorithms used in Machine Learning domain with limitations
- 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 I **15 Hours**

Python: Origin, Programming Basics, data types and Operators, Program Files, Directories, Changing Data Through Names, Copying Data, Accessing a Tuple Through Another Tuple, packages and libraries.

Overview of ML, broad categories of Machine learning- Supervised, Unsupervised, Semi-supervised, and Reinforcement Learning, Applications areas of Machine Learning. Examples and Case studies

UNIT II **15 Hours**

Supervised Learning: Introduction, Classification and Linear Regression, k-Nearest Neighbor, Linear models, Decision Trees, Naive Bayes Classifiers, KernelizedSupport Vector Machine (SVM)

Algorithm.Neural Networks (deep learning), Comparison of different algorithms, discussions on case studies.

UNIT III **15 Hours**

Unsupervised Learning: Introduction, types and challenges, preprocessing and scaling of datasets, Dimensionality reduction, feature extraction. Principal Component Analysis (PCA), k-means, agglomerative,and DBSCAN clustering algorithms. Comparison of different cluster algorithms, discussions on Case studies

UNIT IV **15 Hours**

Semi-supervised: Introduction, discussion on Generative models and Graph-based methods. **Reinforcement:** Introduction, the learning task, Q learning –function, convergence, & updating sequence, rewards and actions, relationship to dynamic programming, discussions on Case studies

Text Books:

1. Introduction of Machine Learning with Python – by Andreas C Muller & Sarah Guidp – O'Reilly & Shroff publishers. Chapters 1, 2 and 3.
2. Introducing Python by Bill Lubanovic(chapters 1-6), Oriely Publications, 1st Edition
3. Python Programming for absolute beginners by Michael Dawson, Course Technology-A part of CENGAGE Learning, 3rd Edition
4. Machine Learning by Tom M Mitchell – McGraw Hill Education publication – 2013. Chapter 13.

References Books:

1. Machine Learning: The Art and Science of algorithms – by Peter Flach – Cambridge University Press. Chapter 12
2. Machine Learning - by EthemAlpaydin – PHI learning private limited. Chapter 1, 7, 16, 18, 19
3. Bayesian Reasoning and Machine Learning – by David barber - Cambridge University Press. Chapter 13, 15
4. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2006
5. Semi-Supervised Learning - by Olivier Chapelle, Bernhard Sch¨olkopf, and Alexander Zien - The MIT Press Cambridge
6. The Elements of Statistical Learning – by Trevor Hastie, Robert Tibshirani and Jerome Friedman – Springer 2017 publication
7. Python Programming for absolute beginners-3rd Edition by Michael Dawson

M19MS2020	Linear Algebra	L	T	P	C
Duration: 60Hours		3	1	0	4

Course Objectives:

This course will:

- Recall basic concepts of matrices and matrix algebra
- Present methods of solving systems of linear equations
- Demonstrate basic concepts of vector spaces
- Interpret the concepts of linear transformations by using the matrices
- Develop methods of computing and using eigen values and eigenvectors

Course Outcomes:

Students in this course will able to:

- Solve the system of Linear Equations by using Matrix Algebra
- Derive the Norms and Inner Product Spaces
- Summarize the vector space properties.
- Analyze different forms of the Linear Transformations

Course Content:

UNIT I **15 Hours**

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; Elementary Matrix Operations and Elementary Matrices, The Rank of a Matrix and Matrix Inverses, Systems of Linear Equations.

UNIT II **15 Hours**

Properties of Determinants, Cofactor Expansions, Elementary Operations and Cramer's Rule; Eigenvalues and Eigenvectors, Diagonalizability, Invariant Subspaces and the Cayley-Hamilton Theorem; Inner Products and Norms, (No theorem proof).

UNIT III **15 Hours**

The Adjoint of a Linear Operator, Normal and Self-Adjoint Operators, Unitary and Orthogonal Operators and Their Matrices, Orthogonal Projections and the Spectral Theorem; Bilinear and Quadratic Forms (No theorem proof).

UNIT IV **15 Hours**

The Diagonal form, The Triangular form; The Jordan Canonical Form; The Minimal Polynomial; The Rational Canonical Form (No theorem proof).

Books for Reference:

1. S. Friedberg, A. Insel, and L. Spence - Linear Algebra, Fourth Edition, PHI, 2009.
2. Jimmie Gilbert and Linda Gilbert – Linear Algebra and Matrix Theory, Academic Press, An imprint of Elsevier.
3. I. N. Herstein – Topics in Algebra, Vikas Publishing House, New Delhi.
4. Hoffman and Kunze – Linear Algebra, Prentice-Hall of India, 1978, 2nd Ed.,
5. P. R. Halmos – Finite Dimensional Vector Space, D. Van Nostrand, 1958.
6. S. Kumeresan – Linear Algebra, A Geometric approach, Prentice Hall India, 2000.

M19MS2030	Big Data with NoSQL	L	T	P	C
Duration: 60Hours		4	0	0	4

Course Objectives:

The objectives of this course:

- 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.
- Understand the usage of advanced data models.
- Learn emerging databases like MongoDB, HBase.

Course Outcomes:

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

- Define, compare and use the four types of NoSQL Databases (Document oriented, Key Value Pairs, Column oriented and Graph).
- Analyze the need of NoSQL databases in handling Big data
- Compare the Difference between the types of NOSQL databases.
- Demonstrate the data models in these databases.

Course Content:

UNIT I Introduction to NOSQL **15 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 **15 Hours**

Introduction to Key-value stores- Exploring Redis Redis 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 **15 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 15 Hours

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

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, Apress 2010 .
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

Reference Websites:

1. www.mongodb.org
2. www.redis.io
3. www.hbase.apache.org

Unit wise Text books reference.

Unit 1- R1- Chapter 1, T1-Chapter 1-4,5.3.1
Unit 2- www.redis.io, www.hbase.apache.org
Unit 3-T4-chapter 4,6
Unit 4-Chapter 9; T5-Chapter 1-3

M19MS2041	System Modeling and Simulation	L	T	P	C
Duration: 45Hours		2	1	0	3

Course Objectives:

The objectives of this course are to:

- Make the students to understand the importance simulation and modeling in a range of important application areas.
- Explain the event – scheduling, time-advance algorithm in computer networks.
- Introduce discrete event stochastic models and queuing models.
- Learn the benefits of probability, random process verification and validation of the models.

Course Outcomes:

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

- Outline the various applications of simulation.
- Describe the role of important elements of simulation in modeling paradigm.
- Generate Random numbers using different techniques.
- Apply simulation on various layers for Optimization and random number generation and Present the Modeling techniques for event systems

Course Content:

UNIT I Introduction **15 Hours**

Why is Simulation Important? When simulation is the appropriate tool and when it is not appropriate? Areas of application, Systems and system environment; Components of a system, Discrete and continuous systems, Model of a system; Types of Models; Discrete-Event System Simulation. Simulation examples: Simulation of queuing systems; Simulation of inventory systems; other examples of simulation. What is model? Advantages and Disadvantages of Modeling and Simulation, Common Pitfalls of Modeling and Simulation and Rules of Thumb, Overview of M&S

tools.

UNIT II General Principal, Statistical & Queuing Models 15 Hours

Simulation Software: Concepts in Discrete-Event Simulation: The Event-Scheduling / Time-Advance Algorithm, World Views, Manual simulation Using Event scheduling; List processing.

Review of terminology and concepts; Useful statistical models; discrete distributions; Continuous distributions; Poisson process; Empirical distributions. Characteristics of queuing systems; Queuing notation; Long-run measures of performance of queuing systems; Steady-state behavior of M/G/1 queue; Networks of queues.

UNIT III Random-Number 15 Hours

Properties of random Numbers; Generation of pseudo-random numbers; Techniques for generating random numbers; Tests for Random Numbers. Random-Variate Generation: Inverse transform technique; Acceptance-Rejection technique; Special properties.

Input Modeling: Data Collection; Identifying the distribution with data; Parameter estimation; Goodness of Fit Tests; Fitting a non-stationary Poisson process; selecting input models without data; Multivariate and Time-Series input models.

UNIT IV Verification and Validation of Simulation Models 15 Hours

Model building, verification and validation; Verification of simulation models; Calibration and validation of models. Optimization via Simulation. Modeling and Simulation using Network Simulator: RF Propagation Wired MANE, Network Layer.

Text Books:

1. Jerry Banks , John S. Carson II , Barry L. Nelson , David M. Nicol, ''Discrete-Event System Simulation'', Pearson Education, 5th edition, 2015 (chapters 1-10).
2. Averill M. Law, ''Simulation Modeling and Analysis'', Tata McGraw-Hill, 4th edition, 2007.(chapters 7, 8).
3. Wehrle, Klaus, Günes, Mesut, Gross, James, "Modeling and Tools for Network Simulation", 2010.(chapters 1-5).

Reference Books:

1. Sheldon M Ross, "Simulation", Elsevier Publication, 5th Edition, 2014(chapters 4, 7, 8 and 11).

M19MS2042	Internet of Things	L	T	P	C
Duration: 45Hours		2	1	0	3

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

- Understand and analyze the usability of the IoTs across various real-world applications
- Analyze low-power devices equipped with sensing, computation, and wireless communication capabilities along with M2M communication.
- Illustrate of environmental parameters measurement and monitoring by exposing participants to the comprehensive fundamentals of Smart Sensors and Internet of Things
- Understand the operating systems, radio communication, networking protocols and develop application with a programming language.

Course Content:

UNIT I Introduction to Internet of Things **15 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 **15 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 **15 Hours**

IoT Design Methodology, Step 1: Purpose & Requirements Specification, Step 2: Process Specification , Step 3: Domain Model Specification , Step 4: Information Model Specification , Step 5: Service Specifications , Step 6: IoT Level Specification, Step 7: Functional View Specification, Step 8: Operational View Specification ,Step 9: Device & Component Integration, Step 10: Application Development. Case Study on IoT System for Weather Monitoring, Motivation for Using Python

UNIT IV Advanced topics in IoT **15 Hours**

Logical Design of IOT using Python, Introduction to Python, Basics of Programming with Rasphberry PI with PYTHON, IOT Physical devices and end points. Python Packages of Interest for IoT-JSON. IoT Physical Servers & Endpoints, Introduction to cloud storage Models for IOT.

Text Book:

1. Internet of Things-An Hands on Approach- Vijay Madisetti (Author), Arshdeep Bahga, 2014 (chapter 1,3,4, 5, 6).

Reference Books:

1. Cuno Pfister Getting Started with the Internet of Things, OReilly, 2011.
2. Francis DaCosta, Rethinking Internet of things, Apress Open Edition, 2013
3. Adrian McEwen, Hakim Cassimally, Design of Internet of Things, 2014 John Wiley and Sons, Ltd.

M19MS2051	Pattern Recognition	L	T	P	C
Duration: 45Hours		2	1	0	3

Course Objectives:

The objectives of this course are to:

- Understand basic concepts in pattern recognition
- Gain knowledge about state-of-the-art algorithms used in pattern recognition research
- Understand pattern recognition theories, such as Bayes classifier, linear discriminant analysis.
- Apply pattern recognition techniques in practical problems.

Course Outcomes:

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

- Understand basic concepts in pattern recognition
- Gain knowledge about state-of-the-art algorithms used in pattern recognition research
- Understand pattern recognition theories, such as Bayes classifier, linear discriminant analysis.
- Apply pattern recognition techniques in practical problems.

Course Content:

UNIT I Introduction **15 Hours**

Machine perception, pattern recognition example, pattern recognition systems, the design cycle, learning and adaptation. Bayesian Decision Theory : Introduction, continuous features – two categories classifications, minimum error-rate classification- zero– one loss function, classifiers, discriminant functions, and decision surfaces

UNIT II Normal density **15 Hours**

Univariate and multivariate density, discriminant functions for the normal density different cases, Bayes decision theory – discrete features, compound Bayesian decision theory and context.

Maximum likelihood and Bayesian parameter estimation : Introduction, maximum likelihood estimation, Bayesian estimation, Bayesian parameter estimation–Gaussian case

UNIT III Un-supervised learning and clustering **15 Hours**

Introduction, mixture densities and identifiability, maximum likelihood estimates, application to normal mixtures, K-means clustering. Date description and clustering – similarity measures, criteria function for clustering

UNIT IV Discrete Hidden Markov Models **15 Hours**

Introduction, Discrete–time markov process, extensions to hidden Markov models, three basic problems for HMMs. Continuous hidden Markov models: Observation densities, training and testing with continuous HMMs, types of HMMs.

Text Books:

1. Pattern classifications, Richard O. Duda, Peter E. Hart, David G. Stroke. Wiley student edition, Second Edition, 2001. {Chapters: 1, 2, 3, 10}
2. Fundamentals of speech Recognition, Lawerence Rabiner, Biing – Hwang Juang Pearson education, 1993. {Chapters: 6}

Reference Books:

- Pattern Recognition and Image Analysis – Earl Gose, Richard John baugh, Steve Jost PHI 2004

M19MS2052	**Social Network Analysis**	**L**	**T**	**P**	**C**
Duration: 45 Hours		**2**	**1**	**0**	**3**

Course Objectives:

The objectives of this course are to:

- Understand the concept of semantic web and related applications.
- Learn knowledge representation using ontology.
- Understand human behaviour in social web and related communities
- Learn visualization of social networks.

Course Outcomes:

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

- Develop semantic web related applications.
- Appreciate how network analysis can contribute to increasing knowledge about diverse aspects of society and knowledge using ontology.
- Predict human behavior in social web and related communities.
- Understand basic principles behind network analysis algorithms

Course Content:

UNIT I **15 Hours**

Social Networks: Introduction, Research Issues & Topics in Social Networks. Statistical Properties of Social Networks: Definitions & Data description, Static Properties of Unweighted Graphs & Weighted Graphs, Dynamic Properties of dynamic Unweighted Graphs & dynamic Weighted Graphs

Community Discovery in Social Networks: Applications, Methods and Emerging Trends, Communities in Context, Core Methods, Quality Functions, The Kernighan-Lin (KL), Agglomerative/Divisive, Spectral Algorithms, Multi-level Graph Partitioning, Markov Clustering, Other Approaches, Community Discovery in Dynamic Networks, Heterogeneous Networks, and Directed Networks.

Coupling Content and Relationship Information for Community Discovery, Cross-cutting Issues.

UNIT II **15 Hours**

Node Classification in Social Networks: Introduction, Problem Formulation, Representing data as a graph, The Node Classification Problem, Methods using Local Classifiers Iterative Classification Method, RandomWalk based Methods, Label Propagation, Graph Regularization, Adsorption, Applying Node Classification to Large Social Networks, Basic Approaches, Second-order Methods, Implementation within Map-Reduce.

Evolution in Social Networks: Introduction, Framework, Modeling a Network across the Time Axis, Evolution across Four Dimensions, Challenges of Social Network Streams.

Models and Algorithms for Social Influence Analysis: Introduction, Influence Related Statistics, Edge and Node Measures, Social Similarity and Influence, Homophily, Existential Test for Social

Influence, Influence and Actions, Influence and Interaction, Influence Maximization,

UNIT III **15 Hours**

Expert Locations in Social Networks: Definitions and Notation, Expert Location without Graph Constraints, Language Models for Expert Location, Expert Location with Score Propagation, PageRank Algorithm, HITS Algorithm, Expert Score Propagation, Expert Team Formation, Metrics, Forming Teams of Experts, Agent-based Approach, Influence Maximization, Expert Location Systems.

Link Prediction in Social Networks:

Introduction, Background, Feature based Link Prediction, Feature Set Construction, Classification Models, Bayesian Probabilistic Models, Link Prediction by Local Probabilistic Models, Network Evolution based Probabilistic Model, Hierarchical Probabilistic Model, Probabilistic Relational Models, Relational Bayesian Network, Relational Markov Network. Linear Algebraic Methods

Privacy in Social Networks: Introduction, Privacy breaches in social networks, Identity disclosure, Attribute disclosure, Social link disclosure, Affiliation link disclosure, Privacy definitions for publishing data, k-anonymity, l-diversity and t-closeness, Differential privacy, Privacy-preserving mechanisms, for social networks, affiliation networks.

UNIT IV **15 Hours**

Data Mining in Social Media: Motivations, Data Mining Methods for Social Media, Data Representation, Data Mining - A Process, Social Networking Sites - Illustrative Example, The Blogosphere: Illustrative Examples, Related Efforts, Ethnography and Netnography, Event Maps

Text Mining in Social Networks: Introduction, Keyword Search, Query Semantics and Answer Ranking, Keyword search over XML and relational data, Keyword search over graph data, Classification Algorithms, Clustering Algorithms, Transfer Learning in Heterogeneous Networks, case study on any one of social media network

Text Books:

1. Social Network Data Analytics – by Charu C. Aggarwal, Springer 2011
2. Scott, J., & Carrington, P. J. (Eds.). (2011). The SAGE Handbook of Social Network Analysis. London; Thousand Oaks, Calif: SAGE Publications Ltd.

3. Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2013). Analyzing social networks. Los Angeles; London: SAGE Publications.

Reference books:

1. D. Easley, J. Kleinberg. Networks, Crowds and Markets: Reasoning About a Highly Connected World. Cambridge University Press, 2010.

2. M. E. J. Newman. Networks: An Introduction. Oxford University Press, 2010.

3. W. de Nooy, A. Mrvar, V. Batagelj. Exploratory Social Network Analysis with Pajek. Cambridge University Press, 2005.

4. Shamanth Kumar, Fred Morstatter, Huan Liu. Twitter Data Analytics. Springer-Verlag New York, 2014.

5. Wasserman, S., & Faust, K. (1994). Social Network Analysis: Methods and Applications. New York: Cambridge University Press.

M19MS2061	**Service Oriented Architecture**	**L**	**T**	**P**	**C**
Duration: 45Hours		**2**	**1**	**0**	**3**

Course Objectives:

The objectives of this course are to:

- gain understanding of the basic principles of service orientation
- Learn service oriented analysis techniques
- Analyse technology underlying the service design
- Understand the concepts such as SOAP, registering and discovering services.

Course Outcomes:

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

- Get the foundations and concepts of service based computing
- Advocate the importance and means of technology alignment with business
- Understanding the basic operational model of web services,
- Gain the knowledge of key technologies in the service oriented computing arena
- Apply and practice the learning through a real or illustrative project/case study s

Course Content:

Course Content

UNIT I **15 Hours**

Service-Oriented Computing and SOA:

Fundamental SOA, Common characteristics of contemporary SOA, Common misperceptions about SOA, Common tangible benefits of using SOA, Common pitfalls of adopting SOA.

UNIT II **15 Hours**

Service-Orientation:

Introduction to Service-Orientation, Problems Solved by Service-Orientation, Challenges Introduced by Service-Orientation, Effects of Service-Orientation on the Enterprise, Origins and Influences of Service-Orientation

UNIT III **15 Hours**

Analysis

Service oriented analysis ,Business-centric SOA , Deriving business services- service modeling ,Service Oriented Design , WSDL basics , SOAP basics , SOA composition guidelines, Entity-centric business service design ,Application service design , Task centric business service design

UNIT IV **15 Hours**

Understanding Design Principles:

Using Design Principles, Principle Profiles, Design Pattern References, Principles that Implement vs. Principles that Regulate, Principles and Service Implementation Mediums, Principles and Service Contract Granularity.

Text Books:

1. Erl, Thomas, Paulo Merson, and Roger Stoffers. Service-Oriented Architecture: Analysis and Design for Services and Microservices. Prentice Hall, 2017. (chap 3, 4, 5)
2. Service-Oriented Architecture: Concepts, Technology, and Design, Thomas Erl, Pearson Education, 2005 (chap 3, 4,)

Reference Book:

1. Hentrich, Carsten, and Uwe Zdun. Process-Driven SOA: Patterns for Aligning Business and IT. Auerbach Publications, 2016.

M19MS2062	Business Intelligence	L	T	P	C
Duration: 45Hours		2	1	0	3

Course Objectives:

The objectives of this course are to:

- Outline different decision making components in business intelligence system.
- Examine modeling and decision support system.
- Demonstrate business intelligence life cycle and the techniques used in it
- Evaluate data analysis tools and techniques.

Course Outcomes

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

- Analyze and Understand the role of decision models and explore solutions of BI
- To understand and apply the mathematical models of Decisions making ·

- Provide solutions to real life problems using classification techniques and clustering algorithms and evaluate the methodologies. ·
- Identify decision process using Software tools and intelligence for individual applications.

Course Content:

UNIT I

Components of decision making process **15 Hours**

Business Intelligence: Effective and timely decisions-Data, information and knowledge-The role of mathematical models-Business intelligence architecture-Ethics and business intelligence.

Decision support system: Definition of system-representation of the decision making process-Evolution of information system- Definition of decision support system-development of decision support system.

UNIT II **15 Hours**

Mathematical model for decision making: Structure of mathematical models-Development of model-classes of models. Regression: Structure of regression models-simple linear regression-multiple linear regression. Time series: Definition of time series-Evaluating time series models-Analysis of the component of time series.

UNIT III **15 Hours**

Classification: Classification problems-Taxonomy of classification models-Evaluation of classification models. Association rules: Motivation and structure of association rules-single dimension association rules-general association rules. Clustering: Clustering Methods-partition method-hierarchical methods-evaluating of clustering models.

UNIT IV **15 Hours**

Business intelligence Applications

Marketing models-Sales force management-Decision process in sales forces management. Business Case studies: Retention in telecommunications-acquisition in the automotive industry-Cross selling in the retail industry.

Text Books:

1. Carlo Vercellis, "Business Intelligence",Wiley publications,2015 (Chapter 1 &2, Chapter 4,8 &9, Chapter 10,11 &12, Chapter 13),

Reference Books:

1. Galit Shmueli, Nitin R. Patel, Peter C Bruce, "Data Mining for Business Intelligence, Wiley publications, 2014
2. Efraim Turban, Ramesh Sharda, Dursun Delen, "Decision Support and Business Intelligence Systems", 9th Edition, Pearson 2013.
3. David Loshin Morgan, Kaufman, "Business Intelligence: The Savvy Manager"s Guide", Second Edition, 2012.

M19MS2070	Soft Skills	L	T	P	C
Duration: 30 Hours		2	0	0	2

M19MS2080	Python Lab	L	T	P	C
Duration: 30Hours		0	0	2	2

Course Objectives:

The objectives of this course are to:

- Describe the basic components of Machine Learning with concepts of Python Programming
- Differentiate broad categories of Machine learning Programming
- Compare different types of Programming used in Machine Learning domain with limitations
- 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 Programming of Machine Learning
- Formulate innovative ideas or techniques of machine learning for the real world problems

- Apply Machine Learning algorithms/ Programming for specific problems.
- Understand the challenges and issues related to machine learning application Programming

Lab Experimenents:

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 module.(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. Design a menu driven program to check whether the number is
   i)A perfect number or not

   ii)Armstrong number or not

   iii)Palindrome or not

8. Show the different operations defined on Lists, Tuples and Dictionaries
9. Write a program to find the factorial of a number using functions and without using functions. Accept the input at runtime.
10. 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:

Lab modules:

1. Implementation of regression algorithm
2. Implementation of Naïve Bayes algorithm
3. Implementation of Decision Tree algorithm
4. Implementation of K-means algorithm
5. Implementation of PCA algorithm
6. Implementation of SVM algorithm

7. Implementation of Q- algorithm

The above algorithms has to be executed on different sets/types of datasets

M19MS2090	Big Data and NoSQL Lab	L	T	P	C
Duration: 30Hours		0	0	2	2

Course Objectives:

The objectives of this course:

- Learn the latest trends in databases.
- Learn various NoSql systems and their features
- Compare NoSql databases with each other and relational systems
- Learn emerging databases like MongoDB, HBase.

Course Outcomes:

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

- Define, compare and use the four types of NoSQL Databases (Document oriented, Key Value Pairs, Column oriented and Graph).
- Analyze the need of NoSQL databases in handling Big data.
- Compare the Difference between the types of NOSQL databases.

- Demonstrate the data models in these databases.

Lab Experiment:

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 “ using upsert as True.
xiii. Increment the price of all food item in food cat: fastfood by 120.

5. 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

M19MS3010	Cloud Computing	L	T	P	C
Duration: Hours		4	0	0	4

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.
- Learn to design the trusted cloud Computing system

Course Outcomes:

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

- Understand the fundamentals of Cloud Computing and evaluate ideas for building cloud computing environments.
- Explain the fundamental concepts of Virtualization and analyze the characteristics of virtualized environments.
- Analyze existing cloud architecture to design and develop new systems using software tools that can solve real time problems without harming environment.
- Explore cloud computing applications in various areas and analyze their usage.

Course Content:

UNIT I Fundamentals of Cloud Computing 15 Hours

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 and Models 15 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 15 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, Introduction to Cloud Software Environments , Architecture of Eucalyptus, Open Nebula, OpenStack, Aneka.

UNIT IV Cloud Applications and AWS Cloud platform 15 Hours

Scientific applications, Healthcare: ECG analysis in the cloud, Biology: protein structure prediction, Geoscience: satellite image processing, Business and consumer applications, CRM and ERP, Social networking, media applications.

Cloud Storage systems. Deploying applications in the cloud, open cloud platforms AWS,GAE.

Textbooks:

1. Rajkumar Buyya, Christian Vechiolla, Thamarai Selvi, "**Mastering Cloud Computing** , Elsevier publications, 2013, USA. (Unit 1 : Chapter 1 and 2, Unit 2: Chapter 3, Unit 3:Chapter 4,5.1, Unit 4:Chapter 8,9.1,9.2 and 10)

References:

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

M19MS3021	Mobile Computing and APP store Management	L	T	P	C
Duration: 45Hours		2	1	0	3

Course Objectives:

The objectives of this course are to:

- Impart basic understanding of the wireless communication systems.
- Expose students to various aspects of mobile computing techniques.
- Understand the basic concepts of mobile computing.
- Be familiar with the network protocol stack
- Gain knowledge about different mobile platforms and application development

Course Outcomes:

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

- Impart basic understanding of the wireless communication systems.
- Expose students to various aspects of mobile computing techniques.
- Understand the basic concepts of mobile computing.
- Be familiar with the network protocol stack and Gaining knowledge about different mobile platforms and application development

Course Content:

UNIT I Mobile Computing Application and Services 15 Hours

Introduction to mobile computing, Middleware and Gateways, Application and services, Internet-Ubiquitous networks, Architecture and three-tier architecture for Mobile Computing, Design consideration for Mobile Computing. Spread spectrum – Direct sequence, Frequency hoping. Medium Access Control - SDMA, FDMA, TDMA, CDMA, Cellular concepts- channel assignment strategy- hand off strategy interface and system capacity- improving coverage and capacity in cellular system, Satellite Systems-GEO, LEO, MEO. Wireless Communication Systems- Telecommunication Systems- GSM- GSM services & features, architecture -DECT features & characteristics, architecture.

UNIT II Mobile Computing Architecture 15 Hours

Wireless LANS: Wireless LAN Standards – IEEE 802 Protocol Architecture, IEEE 802.11 System Architecture, Protocol Architecture & Services, Cellular Networks: Channel allocation, multiple access, location management, Handoffs. MAC Layer & Management, Routing - Classification of Routing Algorithms, Algorithms such as DSR, AODV, DSDV, Mobile Agents, Service Discovery.

UNIT III Introduction to Android 15 Hours

Introduction to Android Architecture: Introduction, History, Features and Android Architecture. Android Application Environment, SDK, Tools: Application Environment and Tools, Android SDK. Programming paradigms and Application Components - Part 1: Application Components, Activity, Manifest File, Programming paradigms and Application Components

UNIT IV User Interface Design 15 Hours

User Interface Design part 1: Views &View Groups, Views : Button, Text Field, Radio Button, Toggle Button, Checkbox, Spinner, Image View, Image switcher, Event Handling, Listeners, Layouts : Linear, Relative, List View, Grid View, Table View, Web View, Adapters. User Interface Design part 2: Menus, Action Bars, Notifications : Status, Toasts and Dialogs, Styles and Themes, Creating Custom Widgets, Focus, Touch Mode, Screen Orientation.

Text Books:

1. Asoke K. Talukder, Hasan Ahmad, Mobile Computing Technology- Application and Service Creation, 2nd Edition, McGraw Hill Education. (chapter 1 & 2)
2. Professional Android 4 Development by Reto Meier, John Wiley and Sons, 2012 .(Chapter 1, 2,3)

Reference Books:

1. Erik Hellman, "Android Programming – Pushing the Limits", 1st Edition, Wiley India Pvt Ltd, 2014.
2. Dawn Griffiths and David Griffiths, "Head First Android Development", 1st Edition, O'Reilly SPD Publishers, 2015.
3. J F DiMarzio, "Beginning Android Programming with Android Studio", 4th Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978-8126565580 4. Anubhav Pradhan, Anil V Deshpande, " Composing Mobile Apps" using Android, Wiley 2014, ISBN: 978-81-265-4660-2
4. Google Developer Training, "Android Developer Fundamentals Course – Concept Reference", Google Developer Training Team, 2017.

M19MS3022	**Deep Learning Techniques**	**L**	**T**	**P**	**C**
Duration: 45Hours		**2**	**1**	**0**	**3**

Course Objectives:

The objectives of this course are to:

- Illustrate the foundation of neural networks and deep learning.
- Formulate deep networks for different applications.
- Demonstrate different deep learning architectures.

- Validate deep learning techniques in object recognition and computer vision.

Course Outcomes:

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

- Describe deep learning and why it is essential to the design of intelligent machines.
- Design the deep networks for various real world applications.
- Acquire the knowledge in deep learning and be able to implement deep learning models for language, vision, speech, decision making and more.
- Discriminate different deep learning architectures.
- Assess the deep learning techniques in object recognition and computer vision.

Course Content:

UNIT I **15 Hours**

Foundations of Neural network and Deep Learning: Neural Networks: The biological Neuron-The perceptron-Multilayer feed forward networks. Training neural networks: Back propagation learning. Activation function: Linear-sigmoid- tanh-hard tanh-soft max-rectified linear. Loss functions: Loss function notation-loss function for regression-loss function for classification-loss function for reconstruction. Hyper parameters: Learning rate, regularization, momentum, sparsity.

UNIT II **15 Hours**

Fundamentals of Deep networks: Defining deep learning and deep networks- advantages in network architecture-from feature engineering to automated feature learning-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 **15 Hours**

Major Architecture of Deep networks: 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 **15 Hours**

Recurrent and recursive neural networks: 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.

Text Books:

1. Josh Patterson and Adam Gibson, "Deep Learning A practitioners Approach",Shroff publishers & Distributors, First edition 2017.(Chapter 2,3,4,6,7 & 8)

Reference Book:

1. Aurelian Geron, "Hands-On Machine Learning with Scikit-Learn & Tensor Flow", Shroff publishers & Distributors, First edition, 2017.
2. Langoog fellow, Yoshuabengio and Aaron courville , "Deep Learning", MIT press, First edition, 2016.
3. Li Deng and Dong Yu, "Deep LearningMethods and Applications",Foundations and Trends *in* Signal Processing,2014.
4. Michael A. Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015

Web sites:

1. www.deeplearning.net
2. www.deeplearning.stanford.edu
3. www.deeplearning.cs.toronto.edu

M19MS3031	Multivariate Methods for data Analysis	L	T	P	C
Duration: 45 Hours		2	0	1	3

Course Objectives:

The objectives of this course are to:

- Cover differential, integral and vector calculus for functions of more than one variable.
- Learn mathematical tools and methods are used extensively in the physical sciences, engineering, economics and computer graphic

Course Outcomes:

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

- Apply Matrices and Vectors on free-body diagrams
- Construct free-body diagrams.
- Understand of the analysis of distributed contents.
- Integrate the mathematical model in various disciplines.

Course Content:

UNIT I **15 Hours**

Matrices and Vectors: Matrices, Matrices Operations, Related Matrices, Determinants, Properties of Determinants, Solution of Linear System of Equations, 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.

UNIT II **15Hours**

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. 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.

UNIT III **15 Hours**

Double Integrals and its Applications: Double Integrals, Change of Order of Integration, Double Integrals in Polar Coordinates; Area enclosed by Plane Curves, Integration of Vectors, Line Integral, Surface, Green's Theorem in the Plane, Stoke's Theorem.

UNIT IV **15 Hours**

Triple Integrals and its Applications: Triple Integrals, Volumes of Solids, Change of Variables, Area of a Curved Surface, Calculation of Mass, Centre of Gravity, Centre of Pressure, Volume Integral, Green's Theorem, Irrotational Fields, Solenoidal Fields, Orthogonal Curvilinear Coordinates, Cylindrical Coordinates, Spherical Polar Coordinates.

Text Book:

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

References:

1. Calculus, Early Transcedentals Plus New May Math Lab by William Briggs, Lyle Cochran, and Gillet Pearson, Addison-Wesley, 2014.
2. Edwards, Henry C., and David E. Penney, Multivariable Calculus. 6th ed. Lebanon, IN: Prentice Hall, 2002. ISBN: 9780130339676.

M19MS3032	Advanced Web Technologies	L	T	P	C
Duration: 45Hours		2	0	1	3

Course Objectives:

The objectives of this course are to:

- Introduce server-side Web technologies.
- Impart knowledge about the concepts, design and basic coding of advanced Web applications such as ASP, Perl, CGI and other server side technologies,
- Explain multimedia web; integrating basic database functions;
- Enable students to publish to multiple servers, XML, XSLT, SHTML, and Cascading Style Sheets may be utilized.

Course Outcomes:

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

- Use and apply different web technologies: XML, DTD, XSLT, Xpath,, JavaScript, JSP and Servlets, PHP;
- Work on PHP/MySQL
- Develop Software using PHP/MySQL
- Apply the knowledge of establishing client/server communication.

Course Content:

UNIT I **15 Hours**

Programming in Perl: Origins and uses of Perl, Scalars and their operations, Assignment statements and simple input and output, Control statements, Fundamentals of arrays, Hashes, References, Functions, Pattern matching, File input and output, Examples. CGI Scripting, Developing CGI Applications, Processing CGI, CGI.pm, CGI.pm methods, An Example, Adding Robustness, Carp, Cookies

UNIT II **15 Hours**

Origins and uses of PHP, Overview of PHP, General syntactic characteristics, Primitives, operations and expressions, Output, Control statements, Arrays, Functions, Pattern matching, Form handling, Files, Building Web applications with PHP Tracking users, cookies, sessions, Using Databases, Handling XML.

UNIT III **15 Hours**

Introduction to RUBY: Origins and uses of Ruby ,Scalar types and their operations ,Simple input and output, Control statements, Arrays, Hashes ,Methods, Classes, Code blocks and iterators ,Pattern matching ,Overview of Rails ,Document requests, processing forms , Rails applications with Databases, Layouts.

UNIT IV **15 Hours**

Web Services : Web 2.0 and 3.0 ,Software as a Service (SaaS) ,Rich user experience, Social Networking .SOAP ,RPC style SOAP , Document style SOAP ,WSDL ,REST services, JSON format ,WAP Architecture – WAP stack. Online Applications and emerging technologies – Online Shopping – Online databases – Monitoring user event.

Textbooks:

1. Robert W. Sebesta, Programming the World Wide Web, Pearson Education 2008. [chapter 8,9,11]
2. Chris Bates: Web Programming Building Internet Applications 3rd edition Willey india 2009[chapter 10,11,13]

Reference Books:

1. Roy, Uttam K. Web Technologies. Oxford University Press, 2010.
2. Holzner, Steven. PHP: the complete reference. Tata McGraw-Hill Education, 2007.

LAB - Advanced Web programming

1. Write a Perl program to display various Server Information like Server Name, Server Software, Server protocol, CGI Revision etc.
2. Write a Perl program to accept UNIX command from a HTML form and to display the output of the command executed.
3. Write a Perl program to accept the User Name and display a greeting message randomly chosen from a list of 4 greeting messages.
4. Write a Perl program to keep track of the number of visitors visiting the web page and to display this count of visitors, with proper headings.
5. Write a Perl program to display a digital clock which displays the current time of the server.
6. Write a Perl program to insert name and age information entered by the user into a table created using MySQL and to display the current contents of this table.
7. Write a PHP program to store current date-time in a COOKIE and display the 'Last visited on' date-time on the web page upon reopening of the same page.
8. Write a PHP program to store page views count in SESSION, to increment the count on each refresh, and to show the count on web page.
9. Create a XHTML form with Name, Address Line 1, Address Line 2, and E-mail text fields. On submitting, store the values in MySQL table. Retrieve and display the data based on Name.

M19MS3040	**Digital Marketing**	**L**	**T**	**P**	**C**
Duration: 60 Hours		**4**	**0**	**0**	**4**

Course Objectives:

- To develop industry background knowledge to knowledgeably navigate Internet Marketing topics including online advertising, search, social media, and online privacy.
- To evaluate an experiment quantitatively and qualitatively to measure the effectiveness of business decisions and online advertising effectiveness in particular.
- To design and implement an experiment.
- To apply best practices for social media marketing

Course Outcomes:

Upon Completion of the course, the students will be able to:

- Assess the impact of digital technology on the practice of marketing.

- Analyze the use of different forms of digital marketing in the development of an online presence.
- Develop a plan for marketing a product of business online.
- Integrate social media tools into a marketing communications strategy.

Course Content:

UNIT I **15 Hours**

Introduction To Digital Marketing: Start with the Customer and Work Backward, What Are the 3i Principles? **Search Engine Optimization (Seo):** An Introduction, Search Engine Result Pages: Positioning, Search Behavior, Goals, On-Page Optimization, Off-Page Optimization, Analyze.

UNIT II **15 Hours**

Pay Per Click: An Introduction, Goals, Setup, Manage, Analyze. **Digital Display Advertising :**An Introduction, Display Advertising: An Industry Overview, Define, Format, Configure, Analyze

UNIT III **15 Hours**

Email Marketing: An Introduction, Data—Email Marketing Process, Design and Content, Delivery, Discovery. **Mobile Marketing:**An Introduction, Opportunity, Optimize, Advertise, Analyze.

UNIT IV **15 Hours**

Social Media Marketing (Smm): An Introduction, Goals, Channels, Implementation, Analyze, Laws and Guidelines

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. (Chapters : 1, 2, 3, 4, 5, 6, 7, 8, 9).

Reference Books:

1. Damian Ryan – "UNDERSTANDING DIGITAL MARKETING : Marketing Strategies for engaging the digital generation" 4th Edition, Kogan Page, 2017.

2. Ryan Deiss and Russ Henneberry – "DIGITAL MARKETING : For Dummies ", , John Wiley & Sons, Inc, 2017.
3. Alan Charlesworth – " DIGITAL MARKETING : A Practical Approach", 2nd Edition, Routledge, 2009.

M19MS3050	SOFT SKILLS	L	T	P	C
Duration:30 Hours		2	0	0	2

Course Objectives:

Note: The students will have to undergo Skill Development course being conducted by UIIC & Training and Placement cell of the University.

M19MS3060	Minor Project	L	T	P	C
Duration: 90 Hours		3	0	3	6

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:

- Familiarize with literature search
- Conduct the experiments related to research and formulate computational techniques
- Interpret the primary data.
- 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.

M19MS3070	**MOOC / SWAYAM**	**L**	**T**	**P**	**C**
Duration: Hours		**4**	**0**	**0**	**4**

Course Objectives:

MOOC / SWAYAM Online Courses: Globally, MOOC (Massive Open Online Course) platforms are gaining much popularity. Considering the popularity and relevance of MOOCs, Government of India has also launched an indigenous platform, SWAYAM. SWAYAM (Study Webs of Active Learning for Young Aspiring Minds) is basically an integrated MOOCs platform for distance education that is aimed at offering all the courses from school level (Class IX) to post-graduation level. The platform has been developed collaboratively by MHRD (Ministry of Human Resource Development) and AICTE (All India Council for Technical Education) with the help of Microsoft and is capable of hosting 2,000 courses.

A student shall register and successfully complete any of the courses available on SWAYAM / MOOC. Student shall inform the MOOC / SWAYAM coordinator of the school about the course to which he/she has enrolled. The duration and credits of the course shall vary depending upon the agency offering MOOC / SWAYAM courses. The student should submit the certificate issued by the agency offering SWAYAM / MOOC courses to the Coordinator of the school, the grades obtained in the course shall be forwarded to concerned authority of the University.

FOURTH SEMESTER

Sl No	Course Code	Title of the Course	Credit Pattern L:T:P	Credits	Working Hrs
1	M19MS4010	Internship/ Certification	2:0:2	4	8
2	M19MS4020	Major Project	0:0:10	10	20
Total Credits			**2:0:12**	**14**	**28**

*** Note: 1.** Project Work and Dissertation will be mandatory of 10 Credits

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

Guide Lines

Project survey has to be completed and problem identification for the project must be done. Students must meet the guide and discuss with due PPT presentations at least two hours per Wk. and do the necessary ground work for Phase II devoting at least 6 hours per Wk..

- The project should be inter disciplinary
- Team size should be of max ***one*** members
- Use any version control software
- Project should be of Research Based
- Proper and meaningful reports should be generated by making use of latest reporting tools
- Project report should follow standard template with the following contents:
    a) Abstract
    b) Introduction to project
    c) Literature Review
    d) Basic Diagrams like (DFD, ER, Class diagram, etc..)
    e) Methodology
    f) Result Analysis
    g) Concussion
    h) Future enhancement
    i) Bibliography
- project reports should be submitted for evaluation

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 skills 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 96 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 96 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 96 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 / MS in Computer Science (with Specialization in Data Science and Analytics) degree.

4.1. Add on Proficiency Diploma:

In excess to the minimum of 96 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 / MS in Computer Science (with Specialization in Data Science and Analytics). 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
Seminars	= 10 marks

5.4. There shall be **three internal tests** conducted as per the schedule given below. T**he students have to attend all the three tests compulsorily.**

- **1st test** for 15 marks during **2nd part of the 6th week** of the beginning of the Semester;
- **2nd test** for 15 marks during **2nd part of the 13th week** of the beginning of the Semester; and
- **3rd test** for 15 marks during **2nd part of the 16th week** of the beginning of the Semester.

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

- For the **1st test** the syllabus shall be **First Unit and 1st half of Second Unit** of the Course;
- For the **2nd test** it shall be **Second half of Second Unit and Third Unit** of the Course;
- For the **3rd test** the syllabus will be **Fourth Unit** of the Course.

5.6. **Out of 3 tests, the highest marks secured in two tests are automatically considered while assessing the performance of the students.**

5.7. There shall be two Assignments and two Seminars each carrying 5 marks. Hence two assignments carry 10 marks (5+5 marks) and two seminars 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. 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.

5.11. 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
Allocation of Topics for Assignments / Seminars / Model Design	Beginning of 5th Week	First Unit and Second Unit		Instructional process and Continuous Assessment
First Internal Test	Second Part of 6th Week	First Unit and 1st half of Second Unit	15	Consolidation of First Unit and 1st half of Second Unit
Submission of Assignments/ Model Design	8th Week	First Unit and Second Unit	5	Instructional process and Continuous Assessment
Seminars	9th Week	First Unit and Second Unit	5	Instructional process and Continuous Assessment
Second Internal Test	2nd Part of 13th Week	2nd half of Second Unit and Third Unit	15	Consolidation of 2nd half of Second Unit and Third Unit
Allocation of	11th	Third Unit		Instructional

Topic for 2nd Assignment / Seminars	Week	and Fourth Unit		process and Continuous Assessment
Submission of Assignments/ Model Design	13th Week	Third Unit and Fourth Unit	5	Instructional process and Continuous Assessment
Seminars	14th Week	Third Unit and Fourth Unit	5	Instructional process and Continuous Assessment
Third Internal Test	2nd Part of 16th Week	Fourth Unit	15	Consolidation of entire Fourth Unit
Semester End Practical Examination	17th & 18th Week	Entire Syllabus	50	Conduct of Semester - end Practical Exams
Preparation for Semester–End Exam	17th & 18th Week	Entire Syllabus		Revision and preparation for semester–end exam
Semester End Theory Examination	19th and 20th Week	Entire Syllabus	50	Evaluation and Tabulation
	End of 21st 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.

1. Practical examination wherever applicable shall be conducted after 3rd 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.

1. 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.

2. 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).

e. **Absence during Internal Test:**

In case a student has been absent from a internal test due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Head of the School, for conducting a separate internal test. The Head of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and arrange to conduct a special internal test for such candidate(s) well in advance before the Semester End Examination of that respective semester. Under no circumstances internal tests shall be held / assignments are accepted after Semester End Examination.

3. **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.

4. **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) = $\sum$(Ci x Gi) / $\sum$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.

Illustration for Computation of SGPA

Illustration No. 1

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade)
Course 1	4	A+	9	4X9=36
Course 2	4	O	10	4X10=40
Course 3	3	B+	7	3X7=21
Course 4	3	O	10	3X10=30
Course 5	3	A	8	3X8=24
Course 6	3	B	6	3X6=18
Course 7	2	O	10	2X10=20
Course 8	2	A	8	2X8=16
	24			205

Thus, **SGPA = 205 ÷ 24 = 8.54**

Illustration No. 2

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade point)
Course 1	4	O	10	4X10=40
Course 2	4	A+	9	4X9=36
Course 3	3	A+	9	3X9=27
Course 4	3	B+	7	3X7=21
Course 5	3	B	6	3X6=18
Course 6	3	A	8	3X8=24
Course 7	2	B+	7	2X7=14
Course 8	2	O	10	2X10=20
	24			200

Thus, **SGPA = 200 ÷ 24 = 8.33**

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 (96) for M.S in Computer Science / M.S in Computer Science with Specialization in Data Science and Analytics degree is calculated taking into account all the courses undergone by a student over all the semesters of a program, i. e

CGPA = ∑(Ci x Si) / ∑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.

Illustration:

CGPA after Final Semester

Semester (ith)	No. of Credits (Ci)	SGPA (Si)	Credits x SGPA (Ci X Si)
1	24	8.33	24 x 8.33 = 199.92
2	24	8.54	24 x 8.54 = 204.96
3	24	9.35	24x9.35 = 224.4
4	24	9.50	24x9.50 = 228.0
Cumulative	96		857.28

Thus, **CGPA** = $\frac{24x8.33+24x8.54+24x9.35+24x9.50}{96}$ = 8.93

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.

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