REVA UNIVERSITY
Bengaluru, India

School of Computing and Information Technology

M.Tech. in Artificial Intelligence

2020-22 Batch

HANDBOOK

Rukmini Knowledge Park

Kattigenahalli, Yelahanka, Bengaluru – 560064

www.reva.edu.in

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Phone No: +91-080-466966966

Rukmini Educational
Charitable Trust

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 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. 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 endeavour to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS".

Welcome to the portals of REVA University!

Dr.M.Dhanamjaya

Vice-Chancellor, REVA University

Director Message

I congratulate and welcome all the students to the esteemed school of Computing and Information Technology (CS& IT)). You are in the right campus to become a computer technocrat. The rising needs of automation in Industry 4.0 and improvising living standards have enabled rapid development of computer software and hardware technologies. Thus providing scope and opportunity to generate more human resources in the areas of computers and IT. The B.Tech, M.Tech and Ph.D. programs offered in the school are designed to cater the requirements of industry and society. The curriculum is designed meticulously in association with persons from industries (TCS, CISCO, AMD, MPHASIS, etc.), academia and research organizations (IISc, IIIT, Florida University, Missouri S & T University, etc.). The Curriculum caters to local, national, regional and global developmental needs. Maximum number of courses are integrated with cross cutting issues relevant to professional ethics, global needs, human values, environment and sustainability. The courses also focus on skill development, innovation and entrepreneurship.

This handbook presents the B.Tech in Computer Science and Information Technology program curriculum. The program is of 4 years duration and split into 8 semesters. The courses are classified into foundation core, hard core, and soft core courses. Hard core courses represent fundamentals study requirements of B.Tech CSIT program. Soft courses provide flexibility to students to choose the options among several courses as per the specialization, such as, Artificial Intelligence, Fuzzy Logic and Systems, Cognitive science and predictive analytics etc. Theoretical foundations of engineering, science, and Information Science are taught in first two and half years. Later, advanced courses and recent technologies are introduced in subsequent semesters for pursuing specialization.

The important features of the B.Tech CSIT are as follows:

1) Choice based course selection and teacher selection, 2) Studies in emerging areas like Machine Learning, Artificial Intelligence, Data Analytics, Cloud Computing, Python/R Programming, NLP, IoT and Cloud security, 3) Short and long duration Internships 4) Opportunity to pursue MOOC course as per the interest in foundation and soft core courses, 5) Attain global and skill certification as per the area of specialization, 6) Self-learning components, 7) Experiential, practice, practical, hackathons, and project based learning, 8) Mini projects and major projects with research orientation and publication, 9) Soft skills training and 10) Platform for exhibiting skills in cultural, sports and technical activities through clubs and societies.

The school has well qualified faculty members in the various areas of computing and IT including cloud computing, security, IOT, AI, ML and DL, software engineering, computer networks, information technology, cognitive computing, block chain technology etc. State of art laboratories are available for the purpose of academics and research.

Dr. Mallikarjun Kodabagi

Director, School of Computing and Information Technology

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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.

REVA consistently ranked as one of the top universities in various categories because of the diverse community of international students and its teaching excellence in both theoretical and technical education in the fields of Engineering, Management, Law, Science, Commerce, Arts, Performing Arts, and Research Studies. REVA offers 28 Undergraduate Programmes, 22 Full-time and 2 Part-time Postgraduate Programmes, 18 Ph. D Programmes, and other Certificate/ Diploma/Postgraduate Diploma Programmes in various disciplines.

The curriculum of each programme is designed with a keen eye for detail by giving emphasis on hands-on training, industry relevance, social significance, and practical applications. The University offers world-class facilities and education that meets global standards.

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 VikasYojana. 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, EMC2, 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.

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 class'severyday to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

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 the School of Computing and Information Technology (C & IT)

The School has a rich blend of experienced and committed faculty who are well-qualified in various aspects of computing and information technology apart from the numerous state-of-the-art digital classrooms and laboratories having modern computing equipment. The School offers five undergraduate programs: B Tech in Computer Science and Engineering, B Tech in Computer Science and Engineering (Artificial Intelligence and Machine Learning), B Tech in Computer Science and Information Technology, B Tech in Information Science and Engineering. Three postgraduate programs offered in the school are: M Tech in Artificial Intelliigence. In addition, the school has a unique academic collaboration with the University of Alabama in Huntsville to jointly offer an MS program in Computer Science. In addition, the school has a research center in which students can conduct cutting edge research leading to a PhD degree.

Curricula of both undergraduate and postgraduate programs have been designed through a collaboration of academic and industry experts in order to bridge the growing gap between industry and academia. This makes the program highly practical-oriented, and thus industry-resilient. The B Tech program aims to create quality human resources to play leading roles in the contemporary, competitive industrial and corporate world. The masters' degrees focus on quality research and design in the core and application areas of computing to foster a sustainable world and to enhance the global quality of life by adopting enhanced design techniques and applications. This thought is reflected in the various courses offered in the masters' programs.

Vision

To produce excellent quality technologists and researchers of global standards in computing and Information technology who have potential to contribute to the development of the nation and the society with their expertise, skills, innovative problem-solving abilities, strong moral and ethical values.

Mission

- To create state of the art computing labs infrastructure and research facilities in information technology.
- To provide student-centric learning environment in Computing and Information technology through innovative pedagogy and education reforms.

- To encourage research, innovation and entrepreneurship in computing and information technology through industry/academia collaborations and extension activities
- Organize programs through club activities for knowledge enhancement in thrust areas of information technology.
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism, moral and ethical values.

Quality Policy

The School of Computing and Information Technology is committed to excellence through following policies.

1. Impart quality education by providing state of art curriculum, experimental learning, and state of the art labs.
2. Enhance skill set of faculty members through faculty development programmes and interaction with academia and industries.
3. Inculcate the competency in software/hardware design and programming through co-curricular activities like Hackathon, Project exihibition, Internship and Enterpreneuship Programme.
4. Provide soft skill and skill development training for personality development and better placement.
5. Promote innovation and research culture among students and support faculty members for better research and development activity.

BOARD OF STUDIES MEMBERS

Sl. No.	Name		Correspondence Address
1	**Dr. Mallikarjun M Kodabagi** Professor and Director School of Computing and Information Technology, REVA University	Chairperson	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
2.	**Dr. Vishwanath R Hulipalled** Professor School of Computing and Information Technology	Member	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
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6.	**Sreenivasa Ramanujam Kanduri** Academic Relationship Manager, TCS	Member (Industry Expert)	Academic Relationship Manager, Tata Consultancy Services, Bangalore.
7.	**Dr. Sundar K S** Associate Vice-President & Head, IMS Academy at Infosys	Member (Industry Expert)	Associate Vice-President & Head, IMS Academy at Infosys, Mysore
8.	**Dr. Ramabrahmam Gunturi** Consultant, TCS	Industry Expert	Tata Consultancy Services, Hyderabad.
9.	**Dr. S. A. Angadi** Professor, School of CSE VTU	Academic Expert	Professor, School of CSE Visvesvaraya, Belagavi
10.	**Dr. Bharati Arakeri** Professor**,** School of CSE BMSIT, Bangalore.	Academic Expert	Professor**,** School of CSE BMSIT, Bangalore
11.	**Abhishek Revanna Swamy** Associate Project Manager, Robert Bosch	Alumni-Member	Associate Project Manager, Robert Bosch, Bangalore

Program Overview

M. Tech. in Artificial Intelligence

Artificial Intelligence (AI) encompasses a variety of topics that relates to computation, like development of algorithms, analysis of algorithms, programming languages, software design and computer hardware. Computer Science engineering has roots in electrical engineering, mathematics, and linguistics. In the past Artificial Intelligence (AI) was taught as part of mathematics or engineering departments and in the last 3 decades it has emerged as a separate engineering field. In the present information era (Knowledge era) Artificial Intelligence (AI) will see an exponential growth as the future machines work on AI.

The oldest known complex computing device, called the Antikythera mechanism, dates back to 87 B.C., to calculate astronomical positions and help Greeks navigate through the seas. Computing took another leap in 1843, when English mathematician Ada Lovelace wrote the first computer algorithm, in collaboration with Charles Babbage, who devised a theory of the first programmable computer. But the modern computing- machine era began with Alan Turing's conception of the Turing Machine, and three Bell Labs scientists invention of the transistor, which made modern-style computing possible, and landed them the 1956 Nobel Prize in Physics. For decades, computing technology was exclusive to the government and the military; later, academic institutions came online, and Steve Wozniak built the circuit board for Apple-1, making home computing practicable. On the connectivity side, Tim Berners-Lee created the World Wide Web, and Marc Andreessen built a browser, and that's how we came to live in a world where our glasses can tell us what we're looking at. With wearable computers, embeddable chips, smart appliances, and other advances in progress and on the horizon, the journey towards building smarter, faster and more capable computers is clearly just beginning.

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 Artificial Intelligence (AI) graduates are plenty and growing. Public and private sectors like agencies of Artificial Intelligence, Robotics companies Coordinating Committee for Artificial Intelligence and other associated fields hire postgraduate candidates who successfully complete M. Tech in AI.

Job Role: Computer Scientist, Robotic Scientist, Game Programmer, Software Engineer or as Developer for AI machines which are used in game playing, speech recognition, language detection, computer vision, expert systems and robotics.

May even go for pursuing higher studies in AI or go for doctorate degree.

The School of Computing and Information Science at REVA UNIVERSITY offers M.Tech, Artificial Intelligence programme to create motivated, innovative, creative thinking graduates to fill ICT positions across sectors who can conceptualize, design, analyse, and develop ICT applications to meet the modern day requirements.

The M.Tech, in Artificial Intelligence curriculum developed by the faculty at the School of Computing and Information Science, is outcome based and it comprises required theoretical concepts and practical skills in the domain. By undergoing this programme, students develop critical, innovative, creative thinking and problem solving abilities for a smooth transition from academic to real-life work environment. In addition, students are trained in interdisciplinary topics and attitudinal skills to enhance their scope. The above mentioned features of the programme, advanced teaching and learning resources, and experience of the faculty members with their strong connections with ICT sector makes this programme unique.

Program Educational Objectives (PEO's)

After few years of graduation, the graduates of M. Tech (Artifical Intelligence) will be able to:

PEO-1: Demonstrate skills as an Artificial Intelligence professional and perform with Ethical and Moral values.

PEO-2: Engage in active research for Professional development in the field of Artificial Intelligence with an attribute of Life long learning.

PEO-3: Carryout consultancy and extension activity either as a member of team or as an individual.

Program Outcomes (POs)

On successful completion of the program, the graduates of M. Tech (Artifical Intelligence) program wil be able to:

PO-1: Demonstrate in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

PO-2: Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

PO-3: Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO-4: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

PO-5: Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.

PO-6: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

PO-7: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.

PO-8: Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

PO-9: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PO-10: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

PO-11: Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback (SELF learning)

Program Specific Outcomes (PSOs)

On successful completion of the program, the graduates of M. Tech (Artifical Intelligence) program will be able to:

PSO-1: Isolate and solve complex problems in the domains of Artificial Intelligence using latest hardware and software tools and technologies, along with analytical and managerial skills to arrive at cost effective and optimum solutions either independently or as a team.

PSO-2: Implant the capacity to apply the concepts of Artificial Intelligence, Deep Learning & Reinforcement Learning, Game Theory, Neural Networks, Machine learning, Fuzzy Logic and Probabilistic Graphs etc. in the design, development of software.

PSO-3: Review scholarly work by referring journals, define a new problem, design, model, analyze and evaluate the solution and report as a dissertation in the area of Artificial Intelligence.

REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Post Graduate Degree Program (M.Tech) – w.e.f Academic Year 2020-2021

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/ Project Based Learning/ Self Study / Online courses from listed portals that equip students to acquire the much required skill component.

2.0. Classification of Courses: 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 TWO to FOUR **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 SIX or **EIGHT or TEN 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 72 credits for successful completion of M Tech degree with a distribution of credits for different courses as prescribed by the University.

3.2. A candidate can enroll for a maximum of 24 credits per Semester. However s/he may not successfully earn a maximum of 24 credits per semester. This maximum of 24 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 72 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 72 credits for the M. Tech Degree 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 in his / her subject of study or in other subjects / discipline along with the M .Tech degree.

4.1. Add on Proficiency Diploma:

In excess to the minimum of 72 credits for the M. Tech degree 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 B. Tech degree. The A**dd -on Proficiency Certification / Diploma** so issued to the candidate contains the courses studied and grades earned.

5.0. Continuous Assessment, Earning of Credits and Award of Grades.

5.1. The assessment and evaluation process happens in a continuous mode. However, for reporting purpose, **a Semester is divided into 3 components as IA1, IA2 and SEE.** The performance of a candidate in a course will be assessed for a maximum of 100 marks as explained below.

(i) Component IA1:

The first Component (IA1), of assessment is for 25 marks. This will be based on test, assignment / seminar. During the first half of the semester (i.e. by 8th week), the first 50% of the syllabus (Unit 1&2) will be completed. This shall be consolidated during the first three days of 8th week of the semester. A review test based on IA1 will be conducted and completed in the beginning of the 9th week. In case of

courses where test cannot be conducted, the form of assessment will be decided by the concerned school and such formalities of assessment will be completed in the beginning of the 9th week. The academic sessions will continue for IA2 immediately after completion of process of IA1.

The finer split - up for the award of marks in IA1 is as follows:

Assignment & Seminars .....10 marks for the **first 20% of the syllabus**
Test (Mid-Term)..... 15 marks forthe **first 30% of the syllabus**
Total.....25 marks

(ii) Component IA2:

The second component (IA2), of assessment is for 25 marks. This will be based on test, assignment /seminar. The continuous assessment and scores of second half of the semester (9th to 16th week) will be consolidated during 16th week of the semester. During the second half of the semester the remaining units in the course will be completed. A review test based on IA2 will be conducted and completed during 16th week of the semester. In case of courses where test cannot be conducted, the form of assessment will be decided by the concerned school and such formalities of assessment will be completed during 16th week.

The 17th week will be for revision of syllabus and preparation for the semester - end examination.

The finer split - up for the award of marks in IA2 is as follows:
Assignment/Seminar.....10 marks for the **second 20% of the syllabus**
Review Test (Mid-Term)..... 15 marks for the **second 30% of the syllabus**
Total..... 25 marks

(iii) Component SEE:

The Semester End Examination of 3 hours duration for each course shall be conducted during the 18th & 19th week. **This forms the third / final component of assessment (SEE) and the maximum marks for the final component will be 50.**

5.2 The Assessment of MOOC and Online Courses shall be decided by the concerned School Board of Studies (BOS).

5.2.1 For> 3 credit courses

i	IA-I	25 marks
ii	IA-2	25 marks
iii	Semester end examination by the concern school board (demo, test, viva voice etc)	50 marks
	Total	**100 marks**

5.2.2 For 1 & 2 credit courses

i	IA-I	15 marks
ii	IA-2	15 marks
iii	Semester end examination by the concern school board (demo, test, viva voice etc)	20 marks
	Total	**50 marks**

5.2.3 The 50 marks meant for Internal Assessment (IA) 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 / Activities /Models / charts etc	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**

5.3 Setting Questions Papers and Evaluation of Answer Scripts:

5.3.1. There shall be three sets of questions papers set for each course. Two sets of question papers shall be set by the internal and one set by external examiner for a course. The Chairperson of the BoE shall get the question papers set by internal and external examiners.

5.3.2. The Board of Examiners shall scrutinize and approve the question papers and scheme of valuation.

5.3.3. There shall be single valuation for all theory papers by internal examiners. In case, the number of internal examiners falls short, external examiners may be invited. The answer scripts evaluated both by internal and external examiners shall be moderated by the external examiner / moderator.

5.3.4. The examination for Practical work/ Field work/Project work will be conducted jointly by two examiners (internal and external). However, in case of non-availability of external examiner or vice versa, the Chairperson BoE at his discretion can invite internal / external examiners as the case may be, if required.

5.3.5. If a course is fully of (L=0):T: (P=0) type, then the examination for SEE Component will be as decided by the BoS concerned.

5.3.6. In case of a course with only practical component a practical examination will be conducted with two examiners and each candidate will be assessed on the basis of: a) Knowledge of relevant processes, b) Skills and operations involved, and c) Results / Products including calculation and reporting.

5.3.7. The duration for Semester-End practical examination shall be decided by the Controller of Examinations.

5.4. 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:

Component – I	(IA1)	Periodic Progress and Progress Reports (25%)
Component – II	(IA2)	Results of Work and Draft Report (25%)
Component– III	(SEE)	Final Evaluation and Viva-Voce (50%). Evaluation of the report is for 30% and the Viva-Voce examination is for 20%.

5.4. The schedule of continuous assessment and examinations are summarized in the following Table below.

Component	Period	Syllabus	Weightage	Activity
IA1	1st Week to 8th Week	First 50% (two units)		Instructional process and Continuous Assessment
	Last 3 days of 8th Week		25%	Consolidation of IA1
IA2	9th week to 16th week	Second 50% (remaining two units)		Instructional process and Continuous Assessment
	Last 3 days of 16th week		25%	Consolidation of IA2
SEE	17th and 18th week			Revision and preparation for Semester end examination
	19th week to 20th week	Entire syllabus	50%	Conduct of semester end examination and Evaluation concurrently
	21st week			Notification of Final Grades
***Evaluation shall begin very first day after completion of the conduct of examination of the first course and both examination and evaluation shall continue concurrently. The examination results / final grades be announced latest by 21st week**				

Note: 1. Practical examination wherever applicable shall be conducted before conducting of IA2 examination. The calendar of practical examination shall be decided by the respective school.

2. Finally**, awarding the Grades** be announced latest by 5 days after completion of the examination.

6.0 Requirements to Pass a Course

6.1. A candidate's performance from all 3 components will be in terms of scores, and the sum of all three scores will be for a maximum of 100 marks (25 + 25 + 50). A candidate who secures a minimum of 40% in the SEE and an overall 40% (IA1+IA2+SEE) in a course is said to be successful.

6.2. Eligibility to Appear for SEE (Semester -End Examination) and Provision to Drop the Course.

Only those students who fulfill 75% attendance requirement and who secure minimum 30% marks in IA1

and IA2 together in a course are eligible to appear for SEE examination in that course.

6.3. Those students who have 75% of attendance but have secured less than 30% marks in IA1 and IA2 together in a course are not eligible to appear for SEE examination in that course. They are treated as dropped the course and they will have to repeat that course whenever it is offered.

Teachers offering the courses will place the above details in the School Council 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 Director of the School before commencement of SEE examination. A copy of this notification shall also be sent to the office of the Controller of the Examinations.

6.4. In case a candidate secures more than 30% in IA1 and IA2 together but less than 40% in aggregate of IA1, IA2 and SEE in a course is considered as unsuccessful and such a candidate may either opt to DROP that course or appear for SEE examination during the subsequent semesters / years within the stipulated period.

In such a case wherein he / she opts to appear for just SEE examination, then the marks secured in IA1 and IA2 shall get continued. Repeat SEE examination will be conducted in respective semesters.

6.5. In case a candidate opts to drop the course he / she has to re-register for the dropped course only in subsequent semesters whenever it is offered if it is Hard Core Course and he / she may choose alternative course if it is Soft Core Course or Open Elective course or Skill Development Course. **The details of any dropped course will not appear in the Grade Card.**

6.6. 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/open elective. **A DROPPED course is automatically considered as a course withdrawn.**

7.1 Provision for Supplementary Examination

In case a candidate fails to secure a minimum of 40% (20 marks) in Semester End Examination (SEE) and a minimum of 40% marks overall (IA and SEE together), such candidate shall seek supplementary examination of only for such course(s) wherein his / her performance is declared unsuccessful. The supplementary examinations are conducted after the announcement of even semester examination results. The candidate who is unsuccessful in a given course(s) shall appear for supplementary examination of odd and even semester course(s) to seek for improvement of the performance.

7.2 Re-Registration and Re-Admission:

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.

In case a candidate fails in more than 2 courses in odd and even semesters together in a given academic year, he / she may either drop all the courses and repeat the semester or reappear (SEE-semester end examination) to such of those courses where in the candidate has failed during subsequent semester / year within a stipulated period.

7.3 In such a case where in a candidate drops all the courses in 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.

7.4 Requirements to Pass the Semester andProvision to Carry Forward the Failed Subjects / Courses:

7.4.1 A candidate who secures a minimum of 40% in the SEE and an overall 40% (IA1+IA2+SEE) in a course is said to be successful.

7.5. Provision to Carry Forward the Failed Subjects / Courses:

A student who has failed in 4 courses in 1st and 2nd semesters together shall move to 3rd semester. And he / she shall appear for SEE examination of failed courses of the said semesters concurrently with 3rd semester end examinations (SEE) and 4th semester end examinations (SEE) of second year of study.

8.0 **Attendance Requirement:**

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

8.2. 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.

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

8.3. Absence during mid semester examination

In case a student has been absent from a mid-semester examination 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 make-up examination. 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 permit such student to appear for make-up mid semester examination.

Absence during Semester End Examination:

In case a student is absent for Semester End Examination on medical grounds or such other exigencies, the student can submit request for make-up examination, with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Director of the School. The Director of the School may consider such request depending on the merit of the case and after consultation with class teacher, course instructor and permit such student to appear for make-up mid semester examination

9.0 Provisional Grade Card:

The tentative / provisional Grade Card will be issued by the Controller of Examinations 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 courses.

9.1 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 Controller of Examination (COE) within 15 days after the announcement of the results. This challenge valuation is only for SEE component.

The answer scripts for which challenge valuation is sought for shall be sent to another external examiner. The marks awarded will be the higher of the marks obtained in the challenge valuation and in maiden valuation.

9.2 **Final Grade Card:** Upon successful completion of the Post Graduate Degree a Final Grade card consisting of grades of all courses successfully completed by the Candidate will be issued by the COE.

9.3 **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
80-89	9	v*9	A
70-79	8	v*8	B
60-69	7	v*7	C
50-59	6	v*6	D
40-49	5	v*5	E
0-39	0	v*0	F

O - Outstanding; A-Excellent; B-Very Good; C-Good; D-Fair; E-Satisfactory; F - Fail;

Here, P is the percentage of marks (P=[(IA1+IA2)+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.

9.4 Computation of SGPA and CGPA

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, i.e

SGPA (Si) = ∑(Ci x Gi) / ∑Ci

Where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade)
Course 1	**3**	**A**	**9**	**3X9=27**
Course 2	**3**	**B**	**8**	**3X8=24**
Course 3	**3**	**C**	**7**	**3X7=21**
Course 4	**3**	**O**	**10**	**3X10=30**
Course 5	**3**	**D**	**6**	**3X6=18**
Course 6	**3**	**O**	**10**	**3X10=30**
Course 7	**2**	**A**	**9**	**2X 9 = 18**
Course 8	**2**	**B**	**8**	**2X 8 = 16**
	22			**184**

Thus, **SGPA = 184 ÷ 22 = 8.36**

9.5 Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (72) for two year post graduate degree in a specialization 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 ith 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	22	8.36	22 x 8.36 = 183.92
2	22	8.54	22 x 8.54 =187.88
3	16	9.35	16x9.35=149.6
4	12	9.50	12x9.50=114
Cumulative	72		635.4

Thus, **CGPA** = $\frac{22x8.36+22x8.54+16x9.35+12x9.50}{72}$ = 8.83

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 8.83 x 10=88.30

9.6 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	Numerical Index	FGP Qualitative Index
> 4 =CGPA < 5	**5**	SECOND CLASS
5 > = CGPA < 6	6	
6 >= CGPA < 7	7	FIRST CLASS
7 >= CGPA < 8	8	
8 >= CGPA < 9	9	DISTINCTION
9 >= CGPA 10	10	

Overall percentage=10*CGPA

10.0. Provision for Appeal

If a candidate is not satisfied with the evaluation of IA1 and IA2 components, 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 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.

11.0. Grievance Committee

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

- The Controller of Examinations - 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.

M.Tech Artificial Intelligence
Scheme of Instruction for 2020-22

(Effective from the Academic Year 2020-21)

Sl. No	Course Code	Course Title	Course Type	Credit Pattern and Credit Value				No. of Hrs.
				L	T	P	C	
First Semester								
1	M20AI1010	Optimization Techniques	HC	3	0	0	3	3
2	M20AI1020	Advaned Machine learning	HC	3	0	1	4	5
3	M20AI1030	Python for Artificial Intelligence	HC	3	0	1	4	5
4	M20AI1040	Applied Statistics	HC	3	0	0	3	3
5	M20AI1050	Neural Networks	HC	2	0	1	3	4
6	M20AI1060	Random Process and Linear Algebra	HC	3	0	0	3	3
7	M20AI1070	Mini Project	HC	0	0	2	2	4
Total Credits for the First Semester							**22**	**27**
Second Semester								
1	M20AI2011	Agile Software Development	SC	3	0	0	3	3
	M20AI2012	Digital Image Processing and Computer vision						
	M20AI2013	Mobile Application Development						
2	M20AI2021	Data Security and Privacy	SC	3	0	1	4	5
	M20AI2022	Big Data Analytics						
	M20AI2023	Deep Learning and Reinforcement Learning						
3	M20AI2031	Fuzzy Logic and Probabilistic Graphs	SC	3	0	0	3	3
	M20AI2032	Robotic Process Automation						
	M20AI2033	Game Theory						
4	M20AI2041	Block Chain Technology	SC	3	0	1	4	5
	M20AI2042	Natural Language Processing						
	M20AI2043	Virtual and Augmented Reality						
5	M20AI2051	Knowledge Representation and Reasoning	SC	3	0	1	4	5
	M20AI2052	Internet of Things						
	M20AI2053	Cloud Computing Technologies						
6	M20AI2060	Predictive Analytics using R Lab	HC	0	0	2	2	4
7	M20AI2070	Mini Project	HC	0	0	2	2	4
Total Credits for the Second Semester							**22**	**29**

Sl. No	Course Code	Course Title	Course Type	Credit Pattern and Credit Value				No. of Hrs.
THIRD SEMESTER								
1	M20AI3011	Swarm and Evolutionary Computation	SC	3	0	1	4	5
	M20AI3012	Advanced Java programming						
	M20AI3013	Multi Agent Systems						
2	M20AI3020	Open Elective	MC	4	0	0	4*	4
3	M20AI3030	Project Phase-1	HC	0	0	4	4	8
4	M20AI3040	Internship/Global Certification	HC	0	0	4	4	8
	Total Credits for the Third Semester						**12**	25
	*(MC)This course must be completed but it will not be graded and not considered for computing CGPA/SGPA							
FOURTH SEMESTER								
1	M20AI4010	Project Phase -2 and Dissertation	HC	0	0	16	16	32
Total Credits for the Fourth Semester							**16**	32
Total Number of Credits for all Four Semesters is 72.								

Note:

Internship: should be carried out in a reputed /Tier-1/R & D organization, preferably, internship should be with stipend. The internship should be approved by the REVA University authorities before completion of 3rd semester and the students should obtain the permission for the same by producing the necessary details of company, selection process, and the offer letter issued by the company. At the end of the Internship, detailed report must be submitted.

Students can take-up the internship only if it is approved by RU authorities.

Project work phase 1: Comprises of literature survey, review paper writing, and problem formulation, identification of tools and techniques, and methodology for the project.

Project work phase 2: In 4thsemester should have an outcome: publication in a reputed National/International Journal or a patent filing is required to earn 2 credits.

Global Certification programs: Students have to register for global certification programs of their choice such as networking, JAVA, ORACLE, etc. The students can also choose skill development programs conducted by the UIIC or School, which may not be globally certified. However, weightage is more for global certification courses (10% weightage is accounted less for non-global programs).

The registration must happen before beginning of the third semester.

Ist Year

Detailed Syllabus

I Semester
Syllabus

Course Title	Optimization Techniques				Course type	Theory	
Course Code	M20AI1010	Credits	3		Class	I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	0	-	-			
	Total	3	3	3	39	50	50

COURSE OVERVIEW:

The course introduces the basic concepts of optimization and the different types of optimization problems, the iterative algorithms and their properties to solve problems. Emphasis is on methodology and the underlying mathematical structures. This course is an important part of the postgraduate stage in education for future economists. It is also useful for students who would like to gain knowledge and skills in an important part of math. It gives students skills for implementation of the mathematical knowledge and expertise to the problems of economics.

Course Objectives:

The objectives of this course are to:

1. Explain basics of optimization techniques.
2. Describe unconstrained optimization techniques for various algorithms
3. Discuss constrained optimization techniques for various problems
4. Illustrate Network optimization and Linear programming models.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Recognize and formulate optimization strategies	1,2,5	1,2
CO2	Apply unconstrained optimization techniques for various algorithms	1,2,	1,4
CO3	Differentiate unconstraint and constrained optimization techniques and apply to solve Various problems	1,2,5	1,2

CO4	Develop algorithms using Network optimization and Linear programming models	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	H	H	M	L	L	L	L	L	L	H	H	H
CO2	H	M	H	H	M	L	L	L	L	L	L	H	H	H
CO3	H	M	H	H	M	L	L	L	L	L	L	H	H	H
CO4	H	M	H	H	M	L	L	L	L	L	L	H	H	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT -1

Introduction: Statement of an optimization problem: Design vector, Design constraints, Objective function; Optimization Problem and Model Formulation; Classification of optimization problems: Continuous versus Discrete Optimization, Constrained and Unconstrained Optimization, Global and Local Optimization, Stochastic and Deterministic Optimization, Convexity, Optimization Algorithms

UNIT-2

Unconstrained Optimization: What Is a Solution? Recognizing a Local Minimum, Non-smooth Problems, and Software Tools for Constrained optimization; Overview of Algorithms: Two Strategies: Line Search and Trust Region, Directions for Line Search Methods, Models for Trust-Region Methods, Scaling, Line search, Newton's method, Numerical Problems.

UNIT-3

Constrained Optimization: Hard Constrained optimization, Langrangian Function, Inequality Constraint, Multiple Constraints; Support Vector Machines: Linear SVM, Non-Linear SVM, SVM for pattern classification, Software Tools for Constrained optimization; Duality and Complementarity: Dual Linear Programs, The Duality Theorem, Relations to the Simplex Procedure, Sensitivity and Complementary Slackness, Max Flow–Min Cut Theorem, The Dual Simplex Method, The Primal-Dual Algorithm

UNIT-4

Network Optimization Models: Shortest path problem, Augmented Path Algorithm, Using Simplex to solve the problem, Minimum cost flow problem; Linear Programming Models: Transportation problem, Assignment problem, Transshipment problem.

SELF-LEARNING COMPONENTS:

Elements of Linear Algebra, Topology, and Calculus, Any open source tool

TEXT BOOKS:

1. D.G. Luenberger and Y. Ye, "Linear and Nonlinear Programming", Springer, 2008
2. Jorge Nocedal, Stephen J. Wright, "Numerical Optimization", Springer Series in Operations Research and Financial Engineering, Springer, 1999.
3. Man-Wai MAK, " Constrained Optimization and Support Vector Machines", Ebook available at: http://www.eie.polyu.edu.hk/~mwmak/EIE6207/ContOpt-SVM-beamer.pdf
4. "Network Optimization Models", Ebook available at: https://fenix.tecnico.ulisboa.pt/downloadFile/3779573173366/4%20OD_Network_Models_s.pdf

REFERENCE BOOKS:

1. Ronald L. Rardin, "Optimization in Operations Research", Second edition, Pearson India, ISBN-13: 978-0-13-438455-9, 1999
2. Gareth James, Daniela Witten, Trevor Hastie, and Rovert Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer, ISBN-13: 978-1461471370, 2015
3. Michael T. Heat, "Scientific Computing", Second edition, Slam, ISBN-13: 978-125900228, 2018
4. Journal of Optimization Theory and Applications, Springer
5. Transactions on Evolutionary Computation, IEEE
6. Journal of Discrete Optimization, Elsevier.

Journals/Magazines:

1. Springer Journal of Optimization Theory and Applications
2. Taylors and Francis Journal of Optimization Methods and Software
3. Elsevier Journal of Applied Combinatorial Optimization

Swayam/NPTEL/MOOCS:

1. https://onlinecourses.nptel.ac.in/noc21_me10/preview
2. https://onlinecourses.nptel.ac.in/noc19_ma29/preview
3. https://onlinecourses.nptel.ac.in/noc20_ee59/preview

<table>
<tr><td>Course Title</td><td colspan="4">Advanced Machine Learning</td><td colspan="2">Course type</td><td colspan="2">Integrated</td></tr>
<tr><td>Course Code</td><td>M20AI1020</td><td>Credits</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2">I Semester</td></tr>
<tr><td rowspan="4">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of ClassesPer Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>-</td><td>0</td><td>-</td><td>-</td></tr>
<tr><td>Total</td><td>4</td><td>5</td><td>5</td><td>39</td><td>26</td><td>50</td><td>50</td></tr>
</table>

COURSE OVERVIEW:

The course introduces machine learning, with various aspects involved in machine learning, types of learning like supervised, unsupervised and reinforcement learning. It also introduces various methods of dimensionality reduction, reasons for dimensionality reduction, concepts of neural networks, different aspects involved in neural networks, their activation function, back propagation algorithm etc.

Course Objectives:

The objectives of this course are to:

1. Explain the basic blocks of machine learning and the techniques involved.
2. Discuss the various Learning trees used in real world problems.
3. Illustrate the use of different Linear Models in real world problems
4. Demonstrate the use of different dimensionality reduction techniques.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Apply the basic blocks of machine learning and the techniques involved	1,2,5	1,2
CO2	Analyze the various Learning trees used in real world problems.	1,2,	1,4
CO3	Design simple linear models to solve real world problems.	1,2,5	1,2
CO4	Formulate different dimensionality reduction techniques to real world problems.	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	H	H	H							H	H	H
CO2	H	H	H	H	H							H	H	H
CO3	H	M	M	M	H							H	H	H
CO4	H	H	M	H	H							H	H	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Introduction: Learning – Types of Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm –– Inductive bias [1] , Bayesian Learning [1], Learning with trees: Learning with Trees, Decision Trees, Constructing Decision Trees, Classification and Regression Trees

UNIT-2

Learning with trees (contd...): Boosting, Bagging, Random Forest, Different ways to combine Classifiers.Probabilistic Learning – Gaussian Mixture Models, Nearest Neighbor Methods Support Vector Machines - Optimal separation, kernels, the support vector machine algorithm, extensions to the SVM.

UNIT-3

Linear models: Perceptron, Linear Separability, Linear Regression.Multi-layer Perceptron, Going Forwards, Going Backwards: Back Propagation Error, Multi-layer Perceptron in Practice, Examples of using the MLP, Overview, and Deriving Back-Propagation.

UNIT-4

Dimensionality Reduction: Dimensionality reduction and evolutionary models Dimensionality Reduction - Linear Discriminant Analysis, Principal Component Analysis, Factor Analysis, Independent Component Analysis,Unsupervised learning: Different types of clustering methods, K means Algorithms, Vector Quantization, and Self-Organizing Feature Map. Unsupervised learning: Classification, Association

SELF- LEARNING COMPONENTS:

Graphical Based Learning Models.

TEXT BOOKS:

1. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
2. Stephen Marsland, Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

REFERENCE BOOKS:

1. Ethem Alpaydin, Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)‖, Third Edition, MIT Press, 2014
2. Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data‖, First Edition, Cambridge University Press, 2012.
3. Jason Bell, Machine learning – Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014

JOURNALS/MAGAZINES:

1 IEEE Transactions on Pattern Analysis and Machine Intelligence

2 Springer Journal of Machine Learning

3 Elsevier Journal of Machine Learning with Applications

SWAYAM/NPTEL/MOOCS:

1. https://www.udemy.com/machinelearning/
2. https://www.coursera.org/learn/machine-learning
3. https://nptel.ac.in/courses/106106139/

PRACTICE:

<table>
<tr><th>Sl.No.</th><th>List of experiments</th></tr>
<tr><td>1.</td><td>R Studio is an integrated development environment (IDE) for R. It includes a console, syntax-highlighting editor that supports direct code execution, as well as tools for plotting, history, debugging and workspace management. Install R studio and Pacakages.</td></tr>
<tr><td>2.</td><td>Machine learning involves learning using different datasets, Perform Data Preprocessing on datasets using R TOOL.
Importing the dataset. Dealing with missing values, Dealing with categorical data, Splitting the data into Training ang and Test data sets, Scaling the features.</td></tr>
<tr><td>3.</td><td>Decision tree are powerful non-linear classifiers, which utilize a tree structure to model the relationships among the features and the potential outcomes. A decision tree classifier uses a structure of branching decisions, which channel examples into a final predicted class value.The C4.5 algorithm is an extension of the ID3 algorithm and constructs a decision tree to maximize information gain (difference in entropy).Apply C 4.5 algorithm classification of Iris data set/ Fruad detection using bank data.</td></tr>
<tr><td>4.</td><td>A Naive Bayes classifier is a probabilistic machine learning model that’s used for classification task. Classify whether a given person is a male or a female based on the measured features.
Consider the following data, which tells us the person’s class depending upon gender and height.
<table>
<tr><td>Name</td><td>Gender(M/F)</td><td>Hieght(cms)</td><td>Class)Medium/Short/Tall)</td></tr>
<tr><td>Radhika</td><td>F</td><td>188</td><td>Medium</td></tr>
</table></td></tr>
<tr><td>5.</td><td>Clustering is the process in which we divide the available data instances into a given number of sub-groups. These sub-groups are called clusters, and hence the name “Clustering”. To put it simply, the K-means algorithm outlines a method to cluster a particular set of instances into K different clusters, where K is a positive integer.
Demonstrate Clustering using k-means for the dataset.</td></tr>
<tr><td>6.</td><td>The EM (expectation maximization) technique is similar to the K-Means technique. Instead of assigning examples to clusters to maximize the differences in means for continuous variables, the EM clustering algorithm computes probabilities of cluster memberships based on one or more probability distributions.
Demonstrate the EM technique on a dataset using R.</td></tr>
<tr><td>7.</td><td>80% of customers who buy operating systems book and database management books also buy Computer Networks book and 75% of customers buy all these products together. This is an example of an association rule. Association rule searches for a pattern (a set of items, subsequences, substructures, etc.) that occurs frequently in a data set.
Demonstrate using R tool to determine Association rules for a given dataset.</td></tr>
</table>

8.	In statistics, linear regression is an approach for modeling the relationship between a scalar dependent variable y and one or more explanatory variables (or independent variables) denoted X. Linear regression is the most basic type of regression and commonly used for predictive analysis. These regression estimates are used to explain the relationship between one dependent variable and one or more independent variables.
9.	R's visualization allows to visualize a 2-D plot of the current working relation. Visualization is very useful in practice, it helps to determine difficulty of the learning problem. R can visualize single attributes (1-d) and pairs of attributes (2-d), rotate 3-d visualizations (Xgobi-style). R has "Jitter" option to deal with nominal attributes and to detect "hidden" data points. Demonstrate the visualization tool
10.	A Breadth-first search (BFS) is an algorithm for traversing or searching tree or graph data structures. It starts at the tree root (or some arbitrary node of a graph, sometimes referred to as a 'search key') and explores the neighbor nodes first, before moving to the next level neighbors. Write a python program to implement Breadth First Search Traversal.

Course Title	Python for Artificial Intelligence				Course type		Integrated	
Course Code	M20AI1030	Credits	4		Class		I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	4	5	5	39	26	50	50

COURSE OVERVIEW:

This course is an introduction to basic concepts of various fields of artificial intelligence like Artificial Neural Networks, Natural Language Processing, Machine Learning and its implementation in Python.

Course Objectives:

The objectives of this course are to:

1. Explain the Basics concepts of Python and Artificial Intelligence.
2. Describe the Intelligent Agents using AI concepts.
3. Demonstratecreation of a sentiment analyzer using python.
4. Illustrate the Concepts of Reinforcement Learning.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Outline the fundamentals of Artificial Intelligence (AI) and python.	1,2,5	1,2
CO2	Apply basic principles of AI to solve real world applications.	1,2,	1,4
CO3	Make use of AI principles to design a Speech recognizer.	1,2,5	1,2
CO4	Develop a real world application for implementing Q-Learning algorithm.	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATIONMATRIX

Course Outcomes	Program Outcomes													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	H	M	H	M	L					L	L	M	M	M
CO2	H	H	M	H	M					L	L	M	H	H
CO3	H	M	H	L	M						M	L	L	L
CO4	H	H	H	M	M						L	L	M	M

Where, (Low), M (Medium) and H (High) represents strength of correlation between CO and PO

Course Contents:

UNIT-1

Python Basics: Introducing Python, Variables and Data Types, Making Choices, Using Lists, Functions, Working with Text, Executable Files.

Introduction to Artificial Intelligence: What is Artificial Intelligence?, Why do we need to study AI?, Applications of AI, Branches of AI, Defining intelligence using Turing Test, Making machines think like humans, Building rational agents, General Problem Solver, Solving a problem with GPS, Building an intelligent agent, Types of models,

UNIT-2

Natural Language Processing: Introduction and installation of packages, Tokenizing text data, Converting words to their base forms using stemming, Converting words to their base forms using lemmatization, Dividing text data into chunks, Extracting the frequency of terms using a Bag of Words model, Building a category predictor, Constructing a gender identifier, Building a sentiment analyzer, Topic modeling using Latent Dirichlet Allocation, Summary.

UNIT-3

Probabilistic Reasoning for Sequential Data: Understanding sequential data, Handling time-series data with Pandas, Slicing time-series data, Operating on time-series data, Extracting statistics from time-series data, Generating data using Hidden Markov Models, Identifying alphabet sequences with Conditional Random Fields, Stock market analysis, Summary.

Building A Speech Recognizer: Working with speech signals, Visualizing audio signals, Transforming audio signals to the frequency domain, Generating audio signals, Synthesizing tones to generate music, Extracting speech features, recognizing spoken words, Summary.

UNIT-4

Reinforcement Learning: Understanding the premise, Reinforcement learning versus supervised learning, Real world examples of reinforcement learning, Building blocks of reinforcement learning, creating an environment, Building a learning agent, Summary.

SELF-LEARNING COMPONENTS:

Artificial neural networks, Machine Learning Techniques

TEXT BOOKS:

1. Tim Hall, J P Stacy, Python 3 for Absolute Beginners, 2009, publishers Apress,
2. Prateek Joshi, Artificial Intelligence with Python, first edition 2017, Packt publishers.

REFERENCE BOOKS:

1. Stuart Jonathan Russell, Peter Norvig, Artificial Intelligence For Dummies, Jan 2015.

JOURNALS/MAGAZINES:

1. Elsevier Journal of Artificial Intelligence
2. IEEE Transactions on Artificial Intelligence
3. Springer Jounal of Artificial Intelligence

SWAYAM/NPTEL/MOOCs:

1. https://www.udemy.com/Artificial intilligence/
2. https://www.coursera.org/learn/machine-learning
3. https://nptel.ac.in/courses/106106139/

PRACTICE:

Sl.No.	List of Programs
1	Machine learning algorithms expect data to be formatted in a certain way before they start the training process. In order to prepare the data for ingestion by machine learning algorithms, we have to preprocess it and convert it into the right format. Apply the following preprocessing techniques on the given data set i) Binarization ii) Normalization iii) Mean removal iv) Scaling The dataset is available in the following website. https://github.com/PacktPublishing/Artificial-Intelligence-with-Python.
2.	Naïve Bayes is a technique used to build classifiers using Bayes theorem. Bayes theorem describes the probability of an event occurring based on different conditions that are related to this event. Build an Naïve Bayes classifier to classify an animal to Cheetah assuming the attributes.
3.	A Support Vector Machine (SVM) is a classifier that is defined using a separating hyperplane between the classes. This hyperplane is the N-dimensional version of a line. Given labeled training data and a binary classification problem, the SVM finds the optimal hyperplane that separates the training data into two classes. Build a Support Vector Machine classifier to predict the income bracket of a given person based on 14 attributes. Our goal is to see where the income is higher or lower than $50,000 per year. The income dataset available at https://archive.ics.uci.edu/ml/datasets/Census+Income.
4	Regression is the process of estimating the relationship between input and output variables. Regression analysis helps us in understanding how the value of the output variable changes when we vary some input variables while keeping other input variables fixed. Build a regression model for a single variable for any given Dataset.
5	A **Decision Tree** is a structure that allows us to split the dataset into branches and then make simple decisions at each level. This will allow us to arrive at the final decision by walking down the tree.Build a classifier using Decision Trees in Python.
6	Clustering is one of the most popular unsupervised learning techniques. This technique is used to analyze data and find clusters within that data. In order to find these clusters, we use some kind of similarity measure such as Euclidean distance, to find the subgroups. This similarity measure can estimate the tightness of a cluster. Apply K-Means clustering on two-dimensional data and analyze the data.
7	Apply unsupervised learning techniques to segment the market, based on customer shopping habits.
8	Build a model to find the relationship between the family members using logic programming.
9.	Build a python program **Predicting traffic** using Extremely Random Forest regressor.
10	Sentiment analysis is the process of determining the sentiment of a given piece of text Build a sentiment Analyzer using NLp concepts to determine whether a movie review is positive or negative.

Course Title	Applied Statistics				Course type	Theory	
Course Code	M20AI1040	Credits	3		Class	I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	0	-	-			
	Total	3	3	3	39	50	50

COURSE OVERVIEW:

The course introduces the basic concepts of Applied Statistics, the science of collecting, organizing, and interpreting numerical data. This course is an important part of the postgraduate stage in education for future economists. Students manipulate data and estimate the probability of an event occurring. Other topics include surveys and experiments, tests of significance, exploratory data analysis, and sampling distributions.

Course Objectives:

The objectives of this course are to:

1. Explain the basics of Probability and Statistics.
2. Discuss the properties of discrete and continuous distribution functions and its applications.
3. Discuss the Mathematical expectations, Correlation and Regression for Practical Problems.
4. Illustrate how to use various tests of hypothesis such as t, F, Chi-square for the given data.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Summarize the basics of Probability and Statistics.	1,2,5	1,2
CO2	Make use of the properties of discrete and continuous distribution functions and its applications.	1,2,	1,4

CO3	Apply Mathematical expectations, Correlation and Regression for Practical Problems.	1,2,5	1,2
CO4	Identify when and how to use various tests of hypothesis such as t, F, Chi-square	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	H	H		L		M		M		H	H	H
CO2	H	M	M	L	M			M		M		H		
CO3	H	H	H	H	M			M		M		H	H	H
CO4	H	H	H	H	M			M		M		H	H	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Sample space: Events - Probability - Probability axioms - addition and multiplication law of probabilities - conditional probability-Independent events - Baye's theorem.

UNIT-2

Random Variables: distribution functions (discrete and continuous)-Joint probability distribution - Marginal and conditional distribution. Mathematical expectations - Moment Generating Functions.Chebyshev's inequality.

UNIT-3

Discrete distributions: Binomial and Poisson -Continuous distributions: Uniform, Exponential and Normal. Correlation and Regression.

UNIT-4

Testing of hypothesis: Tests based on normal population. Applications of chi -square, Student's-T, F- distributions - Chi-square Test - goodness of fit - Test based on mean, means, variance, correlation and regression coefficients.

SELF-LEARNING COMPONENTS:

Analysis of Variance (one way and two way classifications). Design of Experiments - Principles of Design of Experiments - Completely Randomized Design - Randomized Block Design and Latin Square Design. Note: Stress is given on the working of problems.

TEXTBOOKS:

1. S.C.Gupta and V.K.Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 11th edition, 2002.
2. S.C. Gupta and V.K. Kapoor, "Fundamentals of Applied Statistics", Sultan Chand & Sons, New Delhi, 4th edition, 2007.

REFERENCE BOOKS:

1. Erwin Kryszig, "Introductory Mathematical Statistics", John Wiley & sons, New York, 1990.
2. J.S. Milton and J.C. Arnold, "Probability and Statistics in Engineering and Computer Science", McGraw Hill, New York, 1986.

JOURANALS/MAGAZINES:

1. Elsevier Jounral on Computational Statististics and Data Analaysis
2. Springer Jounal on Computational Statistics
3. Taylor and Francis , A Journal of Theoretical and Applied Statistics

SWAYAM/NPTEL/MOOCS:

1. https://onlinecourses.nptel.ac.in/noc20_ma22/preview
2. https://www.udemy.com/course/statistics-probability/
3. https://onlinecourses.nptel.ac.in/noc21_ma34/preview

Course Title	Neural Networks				Course type		Integrated	
Course Code	M20AI1050	Credits	3		Class		I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	3	4	4	26	26	50	50

COURSE OVERVIEW:

The course introduces neural networks: perceptrons, multi layer perceptrons, back propagation algorithm, hessian learning and radial basis functions.

Course Objectives:

The objectives of the course are to:

1. Explain Rosenblatt's Perceptron
2. Implement multilayer perceptron.
3. Discuss generalization, regularization, cross validation.
4. Understand the Kernel Methods and Radial-Basis Function Networks.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Explain Perceptron	1,2,5	1,2
CO2	Implement multilayer perceptron	1,2,	1,4
CO3	Make use of generalization, regularization, cross validation when building a model .	1,2,5	1,2
CO4	Make use of neural networks to solve a supervised problem	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M	M	M	M	-	-	-	-	-	-	M	M	M	-
CO2	M	M	M	M	M	-	-	-	-	-	-	M	M	M	-
CO3	M	M	M	M	M	-	-	-	-	-	-	M	M	M	-
CO4	M	M	M	M	M	-	-	-	-	-	-	M	M	M	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Introduction: What is a Neural Network?, The Human Brain, Models of a Neuron, Neural Networks Viewed As Directed Graphs, Feedback, Network Architectures, Knowledge representation, Learning Processes, Learning Tasks Rosenblatt's Perceptron: Introduction, Perceptron, The Perceptron Convergence Theorem, Relation Between the Perceptron and Bayes Classifier for a Gaussian Environment, Computer Experiment: Pattern Classification, The Batch Perceptron Algorithm

UNIT-2

Multilayer Perceptrons: Introduction, Some Preliminaries, Batch Learning and On-Line Learning, The Back-Propagation Algorithm, XOR Problem, Heuristics for Making the Back-Propagation Algorithm Perform Better, Computer Experiment: Pattern Classification Back Propagation and Differentiation

UNIT-3

Heasian Learning : The Hessian and Its Role in On-Line Learning, Optimal Annealing and Adaptive Control of the Learning rate, Generalization, Approximations of Functions, Cross-Validation, Complexity Regularization and Network Pruning, Virtues and Limitations of Back-Propagation Learning, Supervised Learning Viewed as an Optimization Problem, Convolutional Networks, Nonlinear Filtering, Small-Scale Versus Large-Scale Learning Problems,

UNIT-4

Kernel Methods and Radial-Basis Function Networks: Introduction, Cover's Theorem on the separability of Patterns, The Interpolation Problem, Radial-Basis-Function Networks, K-Means Clustering, Recursive Least-Squares Estimation of the Weight Vector, Hybrid Learning Procedure for RBF Networks,

SELF-LEARNING COMPONENTS:

Applications of neural network in real time systems, Computer Experiment: Pattern Classification, Interpretations of the Gaussian Hidden Units, Kernel Regression and Its Relation to RBF Networks,

TEXT BOOKS:

1. Simon Haykins, "Neural networks and Learning machines", Pearson Education India; Third edition, 2016.
2. B. Yegnanarayana, "Artificial Neural Networks" , PHI Learning Pvt. Ltd., 2009

REFERENCE BOOKS:

1. Tom M. Mitchell, "Machine Learning", India Edition McGraw Hill Education, 2013.
2. Yoshua Bengio and Aaron Courville ,"Deep Learning",Ian Good fellow, MIT Press book,2016.
3. Chris Bishop,"Pattern Recognition and Machine Learning" , Springer (India) Private Limited, 2013.
4. IEEE Transactions on Pattern Analysis and Machine Intelligence
5. Springer machine learning
6. Elsevier Computational Statistics and Data Analysis
7. Wiley- International Journal of Intelligent Systems

JOURNALS/MAGAZINES:

1. Springer Journal on Neural Computing & Applications
2. Elsevier Journal on Neural Networks
3. IEEE Transactions on Neural Networks and Learning Systems

SWAYAM/NPTEL/MOOCS:

1. https://nptel.ac.in/courses/117/105/117105084/
2. https://nptel.ac.in/courses/108/108/108108148/
3. https://nptel.ac.in/courses/127/105/127105006/
4. https://onlinecourses.nptel.ac.in/noc19_ee53/preview

Practice:

Sl.No.	List of Programs
1	Neural networks were initially designed to work as linear models. The working basic gates of And, Or, Not are linear in nature. Implement a neural network to simulate the working of these gates.
2	Most of the problems in nature is nonlinear in nature. But these non linear problems can be broken into combinations of linear. XOR gate is one such non linear model. Implement a neural network to simulate the working of XOR and XNOR gate
3.	Neural network model is generated by first training the model on training data. During learning, the weights are updated using back propagation algorithm. Implement a neural network model which uses back propagation for learning on the training data.
4.	Classifiers could be binary classifiers or multi label classifiers. Consider a real time example of data which needs to be classified into two classes and implement it using neural network model.
5.	Using high-level APIs, implement multilayer perceptrons much more concisely. For classification problem, the implementation of an MLP is the same as that of softmax regression except for additional hidden layers with activation functions. a) Try adding different numbers of hidden layers (you may also modify the learning rate). What setting works best? b) Try out different activation functions. Which one works best? c) Try different schemes for initializing the weights. What method works best?
6.	Write a program that learns how to recognize handwritten digits, using stochastic gradient descent and the MNIST training data.
7.	Try creating a network with just two layers – an input and an output layer, no hidden layer – with 4 and 3 neurons, respectively. Train the network on MNIST data using stochastic gradient descent. What classification accuracy can you achieve?
8.	Consider two one dimensional Gaussian distributed classes c1,c2 that have a common variance equal to 1. Their mean values are m1=-10, m2 = +10. These two classes are essentially linearly separable. Design a classifier that separates these two classes.

9.	Investigate the use of back-propagation learning using a sigmoidal nonlinearity to achieve one-to-one mappings, as described here. a) f(x) = 1/x , 1<=x<= 100 b)f(x) = exp(-x), 1<=x<=10 For each mapping, divide the data into train set and test set, train on train set and evaluate on test set
10.	Envision a radial-basis-function (RBF) network in the form of a layered structures of input layer, hidden layers and output layers. Implement XOR problem using Radial basis function network with four hidden units.
11.	Overfitting can be overcome using regularization techniques. Multiple regularization techniques exists. Compare the performance of multiple regularizers on suitable data.
12.	For a neural networks learning problem, we will usually define a loss function first. Once we have the loss function, we can use an optimization algorithm in attempt to minimize the loss. In optimization, a loss function is often referred to as the objective function of the optimization problem. By tradition and convention most optimization algorithms are concerned with minimization. There are various optimization functions used in neural networks. Implement any two optimization technique on binary classifier and compare the results

Course Title	Random Process and Linear Algebra				Course type	Theory	
Course Code	M20AI1060	Credits	3		Class	I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	0	-	-			
	Total	3	3	3	39	50	50

COURSE OVERVIEW:

This course introduces on the basic mathematics of Linear Algebra and Random Variables and Processes.for your research oriented post-graduate studies you need to go deeper in these two topics. SC532 fulfils this role by adding depth and breadth.

Course Objectives:

The objectives of the course are to:

1. Determine Eigen values and Eigen vectors of matrix and further to diagonalize the matrix and singular value decomposition.
2. Find basis and dimension of a subspace and inner product spaces.
3. Understand about random variables, probability density function and joint distribution function.
4. Laws of large numbers, central limit theorem and Markov chain.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Analyze and Comprehend linear algebraic structures that appear in various areas of computer science and apply linear algebraic methods to perform computational tasks.	1,2,5	1,2
CO2	Apply properties of eigenvalues and orthogonality to analyze computational problems.	1,2,	1,4
CO3	Apply various concepts of probability theory.	1,2,5	1,2

CO4	Comprehend and apply the properties of random processes in real world situations.	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATIONMATRIX:

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
	CO1	**3**	**2**	**2**	**1**	**2**	**1**	**2**	**1**			
	CO2	**3**	**2**	**2**	**1**	**2**	**1**	**1**	**1**			
	CO3	**3**	**2**	**1**	**2**	**3**	**2**	**1**	**1**			
	CO4	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**1**			

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Linear algebra: Matrices and linear transformation: Rank, determinant, trace of a matrix. Gauss elimination method to solve linear simultaneous equations.Condition number of a matrix. Eigen values, Eigen vectors, singular values, singular vectors. Computation of Eigen values and Eigen vectors.Similarity of matrices.Diagonalizaion of matrix and its applications.Singular value decomposition.

UNIT-2

Linear Algebra-2: Vector spaces: Column and row spaces, Solving Ax=0 and Ax=b, Independence, basis, dimension.**Orthogonality:** Inner products, orthogonal vectors and subspaces, projection and least squares, Gram-Schmidt orthogonalization

UNIT-3

Random process-1: Random Variables, Distributions, law of averages, discrete and continuous r.v.s, random vectors.

Discrete Random Variables: Probability mass functions, independence, expectation, conditional expectation, sums of r.v.s.

Continuous Random Variables: Probability density functions, independence, expectation, conditional expectation, functions of r.v.s, sum of r.v.s, multivariate normal distribution, sampling from a distribution

UNIT-4

Random process-2: Convergence of Random Variables, Modes of Convergence, Borel-Cantelli lemmas,laws of large numbers, central limit theorem, tailinequalities, Markov chains, minimum mean squared error estimation.

TEXT BOOKS:

1. Linear Algebra and Its Applications - Gilbert Strang- Fourth Edition- Cengage Learning, 2006.
2. Probability, Random Variables and Stochastic Processes, Papoulis and Unnikrishnan, Fourth Edition, 2002, available in paperback.
3. Probability and Random Processes - an introduction for application scientists and engineers, W B Davenport, 1970, McGraw Hill.

REFERENCE BOOKS:

1. N. Herstein – Topics in Algebra, Vikas Publishing House, New Delhi.
2. Hoffman and Kunze – Linear Algebra, Prentice- Hall of India, 1978, 2nd Ed.,
3. P. R. Halmos – Finite Dimensional Vector Space, D. Van Nostrand, 1958.
4. S. Kumeresan – Linear Algebra, A Geometric approach, Prentice Hall India, 2000
5. SC Gupta and VK Kapoor -Fundamentals of mathematical statistics 11th Edition, 2013, S. Chand Publication.
6. S.C Gupta- Fundamentals of statistics, 6th Edition 2005, S. Chand Publication.
7. Dr. T.K.V. Iyengar, Dr. B. Krishna Gandhi, S. Ranganatham, Dr. M.V.S.S.N. Prasad-Probability and Statistics, 3rd Edition 2011, S. Chand Publication.

Course Title	Mini Project				Course type	Pratice	
Course Code	M20AI1070	Credits	3		Class	I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	0	3	3			
	Practice	2	0	0	Practical	CIE	SEE
	-	0	-	-			
	Total	2	3	3	26	50	50

COURSE OVERVIEW:

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 week.

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	M	M	M							H	H	H
CO2	M	H	H	H	H							H	H	H
CO3	M	H	H	H	H							H	H	
CO4	L	L	M	L	M							H	H	

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

Sample Mini Projects: (if any)

1. Consider a mini project that includes work in most disciplines, ending in a stable executable for a 3-week iteration(any example of software project of candidate choice). Construct a disciplines across iterations diagram considering the sample disciplines i.e., Requirements, Design, Implementation and Test.

2. Imagine there is ultimately be a 20-iteration project for evolutionary and iterative development. Design an evolutionary requirements analysis, and show the diagram for the same 20-iteration project for evolutionary and iterative development.

II Semester
Syllabus

Course Title	Agile software development				Course type	Theory	
Course Code	M20AI2011	Credits	3		Class	II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	0	-	-			
	Total	3	3	3	39	50	50

COURSE OVERVIEW:

The objective of the course will help you gain knowledge on what is agile? Why agile is better suited for the situations and to cover some of the most common agile frameworks like scrum and XP in depth. The course also examines Agile Development concepts, its evolution from the Waterfall Lifecycle, various agile methods and best practices and knowledge on how to apply Agile to your software projects.

Course Objectives:

The objective of this course is to:

1. Explain the basics of Agile Software Development and Software Development Rhythms.
2. Demonstrate the unique features related to traditional agile software practices.
3. Describe the core principles of a DevOps implementation and culture.
4. Discuss the enormous benefits of DevOps practices and culture.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Develop applications using traditional Agile Software practices	1,2,5	1,2
CO2	Outline the fundamental principles and practices of Agile Software in real world problem	1,2,	1,4
CO3	Analyze the agile principles and values to a given situation	1,2,5	1,2
CO4	Make use of Building Blocks of DevOps methods in real world problems.	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	M	M	M							H	H	H
CO2	H	M	M	M	H							H	H	H
CO3	H		M	M	L							H	H	H
CO4	H	M	M	M	M					L		H	H	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Introduction: Iterative Development, Risk-Driven and Client-Driven Iterative Planning, Time boxed Iterative Development, Evolutionary and Adaptive Development, Evolutionary Requirements Analysis, Early "Top Ten" High-Level Requirements and Skillful Analysis, Evolutionary and Adaptive Planning. Incremental Delivery, Evolutionary Delivery.

UNIT-2

Agile: Agile Development, Classification of Methods, The Agile Manifesto and Principles, Agile Project Management, Embrace Communication and Feedback, Programming as If People Mattered, Simple Practices and Project Tools, Empirical vs. Defined & Prescriptive Process, Principle-Based versus Rule-Based. Sustainable Discipline: The Human Touch, Team as a Complex Adaptive System, Agile Hype? Specific Agile Methods.

UNIT-3

Motivation: The Facts of Change on Software Projects, Key Motivations for Iterative Development, Meeting the Requirements Challenge Iteratively, Problems with the Waterfall.Evidence: Research Evidence, Early Historical Project Evidence, Standards-Body Evidence, Expert and Thought Leader Evidence, Business Case for Iterative Development.

UNIT- 4

Fundamentals: Beginning DevOps for Developers, Introducing DevOps, Building Blocks of DevOps.Metrics and Measurement View: Quality and Testing, Process view. Technical View: Automatic Releasing, Infrastructure as Code, Specification by Example

SELF-LEARNING COMPONENTS:

A Qualitative Study of DevOps Usage in Practices, A Case Study of DevOps at Netflix.

TEXT BOOKS:

1. Craig Larman; Agile and Iterative Development: A Manager's Guide. Pearson Education; 2006.
2. Jim Highsmith; Agile Project Management: Creating Innovative Products (Agile Software Development), Addison Wesley; 2009.
3. Robert Cecil Martin; Agile Software Development: Principles, Patterns, and Practices; Prentice Hall PTR, Upper Saddle River, NJ, USA; 2009.
4. Michael Huttermann; DevOps for Developers, Integrate Development and Operations, the Agile Way, Apress Publications. (https://books.google.co.in/).

REFERENCE BOOKS:

1. Jeff Sutherland: Scrum: A revolutionary approach to building teams, beating deadlines, and boosting productivity; Random House Business Books; 2014.
2. Mitch Lacey; The Scrum Field Guide: Agile Advice for Your First Year; Addison Wesley: 2012.
3. Martin C. Robert, Martin Micah: Agile Principles, Patterns, and Practices in C#: Prentice Hall, 2006.

JOURNALS/MAGAZINE:

1. IEEE transactions on Agile Software Development Using Scrum.
2. ACM Transactions on DevOps.
3. InderScience Journal on Agile and Extreme Software Development
4. Springer Journal on Software Engineering Research nd Development

SWAYAM/NPTEL/MOOCS:

1. https://nptel.ac.in/courses/106/105/106105182/
2. https://nptel.ac.in/courses/106/101/106101061/
3. http://www.nptelvideos.com/video.php?id=904
4. https://www.classcentral.com/course/edx-agile-software-development-6878

Course Title	Digital Image Processing and Computer vision				Course type	Theory	
Course Code	M20AI2012	Credits	3		Class	II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	0	-	-			
	Total	3	3	3	39	50	50

COURSE OVERVIEW:

The course familiarizes readers with fundamental concepts and issues related to computer vision and major approaches that address them. The focus of the course is on image acquisition and image formation models, radiometric models of image formation, image formation in the camera, image processing concepts, concept of feature extraction and feature selection for pattern classification/recognition, and advanced concepts like object classification, object tracking, image-based rendering, and image registration. Intended to be a companion to a typical teaching course on computer vision, the course takes a problem-solving approach.

Course Objectives:

The objectives of this course are to:

1. Explain the fundamentals of Computer vision
2. Discuss various segmentation techniques.
3. Demonstrate the use of techniques for registration and classification of images.
4. Describe the object detection and recognition process in a given application.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Utilize linear filters to enhance the quality of images in given real worl application.	1,2,5	1,2
CO2	Develop Segmentation technique to solve real world problems.	1,2,	1,4

CO3	Design and Develop program for registration and classification of images in the real world application.	1,2,5	1,2
CO4	Apply object detection and recognition techniques to solve real world problems.	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	M	H	H	-	-	-	-	-	-	-	-	-
CO2	H	M	M	M	H	-	-	-	-	-	-	-	-	-
CO3	H	M	H	H	H	-	-	-	-	-	-	-	-	-
CO4	H	M	H	H	H	-	-	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Introduction: Computer Vision and Basic Concepts of Image: Formation Introduction and Goals of Computer Vision, Image Formation and Radiometry, Geometric Transformation, Geometric Camera Models, Image Reconstruction from a Series of Projections.

UNIT-2

Image Processing Concepts: Fundamentals of Image Processing, Image Transforms, Image Filtering, Colour Image Processing, Mathematical Morphology, Image Segmentation, Summary.

UNIT-3

Image Descriptors and Features: Texture Descriptors, Colour Features, Edge Detection, Object Boundary and Shape Representations, Interest or Corner Point Detectors, Histogram of Oriented Gradients (HOG), Scale Invariant Feature Transform (SIFT), Speeded up Robust Features (SURF), Saliency.

UNIT-4

Fundamental Pattern Recognition Concepts: Introduction to Pattern Recognition, Linear Regression, Basic Concepts of Decision Functions, Elementary Statistical Decision Theory, Gaussian Classifier, Parameter Estimation, Clustering for Knowledge Representation, Dimension Reduction, Template Matching, Artificial Neural Network (ANN) for Pattern Classification, Convolutional Neural Networks (CNNs).

SELF LEARNING COMPONENTS:

Machine Learning Algorithms and their Applications in Medical Image Segmentation, Motion Estimation and Object Tracking, Face and Facial Expression Recognition, Gesture Recognition, Image Fusion.

TEXT BOOKS:

1. M. K. Bhyan, 2020, "Computer Vision and Image Processing", Tayler and Francis Publisher, 1st edition, 2020.
2. David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach" , 2nd Edition, University of Illinois at Urbana-Champaign Jean Ponce, Ecole Normale Superieure, Paris©2012, Pearson
3. Richard Szeliski, " Computer Vision: Algorithms and Applications" , Springer
4. David Marr, Tomaso A. Poggio, Shimon Ullman "A Computational Investigation into the Human Representation and Processing of Visual Information", , eBook - Amazon.com

REFERENCE BOOKS:

1. Gary Bradski, Adrian Kaehler, " Learning OpenCV: Computer Vision with the OpenCV Library" Amazon

JOURNALS/MAGAZINES:

1. Springer International Journal of Computer Vision
2. Elsevier Journal on Image and Vision Computing
3. Elsevier Journal on Computer Vision and Image Understanding
4. IEEE Transactions on Image Processing
5. IEEE Transactions on Pattern recognition and machine intelligence

SWAYAM/NPTEL/MOOCS:

1. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee75/
2. https://nptel.ac.in/courses/106/105/106105032/
3. https://nptel.ac.in/courses/106/105/106105216/
4. https://onlinecourses.nptel.ac.in/noc20_ee83/preview

Course Title	Mobile Application Development				Course Type	Theory	
Course Code	M20AI2013	Credits	3		Class	II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	**0**	-	-			
	Total	**3**	**3**	**3**	**39**	**50**	**50**

COURSE OVERVIEW:

This course introduces programming technologies, design and development tools related to mobile applications. Topics include accessing device capabilities, industry standards, operating systems, and programming for mobile applications using OS Software Development Kit (SDK).

Course Objectives:

The objectives of this course are to:

1. Explain basics of Mobile communication.
2. Demonstrate the use of fundamentals of Android Application development.
3. Illustrate the use of Menus and Graphics in app development.
4. Describe the concepts related to views and activity.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Analyse Android Platform, its architecture and features.	1,2,5	1,2
CO2	Design and implementation of user interface, database and content providers.	1,2,	1,4
CO3	Make use of activities, layouts and Graphics in the development of apps for android	1,2,5	1,2
CO4	Evaluate multimedia, camera and location based services in Android application.	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	H	M	L	L		L	M	M	L	H		H
CO2	H	H	M	H	M	M		M	H	M	L	H	H	H
CO3	L	M	H	L	M	L		L	H	M	M	H	H	
CO4	H	H	H	M	M	L		M	M	M	L	H		H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Introduction to mobile communication and computing: Introduction to mobile computing, Novel applications, limitations and GSM architecture, Mobile services, System architecture, Radio interface, protocols, Handover and security, Smart phone operating systems and smart phones applications.

UNIT-2

Fundamentals of Android Application Development: Introduction to Android., The Android 4.1 Jelly Bean SDK, Understanding the Android Software Stack, Installing the Android SDK, Creating Android Virtual Devices, Creating the First Android Project, Using the Text View Control, Using the Android Emulator.

UNIT-3

Layouts, Menus and Graphics in Android:Menus: Options menu and app bar,Context menu and contextual action mode, Popup menu, Defining a Menu in XML, Creating an Options Menu, Changing menu items at runtime, Creating Contextual Menus, Creating Menu Groups, Adding Menu Items Based on an Intent.

Activity, Service, BroadcastReceiver and Content Provider. Building Blocks for Android Application Design, Laying Out Controls in Containers. Graphics and Animation: Drawing graphics in Android, Creating Animation with Android's Graphics API.

UNIT-4

Creating the Activity, Working with views: Exploring common views, using a list view, creating custom views, understanding layout. Using Selection Widgets and Debugging Displaying and Fetching Information Using Dialogs and Fragments. Multimedia: Playing Audio, Playing Video and Capturing Media. Advanced Android Programming: Internet, Entertainment, and Services.

SELF-LEARNING COMPONENTS:

More Recent Applications: Multimedia; 2D graphics; networking support in Android, Introduction to IoS, App. Development.

TEXT BOOKS:

1. Bill Phillips, Chris Stewart, and Kristin Marsican, Android Programming: The Big Nerd Ranch Guide pearson technology group,3rd Edition,2015
2. Barry Burd, Android Application Development All-in-One For Dummies, wiley publisher, 2nd Edition, 2012.
3. ZigurdMednieks, Laird Dornin, G. Blake Meike, Masumi Nakamura,Programming Android: Java Programming for the New Generation of Mobile Devices,oiley,2nd Edition,2012.

REFERENCE BOOKS:

1. Greg Nudelman, Android Design Patterns: Interaction Design Solutions for Developer, wiley, 2013.
2. Jason Tyler, App Inventor for Android: Build Your Own Apps No Experience Required!, wiley,2011.
3. J.F.Dimarzio, Android programming with Android studio,wrox,4th edition ,2017
4. Maurice Sharp Erica Sadun Rod Strougo, Learning iOS Development-A Hands-on Guide to the Fundamentals of iOS Programming, Addison Wesley by Pearson Education, Inc.2014.
5. Wei-Meng Lee, Beginning Swift Programming, Wiley India Pvt. Ltd.,2018

JOURNALS/MAGAZINES:

1. Springer Journal on Mobile Networks and Applications
2. Springer Journal on Multimedica and Applications
3. Elsevier Journal on Systems and Software

SWAYAM/NPTEL/MOOCS:

1. https://onlinecourses.nptel.ac.in/noc20_cs52/preview
2. https://www.classcentral.com/course/swayam-introduction-to-modern-application-development-7908
3. https://nptel.ac.in/courses/106/106/106106156/

Course Title	Data Security and Privacy				Course Type		Integrated	
Course Code	M20AI2021	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	**4**	**5**	**5**	**39**	**26**	**50**	**50**

COURSE OVERVIEW:

The ubiquity of computers and internet in the life of human beings has enabled chance, motive and means to do harm. With such endangers in front of us, it becomes necessary security for security professionals, to learn about how manage computer and information security aspects. This course provides a comprehensive view of the data security principles and measures to prevent vulnerabilities and security attacks. The course deals with the security and privacy problems in the realm of networks. The subject is useful to researchers working in the fields of security and privacy and to graduate students seeking new areas to perform research.

Course Objectives:

The objectives of this course are to:

1. Discuss the stream ciphers and block ciphers with relevant case studies.
2. Describe the principles of authentication, public key cryptosystems, hash functions and digital signatures.
3. Illustrate the different techniques for identification, login and key exchange
4. Explain the intrusion detection techniques and significance of data privacy

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Contrast and compare different stream ciphers and block ciphers.	1,2,5	1,2
CO2	Understand the principles of authentication, public key cryptosystems, hash functions and digital signatures.	1,2,	1,4

CO3	Build applications by considering techniques for identification, login, key exchange and intrusion detection	1,2,5	1,2
CO4	Understand the concept of IDS and data Privacy.	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	**Program Outcomes**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	L	L	M		L							H		H
CO2	L	M	H	M	L							H	H	H
CO3	L	M	H	H	L				L			H	H	
CO4	M	M		L	M							H		H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO

Course Contents:

UNIT-1

Introduction: Stream ciphers: Pseudo-random generators, Attacks on the one time pad, Linear generators, Cryptanalysis of linear congruential generators, The subset sum generator, Case study: cryptanalysis of the DVD encryption system.

Block ciphers: Pseudorandom functions and permutations (PRFs and PRPs), PRP, under chosen plaintext attack and chosen ciphertext attack, Case study: DES, AES, modes of operation.

UNIT-2

Message integrity: Cryptographic hash functions, message authentication code, CBC MAC and its security, Cryptographic hash functions based MACs, Case study: *SHA512, SHA3, Merkle trees*. Authenticated Encryption-Authenticated encryption ciphers from generic composition.

Public key encryption and Digital Signatures: RSA, Rabin, Knapsack cryptosystems, Diffie-Hellman key exchange protocol, ElGamal encryption, Elliptic curve cryptography. Generic signature schemes, RSA, ElGamal and Rabin's signature schemes, blind signatures, threshold signature schemes, ECDSA, Signcryption.

UNIT-3

Protocols for identification and login: Interactive protocols, ID protocols, Password protocols, Challenge response protocols, Schnorr's identification protocol, proving properties in zero-knowledge.

Authenticated Key Exchange: encryption-based protocol and its attacks, Perfect forward secrecy, Protocol based on ephemeral encryption, Attacks on Insecure variations, Identity protection.

UNIT- 4

Techniques for Network Intrusion Detection System: Snort, Signature-based and Anomaly-based detection; Firewalls: packet filters and stateful firewalls, application-aware firewalls, Proxies, NAT, VPN, Honeypots and Honeynets. Single Sign On (SSO).

Understanding data Privacy: Social Aspects of Privacy, Privacy Models, Using technology for preserving privacy, Emerging Applications Social Network Privacy: Location Privacy, Query Log Privacy, Biomedical Privacy

SELF-LEARNING COMPONENTS:

Attacks on SSL/TLS: Drown attack, Poodle attack, and Secure HTTP, DNSSEC. ARP Cache poisoning, MAC flooding, Port Stealing, DHCP attacks, DNS based attacks, VLAN hopping, Man in the middle attacks.

TEXT BOOKS:

1. J. Menezes, P. C. V. Oorschot and S. A. Vanstone, Handbook of Applied Cryptography, CRC Press, 1996.
2. O. Goldreich, Foundations of Cryptography: Vol. 1, Basic Tools, Cambridge University Press, 2001.
3. Dan Boneh and Victor Shoup, A Graduate Course in Applied Cryptography,V4, 2017

REFERENCE BOOKS:

1. O. Goldreich, Foundations of Cryptography: Vol. 2, Basic Applications, Cambridge University Press, 2004.
2. J. Katz and Y. Lindell, Introduction to Modern Cryptography, Chapman & Hall/CRC, 2007.
3. Abhijit Das and Veni Madhavan C. E., Public-Key Cryptography: Theory and Practice, Pearson Education India, 2009.
4. Abijit Das, Computational Number theory, CRC Press, 2013.
5. J. Pieprzyk, T. Hardjono and J. Seberry, Fundamentals of computer security , Springer, 2003.
6. C. Boyd and A. Mathuria, Protocols for Authentication and Key Establishment, Springer, 2010.
7. L. Dong and K. Chen, Cryptographic Protocol: Security Analysis Based on Trusted Freshness, Springer, 2012.

JOURNALS/MAGAZINES:

1. Springer transaction for advances in Information security.
2. IEEE transaction for Information security.
3. ACM transaction for Information security.

SWAYAM/NPTEL/MOOCS:

1. https://onlinecourses.nptel.ac.in/noc20_cs31/preview
2. https://nptel.ac.in/courses/106/106/106106146/
3. https://nptel.ac.in/courses/106/106/106106129/
4. https://onlinecourses.swayam2.ac.in/ugc19_hs25/preview
5. https://onlinecourses.swayam2.ac.in/nou19_cs08/preview

Practice:

Sl. NO.	List of Programs
1	**LAN based Network Security:** LAN based Network Security Set up a simple LAN as shown in Figure 1. M1-3 and S1-3 are machine which have Linux and Windows running. 1. Configure LAN-1 and LAN-2 as separate VLANs in the Network Switch. –Use inter VLAN ACL 2. Create a SPAN port in the Network switch and send the mirrored traffic to a promiscuous mode port for the purpose of IDS and other packet analysis. Practice port based and VLAN based mirroring. 3. Familiarize with 802.1x, Network Admission Control, Microsoft NAP, RADIUS protocol, RADIUS per port ACL
2	**Network reconnaissance and Protection**– Installing 'iptable' in Ubuntu VM to allow/block communication between VMs – Installing Email server and Web server in VMs. Usage of Firewall (iptable) in blocking/allowing a sub-network from accessing the servers – Configuring iptable to block Telnet inbound and outbound connections 1. Use 'nmap' tool to perform vertical and horizontal scanning for checking open and closed ports. Use nmap commands for performing the following experiments: – Use ping sweeping to determine which hosts are running – Check for vulnerable services available using TCP connect scans – Perform OS Fingerprinting to determine the OS of target machine – Choose different options under each category according to your creativity.
3	**Application of Cryptographic algorithms using Crypto Tools.** Establish a Client-Client Secure communication protocol. The Client machines (Client-1 and Client-2) and Admin machine are installed in different VMs. All the three machines are interconnected through a network switch with different IP addresses. The Admin runs a program that generates 2048 bit RSA public and private key for a Client that wants to communicate. Admin generates 2048 bit RSA public and private key for Client-1 and Client-2. The private keys are distributed to client machines and public keys are stored in a structure in the admin machine. When Client-1 wants to send message to Client-2, it encrypts the messages with public key of Client-2. The message is decrypted by Client-2 with its private key. Similar communication pattern from Client-2 to Client-1 need to be

	maintained. Manually capture the traffic between the hosts to ensure the proper working of the encryption. Construct an asynchronous communication between Client-1 and Client-2. Run a Wireshark/ TCPdump at the SPAN/Promiscuous port of the network switch and identify the communication between the communicating entities (Admin, Client-1, and Client-2).
4	LAN based insider attacks Make use of Ettercap/arpspoof tool to perform ARP Cache Poisoning based attacks in a LAN environment: 1. Perform Denial of Service (DoS) attacks using ARP Cache Poisoning attacks 2. Perform DNS Spoofing attack using ARP Cache Poisoning attacks 3. Perform Password stealing (over plaintext) using ARP Cache Poisoning attacks 4. Invoke 'sslstrip tool' for stealing password from any machine that is connected in a LAN by stripping the https connection. For all the above attacks, observe the ARP cache table, CAM table, etc., before and after the attack. Run Wireshark and observe the traffic patterns before and after the attack.
5	Malware & Attack evasion Techniques Install Virtual Machines (VM) – Win2000 Server and Win 8. Install 'Poison Ivy' Remote Administration Toolkit in Server VM (admin.exe). Build and Generate a client.exe (client) program. Install the client.exe program in the Win XP machine. The client.exe communicates with the admin.exe in Win Server2000 VM. Consider the following tasks: 1) Enlist the processes, installed programs, dump the LM hashes, etc. from the Win XP machine 2) Does 'client.exe' enlisted in the process list? If, write a procedure/program to hide the process (client.exe) from process table list? 3) Set Firewall rules in Windows machine to block communication between the two VMs.
6	Vulnerability Assessment and Penetration Testing (VAPT) Lab Perform Vulnerability Assessment and Penetration Testing aimed at virtual machine images of computer network with distributed misconfigurations and vulnerabilities. The virtual machine images contain vulnerable network services, web services, social engineering and buffer overflow to be exploited. Generate VAPT Pen Test report based on standards such as Pen Test Report SANS, Offensive-security, or ISACA.
7	Wireless Security Lab Perform a VA/PT on your local Wi-Fi network and try automated attacks with NetStumbler and Kismat to gather information wireless network and try attacks like CowPatty and Airsnort. Further execute aircrackng to simulate attacks 802.11 WEP and WPA-PSK keys for auditing wireless networks and performing airodump, aircrack, airmon, airbase, aireplay and airtun using Kali 2.0 (Sana) Linux. Attempt a Wi-Fi sniffing to gather location data which can be used to identify device parameters of wireless communication devices.
8	Reverse Engineering Lab Use Metasploit (open-source exploit framework) to write and test your own exploit into any PC/Site with existing payloads using Virtual Machines in Ubuntu Host and Windows XP Virtual disk. These traces should be executed in OllyDbg step by step, and debug the protocols every single command, laidback with registers and flags, with buffer information. Also debug standalone DLL's like Message Box and wsprintf. Use IDA Pro (evaluate a limited version of the disassembler) to examine a

	protected and obfuscated sample executable. (.NET Reflector can be used to search through, the class hierarchies of .NET assemblies, even without any source code). Perform static and dynamic code auditing.
9	Security Data Analytics Lab Download KDD CUP'99 dataset (http://kdd.ics.uci.edu/databases/kddcup99/kddcup99.html). Separate the datasets into two class dataset such as normal-dos, normal-probe, normal-u2r, and normal-r2l. Any of the toolkits such as R, Weka, RapidMiner, Matlab, etc., can be used. 1. Apply Correlation based Feature Selection Algorithms (FSA) in order to derive the subset of features that represent the dataset. What is the gain in applying FSA? Is there any change in detection rate with and without applying FSA? How the execution time/model building time varies with and without applying FSA? 2. Apply Multilayer Perceptron Classification algorithm and calculate the metrics such as detection rate, false alarm rate, ROC value, F-measure for each class. Also, vary the parameters such as momentum and learning rate and calculate the metrics. 3. Apply Simple k-Means Clustering algorithm and calculate the metrics such as detection rate, false alarm rate, ROC value, F-measure for each class. Also, vary the parameters such as Euclidean and Manhattan distances and calculate the metrics. 4. Apply RIPPER algorithm (rule based classifier) to formulate the rules extracted from the dataset. Determine the number of rules extracted and enumerate each rule. Devise a procedure/mechanism in building a dataset for the following: 1. Network Intrusion Detection system dataset 2. Host Intrusion Detection system dataset 3. Malware dataset 4. Botnet dataset 5. Spam email, Web browsing, Net flow data, firewall logs, Anomilize Tools, DNS records Refer: http://www.unb.ca/research/iscx/dataset/index.html Systematically generate the dataset involving each of the four identified modules – Experimental set up, Data collection, Feature construction and Class labeling.
10	Mobile & Smart Phone Security Lab Familiarize with mobile .apk files. Create your own Android app. Find vulnerable app in play store and perform forensics analysis on the app and document the inferences.
	Take Home assignments
1	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars.
2	Study of packet sniffer tools like wireshark, ethereal, tcpdump etc. Use the tools to do the following: 1. Observer performance in promiscuous as well as non-promiscous mode. 2. Show that packets can be traced based on different filters.
3	Download and install nmap. Use it with different options to scan open ports,perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, etc
4	Detect ARP spoofing using open source tool ARPWATCH.
5	Use the Nessus tool to scan the network for vulnerabilities.
6	Implement a code to simulate buffer overflow attack.

7	Set up IPSEC under LINUX
8	Install IDS (e.g. SNORT) and study the logs.
9	Design and develop a data recording system that receives data from LAN and records it in a file .Use threading and buffering & Synchronization Mechanisms.
10	Use of iptables in linux to create firewalls.

Course Title	Big Data And Analytics				Course Type		Integrated	
Course Code	M20AI2022	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	4	5	5	39	26	50	50

COURSE OVERVIEW:

This course is to familiarize the students with most important information technologies used in manipulating, storing, and analyzing big data. The basic tools for statistical analysis, R and Python, and several machine learning algorithms are introduced. The emphasis of the course will be on mastering Spark 2.0 which emerged as the most important big data processing framework. Spark ML (Machine Learning) API and Spark Streaming which allows analysis of data in flight, i.e. in near real time. We will learn about so-called NoSQL storage solutions exemplified by Cassandra for their critical features: speed of reads and writes, and ability to scale to extreme volumes. We will learn about memory resident databases (VoltDB, SciDB) and graph databases (Ne4J). Students will gain the ability to initiate and design highly scalable systems that can accept, store, and analyze large volumes of unstructured data in batch mode and/or real time. Most lectures will be presented using Python examples. Some lectures will use Java and R.

Course Objectives:

1. Discuss the fundamentals of Hadoop distributed file system and Big Data Analytics.
2. Demonstrate Big Data Processing with MapReduce and Batch Analytics with Apache Spark.
3. Describe the implementation of Real-Time Analytics with Apache spark in real world Applications.
4. Illustrate the working of Stream Processing and also discuss the fundamentals of Cloud Computing

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Summarize the fundamentals of Hadoop distributed file system and Big Data Analytics.	1,2,5	1,2

CO2	Apply Big Data Processing with MapReduce and Batch Analytics with Apache Spark to simple real world problems..	1,2,	1,4
CO3	Implement Real-Time Analytics with Apache spark in real world Applications.	1,2,5	1,2
CO4	Develop data models for real world stream processingApplications.	2,4,5	1,2,6

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BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1									H			H	H	H
CO2	M			L	H				M			H	H	H
CO3		H										H	H	H
CO4		H		M					H			H	H	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Introduction to Hadoop: Hadoop distributed file system: High availability, Intra-Data Node balancer, EC, Port mapping; MapReduce: Task Level optimization; YARN: Opportunistic Containers, Timeline service v.2; Overview of Big data Analytics: Introduction to data analytics, Introduction to big data, distributed computing using Apache Hadoop, MapReduce framework.

UNIT-2

Big Data Processing with MapReduce: The MapReduce framework, MapReduce job types: Single mapper jobs, Single mapper reducer jobs, Multiple Mapper's reducer jobs; MapReduce patterns: Aggregation patterns, Filtering patterns, Join patterns.
Batch Analytics with Apache Spark: SparkSQL and Data Frames, Data Frames and the SQL API, Data Frame schema, Datasets and encoders, loading and saving data, Aggregations and Joins.

UNIT-3

Real-Time Analytics with Apache Spark: A short introduction to streaming: At-least-once processing, At-most-once processing, Exactly-once Processing; Spark Streaming: Streaming context, creating streaming context, Starting and Stopping Streaming Context; Discretized Streams, Stateful and stateless transformations, CheckPointing.
Batch Analytics with Apache Flink: Introduction to Apache Flink.

UNIT-4

Stream Processing with Apache Flink: Data processing using the DataStream API transformations, Aggregations, Window, Physical partitioning, Rescaling, Data sinks, Event time and watermarks.
Introduction to Cloud Computing: Cloud computing basics, Concepts and terminology, Goals and benefits, Risks and challenges, Roles and boundaries, Cloud characteristics, Cloud delivery models, Cloud deployment models.

SELF-LEARNING COMPONENTS:

Concept of AWS and its Services.

TEXT BOOKS:

1. Sridhar Alla, Big Data Analytics with Hadoop 3, published by Packt Publishing Ltd, May 2018
2. Seema Acharya, Subhashini Chellappan, Big Data and Analytics, published by wiley india pvt ltd, April 2015.

REFERENCE BOOKS:

1. Deka, Ganesh Chandra_ Mazumder, Sourav_ Singh Bhadoria, Robin - Distributed Computing in Big Data Analytics - Concepts, Technologies and Applications (Springer International Publishing AG 2017)
2. Arthur Zhang - Data Analytics_ Practical Guide to Leveraging the Power of Algorithms, Data Science, Data Mining, Statistics, Big Data, and Predictive Analysis to Improve Business, Work, and Life, CreateSpace Independent Publishing Platform, 2017.
3. ACM Transactions on Knowledge Discovery in Data (TKDD).
4. SIGKDD Explorations, a magazine of the SIGKDD, the data miners professional group.
5. Data Mining and Knowledge Discovery journal (now published by Springer).

JOURNALS/MAGAZINES:

1. IEEE Transactions on Big Data
2. Sprnger jounal of Big Data

3. Elsevier Jounal of Big Data Research
4. Springer Jounal on Big Data Analytics
5. Elsevier Jounal on Big Data Analytics & Applications

Practice:

Sl. No.	**List of Programs**	Course Outcome	Program Outcome
1	Installing Hadoop 3, Hive, Derby, R, Anaconda, Python, Apache Spark, Apache Flink, Tableu	1, 2	a, b, e, k, l
2	Download any data sets from UCI Machine Learning Repositories or Kaggle. Perform Exploratory data analytics that include: Study of data through pairplots, heatmaps, histograms, finding correlations amongst data, and so on	2, 3	a, b, e, k, l
3	Install R on a shared server and connect to Hadoop. Demonstrate execution of R programming constructs inside MapReduce using RMR2. Hence, develop any application using R and Hadoop Streaming by choosing data sets from Internet-bound big data repositories	1, 2, 3	a, b, e, k, l
4	Perform Machine Learning Clustering Task using SparkML in Python by choosing public datasets that are openly available for the task identified. Then, perform experiments and interpret the results obtained	3, 4	a, b, e, k, l
5	Use Map Reduce framework to perform big data analytics on distributed clusters. by choosing public datasets that are openly available for the task identified. Then, perform experiments and interpret the results obtained.	1, 3, 4	a, b, e, k, l
6	Use Spark framework to perform big data analytics on distributed clusters. by choosing public datasets that are openly available for the task identified. Then, perform experiments and interpret the results obtained.	1, 2, 3	a, b, e, k, l
7	Perform big stream data analytics on using spark framework using SparkML in Python by choosing public datasets that are openly available for the task identified. Then, perform experiments and interpret the results obtained.	3, 4	a, b, e, k, l

8	Perform big stream data analytics on using Flink framework using SparkML in Python by choosing public datasets that are openly available for the task identified. Then, perform experiments and interpret the results obtained.	1, 3, 4	a, b, e, k, l
9	Hadoop requires external memory for processing big data applications, whereas, it suffers from its poor processing time due to this limitation. Apache Spark is found to overcome the limitations of Hadoop by performing in-memory data processing. Develop a) Batch Analytics application using Apache Spark. b) Real time-Analytics application using Apache Spark. (Note: choose data sets from Internet-bound big data repositories)	2, 3, 4	a, b, e, k, l
10	Develop any Batch-Analytics application using Apache Flink.	3, 4	a, b, e, k, l

Course Title	Deep Learning and Reinforcement Learning				Course Type		Integrated	
Course Code	M20AI2023	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	**0**	-	-				
	Total	**4**	**5**	**5**	**39**	**26**	**50**	**50**

COURSE OVERVIEW:

This course is an introduction to deep learning, a branch of machine learning concerned with the development and application of modern neural networks. Deep learning algorithms extract layered high-level representations of data in a way that maximizes performance on a given task. Deep learning is behind many recent advances in AI, including Siri's speech recognition, Face book's tag suggestions and self-driving cars.

Course Objectives:

The objectives of this course are to:

1. Explain the basic concepts of Deep learning and Reinforcement learning.
2. Describe the convolutional Neural Network concepts.
3. Discuss the Monte-carlo concepts in Reinforcement Learning.
4. Demonstrate the use of SARSA and Q-learning n RL

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Outline the basic concepts of Reinforcement Learning and Deep learning.	1,2,5	1,2
CO2	Make use of Convolutional Neural Networks to build an simple Model.	1,2,	1,4
CO3	Apply Monte-Carlo method in real time applications.	1,2,5	1,2

CO4	Utilize SARSA and Q-learning in Reinforcement Learning.	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M	L	M	-	-	-	-	-	-	-	-	H	H	-
CO2	M		L	M	L	-	-	L	-	-	-	-	H	H	-
CO3	L	-	L	M	M	-	-	L	-	-	-	-	H	H	-
CO4	L	L	-	M	L	-	-		-	-	-	-	H	H	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO-PO and CO-PSO.

Course Contents:

UNIT-1

Basics of Deep Learning- Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.**FFN -** Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization, regularization, autoencoders.**DNN-** Difficulty of training deep neural networks, Greedy layerwise training.**BTNN-Better Training of Neural Networks:** Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).

UNIT-2

Recurrent Neural Networks: Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs,**Convolutional Neural Networks:** LeNet, AlexNet.**Generative models:** Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.**Recent trends:** Variational Autoencoders, Generative Adversarial Networks, Multi-task Deep Learning, Multi-view Deep Learning,**Applications:** Vision, NLP, Speech (just an overview of different applications in 2-3 lectures)

UNIT-3

The Reinforcement Learning problem: evaluative feedback, non-associative learning, Rewards and returns, Markov Decision Processes, Value functions, optimality and approximation. Dynamic programming: value iteration, policy iteration, asynchronous DP, generalized policy iteration. Monta-Carlo methods: policy evaluation, roll outs, on policy and off policy learning, importance sampling.

UNIT-4

Temporal Difference learning: TD prediction, Optimality of TD(0), SARSA, Q-learning, R-learning, Games and after states. Eligibility traces: n-step TD prediction, TD (lambda), forward and backward views, Q (lambda), SARSA (lambda), replacing traces and accumulating traces. Function Approximation: Value prediction, gradient descent methods, linear function approximation, ANN based function approximation, lazy learning, instability issues Policy Gradient methods: non-associative learning – REINFORCE algorithm, exact gradient methods, estimating gradients, approximate policy gradient algorithms, actor-critic methods

SELF-LEARNING COMPONENTS:

Policy based Reinforcement learning approaches, Actor-Citric Models and A3C.

TEXT BOOKS:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, “Deep Learning”, MIT Press, 2016.
2. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996
3. Pattern Recognition and Machine Learning, Christopher Bishop, 2007

REFERENCE BOOKS:

1. Richard S. Sutton and Andrew G. Barto,” Introduction to Reinforcement Learning”, 2nd Edition, MIT Press. 2017.
2. Dimitri Bertsikas and John G. Tsitsiklis. Athena Scientific,”Neuro Dynamic Programming”, 1996.
3. .Engr.S.M.Farrukh Akhtar, “Practical Reinforcement Learning”, Packt Publisher, 2017.

JOURNALS/MAGAZINES:

1. IEEE Transactions on Neural Networks and Learning System
2. IEEE Transactions on Pattern Analysis and Machine Intelligence
3. Springer Journal of Deep Learning.

4. Elsevier journal on Deep learning Based Intelligent Systems
5. ACM Jounral on Machine Learning Research

SWAYAM/NPTEL/MOOCS:

1. https://onlinecourses.nptel.ac.in/noc20_cs11/preview
2. https://onlinecourses.nptel.ac.in/noc19_cs53/preview
3. https://www.udemy.com/topic/reinforcement-learning/?utm_source=adwords&utm_medium=udemyads&utm_campaign=DSA_Catchall_la.EN_cc.INDIA&utm_content=deal4584&utm_term=_._ag_82569850245_._ad_486896172440_._kw_._de_c_._dm_._pl_._ti_dsa-483190909101_._li_9062047_._pd_._&matchtype=b&gclid=CjwKCAiAirb_BRBNEiwALHlnD3rKrXgmeJ7MQK1lCmhsNQbediia2xW1RB7fr18FIloDepdqhYDMrBoC39QQAvD_BwE
4. https://www.coursera.org/learn/deep-learning-reinforcement-learning

PRACTICE:

Sl.No.	List of experiments
1.	Environment Setup Make sure you have Homebrew installed: I would suggest starting a virtualenv for your development. It makes life so much easier when you have multiple projects with conflicting requirements; i.e. one works in Python 2.7 while the other is only compatible with Python 3.5+.(For every new installation below, please make sure you are in the virtualenv.) Install OpenAI gym according to the instruction. • Finally clone the "playground" code and install the requirements.
2.	Simple Reinforcement Learning with Tensorflow: Q-Learning with Tables Q-Learning with Neural Networks. Solution:https://medium.com/emergent-future/simple-reinforcement-learning-with-tensorflow-part-0-q-learning-with-tables-and-neural-networks-d195264329d0
3.	Consider the familiar child's game of tic-tac-toe. Two players take turns playing on a three-by-three board. One player plays Xs and the other Os until one player wins by placing three marks in a row, horizontally, vertically, or diagonally. If the board fills up with neither player getting three in a row, the game is a draw. Implement tic-tac-toe problem that would be approached with a method making use of a value function. Solution:https://towardsdatascience.com/reinforcement-learning-implement-tictactoe-189582bea542
4.	Q-learning (Watkins & Dayan, 1992) learns the action value ("Q-value") and update it according to the Bellman equation. The key point is while estimating what is the next action, it does not follow the current policy but rather adopt the best Q value (the part in red) independently. Implement the Naive Q-Learning algorithm using tensorflow and openAI Gym environment.

5.	Cartpole - also known as an Inverted Pendulum is a pendulum with a center of gravity above its pivot point. It's unstable, but can be controlled by moving the pivot point under the centre of mass. The goal is to keep the cartpole balanced by applying appropriate forces to a pivot point.Implement the same using a 2-layer densely connected neural network to learn Q values for the cart pole balancing problem. Solution:https://lilianweng.github.io/lil-log/2018/05/05/implementing-deep-reinforcement-learning-models.html#deep-q-network
6.	The game of Poker has many variants. One of the simplest settings is the head's up push-or-fold scenario, in no-limit Texas Hold'em Poker. In this scenario, there are only two players. The Small Blind (first player to act) has only two actions possible: folding, thus losing the current hand, or going all-in, risking all his chips. Once the small blind went all-in, the Big Blind (second player to act) has also two actions possible: folding, meaning he lost the hand or calling the small blind's all-in. Once the two players went all-in, the 5 community cards are dealt, and the best hand wins the pot.Implement a Q learning algorithm for no-limit head's up poker. Solution:https://github.com/scascar/PokerDeepLearning
7.	Monte-Carlo policy gradient, also known as REINFORCE, is a classic on-policy method that learns the policy model explicitly. It uses the return estimated from a full on-policy trajectory and updates the policy parameters with policy gradient.The returns are computed during rollouts and then fed into the Tensorflow graph as inputs. Write a Program to calculate rollout and return During the episode. Solution:https://lilianweng.github.io/lil-log/2018/05/05/implementing-deep-reinforcement-learning-models.html#monte-carlo-policy-gradient
8.	Suppose a wire frame forming a closed loop is dunked in soapy water to form a soap surface or bubble conforming at its edges to the wire frame. If the geometry of the wire frame is irregular but known, compute the shape of the surface using Monte Carlo methods. (https://web.stanford.edu/class/psych209/Readings/SuttonBartoIPRLBook2ndEd.pdf)
9.	The actor-critic algorithm learns two models at the same time, the actor for learning the best policy and the critic for estimating the state value.Implementation the same which is similar to REINFORCE with an extra critic network. Solution:https://lilianweng.github.io/lil-log/2018/05/05/implementing-deep-reinforcement-learning-models.html#monte-carlo-policy-gradient
10.	One traveling salesman is getting ready to go on a sales tour. Starting from hishometown, in this case A, he needs to get to his destination, in this case F.There are many cities between A and F, and many different routes to take.Some of them carry costs, but on some of them, there is a way for the salesmanto earn some money on his way.The aim is to choose the most affordable route from place A to place F. Implement the above concept in python.
11.	Random walks are famous stochastic processes that represent a path madefrom random steps on integers or other mathematical space. This can besomething like the prices of fluctuation stocks, the financial situation of agambler, the molecule's traveled path in gas or liquid form, etc. Implement the random walk example using python.
12.	Suppose you are the mouse andthe cat is in front of you. If you choose to move one step forward the cat, youwill end up being eaten by the cat. That will have an undesirable outcome, sonext time, you will choose a different move and choose to go away to the sideof the cat. This may not reduce the value of you moving forward when the catisn't in front of you. It's a simple example but it serves the purpose well. Thepoint of Q learning is to choose the actions which will maximize the rewardand lower the value of those that bring you unsatisfactory results. Implement the above concept in python using Q-Learning algorithm.

Course Title	Fuzzy Logic and Probabilistic Graphs				Course Type	Theory	
Course Code	M20AI2031	Credits	3		Class	II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	0	-	-			
	Total	**3**	**3**	**3**	**39**	**50**	**50**

COURSE OVERVIEW:

This course aims to deepen understanding of knowledge representation principles beyond the predicate logic formalism. The course covers the introduction to Classical Sets, Fuzzy Sets, Classical Relations and Fuzzy Relations, Properties of Membership Functions, Fuzzification and Defuzzification, Development of Membership Functions, Decision Making with Fuzzy Information, Classification by Equivalence Relations, Fuzzy Pattern Recognition and to understand the difference between Logic and Fuzzy systems.

Course Objectives:

The objectives of this course are to:

1. Discuss insights about the basics of Classical Sets, Fuzzy Sets, and Fuzzy Arithmetic.
2. Explain the Fuzzy Relation Equations and Fuzzy Relations.
3. Describe the Multivalued Logics and Uncertainty-Based Information.
4. Illustrate the use of Fuzzy logic in real world applications.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Make use of the fundamental concepts of Fuzzy sets, functions and classification.	1,2,5	1,2
CO2	Develop Fuzzy logic to solve real life problems.	1,2,	1,4

CO3	Build a Fuzzy logic model for the given problem domain.	1,2,5	1,2
CO4	Apply the different types of Fuzzy system and decision making with fuzzy in real world applications.	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M	H	M	L	M	M	L			M	M	H	H	-
CO2	L	H	H	M	L	M	M	L			M	M	H	H	-
CO3	M	H	H	M	L	H	H	L			M	M	H	H	-
CO4	L	H	M	M	M	M	M				M	M	H	H	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO-PO and CO-PSO.

COURSE CONTENTS:

UNIT-1

From Classical (Crisp) Sets To Fuzzy Sets: Introduction Crisp Sets: An Overview, Fuzzy Sets: Basic Types, Fuzzy Sets: Basic Concepts, Characteristics and Significance of the Paradigm Shift,

Fuzzy Sets versus Crisp Sets: Additional Properties of a-Cuts, Representations of Fuzzy Sets, Extension Principle for Fuzzy Sets.

Operations On Fuzzy Sets: Types of Operations, Fuzzy Complements, Fuzzy Intersections: t-Norms, Fuzzy Unions: i-Conorms, Combinations of Operations, Aggregation Operations.

FUZZY ARITHMETIC: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals, Arithmetic Operations on Fuzzy Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.

UNIT-2

Fuzzy Relation Equations: General Discussion, Problem Partitioning, Solution Method, Fuzzy Relation Equations, Based on Sup-i Compositions, Fuzzy Relation Equations Based on Inf-wi Compositions, Approximate Solutions, The Use of Neural Networks.

Fuzzy Relations: Crisp versus Fuzzy Relations, Projections and Cylindric Extensions, Binary Fuzzy Relations, Binary Relations on a Single Set, Fuzzy Equivalence Relations, Fuzzy Compatibility Relations, Fuzzy Ordering Relations, Fuzzy Morphisms, Sup-i Compositions of Fuzzy Relations, Inf- o Compositions of Fuzzy Relations.

UNIT-3

Multivalued Logics: Fuzzy Propositions, Fuzzy Quantifiers, Linguistic Hedges, Inference from Conditional Fuzzy Propositions, Inference from Conditional and Qualified Propositions.

Probabilistic Graphical Models: Fundamentals of Probability Theory - Views of Probability, Random Variables and Joint Distributions, Conditional Probability, Conditional Independence, Expectation and Variance, Probability Distributions - Conjugate Priors, Introduction to Exponential Family; Fundamentals of Graph Theory - Paths, Cliques, Subgraphs, Cycles and Loops.

UNIT-4

Graphical Models: Introduction - Directed Models (Bayesian Network), Undirected Models (Markov Random Fields), Dynamic Models (Hidden Markov Model & Kalman Filters) and Factor Graph; Conditional Independence (Bayes Ball Theorem and D-separation), Markov Blanket, Factorization (Hammersley-Clifford Theorem), Equivalence (I-Maps & Perfect Maps); Factor Graphs - Representation, Relation to Bayesian Network and Markov Random Field

SELF-LEARNING COMPONENTS:

Possibility Theory, Fuzzy Propositions, Fuzzy Quantifiers, Linguistic Hedges,

TEXT BOOKS:

1. "Fuzzy Sets and Fuzzy Logic: Theory and Applications", George K Klir and Bo Yuan, Prentice Hall, 1995.
2. "Fuzzy Logic with Engineering Applications", Timothy J. Ross, Wiley India, 3rd Edition, 2010.
3. Koller, D. and Friedman, N. (2009). Probabilistic Graphical Models: Principles and Techniques. MIT Press.

REFERENCE BOOKS:

1. "Neural Networks and Fuzzy Systems: A Dynamical System Approach", B Kosko, PHI, 1991.
2. Jensen, F. V. and Nielsen, T. D. (2002). Bayesian Networks and Decision Graphs. Information Science and Statistics. Springer, 2nd edition.
3. Kevin P. Murphy (2013) Machine Learning: A Probabilistic Perspective. 4th Printing. MIT Press.
4. Barber, D. (2011). Bayesian Reasoning and Machine Learning. Cambridge University Press, 1st edition.

5. Bishop, C. M. (2011). Pattern Recognition and Machine Learning (Information Science and Statistics). Springer, 2nd printing.
6. Wainwright, M. and Jordan, M. (2008). Graphical Models, Exponential Families, and Variational Inference. Foundations and Trends in Machine Learning, 1:1–305.

JOURNALS/MAGAZINES:

1. IEEE Tansactions on Fuzzy Systems
2. Elsevier Jounal on Fuzzy Sets and Systems
3. Springer International Journal on Fuzzy System

Course Title	Robotic Process Automation				Course Type	Theory	
Course Code	M20AI2032	Credits	3		Class	II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	0	-	-			
	Total	3	3	3	39	50	50

COURSE OVERVIEW:

Robotic Process Automation (RPA) offers many challenges for software developers and scientists. This course introduces the UiPath Robotic Process Automation concepts through UiPath Studio and UiPath Orchestrator where a student gains knowledge of how to build a bot to automate required tasks.

Course Objectives:

The objectives of this course are to:

1. Discuss the concepts of Robotics Process automation
2. Describe the sequence, flowchart and control flow in automation tool
3. Demonstrate the data manipulation techniques
4. Demonstrate the usage of UI Explorer and Screen scraping

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Make use of recording features in UiPath Studio to automate the repetitive tasks.	1,2,5	1,2
CO2	Apply appropriate Workflow Activities in UiPath Studio to automate the complex tasks using Flowchart and Sequence.	1,2,	1,4
CO3	Build data table and data manipulation techniques in UiPath Studio to automate CSV / Excel workbook applications	1,2,5	1,2

CO4	Design and Develop bot process using UI Explorer and Automate using Screen Scraping for applications in	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	H	M	M					M		H	H	H
CO2	H	H	H	H	H					M		H	H	H
CO3	H	H	H	H	H					M		H	H	
CO4	H	H	H	H	H					M		H	H	

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Content:

UNIT-1

What Is Robotic Process Automation: Scope and techniques of automation, Robotic process automation, About UiPath, Future of Automation? Record and Play: UiPath stack, Downloading and installing UiPath Studio, Learning UiPath Studio, Task recorder, Step-by-step examples using the recorder.

UNIT-2

Sequence. Flowchart and Control Flow: Sequencing the Workflow, Activities, Control Flow, various types of loops, and decision making, Step-by-step example using Sequence and Flowchart, Step-by-step example using Sequence and Control Flow

UNIT-3

Data Manipulation: Variables and Scope, Collections, Arguments-Purpose and use, Data table usage and examples, Clipboard management, File operation with step-by-step example, CSV/Excel to data table and vice versa with a step-by-step example.

UNIT-4

Taking Control of the Controls: Finding and attaching windows, Finding the control, Techniques for waiting for a control, Act on controls-mouse and keyboard activities, Working with UI Explorer, Handling events, Screen Scraping, When to use OCR, Types of OCR available, How to use OCR.

SELF-LEARNING COMPONENTS:

Handling User Events and Assistant Bots

TEXT BOOKS:

1. Learning Robotic Process Automation Alok mani Tripathi Kindle Edition, Published rch by Packt Publishing, 2018
2. E. Turban, R. Sharda, D. Delen, David King, Business Intelligence, 2nd ed. Pearson India, 2010.

REFERENCE BOOKS:

1. Marlon Dumas et. al., Fundamentals of Business Process Management, Springer, ebook, 2012.
2. Van der Aalst, Process Mining: Discovery, Conformance and Enhancement of Business Processes, Third edition, 2011.

JOURNALS/MAGAZINES:

1. IEEE Transactions on Automatic Control
2. Springer International Journal of Control Automation and Systems
3. Inderscience International Journal of Automation anc Control

SWAYAM/NPTEL/MOOCS:

1. https://www.classcentral.com/course/swayam-introduction-to-robotics-19912
2. https://onlinecourses.nptel.ac.in/noc19_me74/preview
3. https://nptel.ac.in/courses/112/103/112103174/
4. https://onlinecourses.nptel.ac.in/noc20_me03/preview
5. https://www.coursera.org/learn/robotic-process-automation

Course Title	Game Theory				Course Type	Theory	
Course Code	M20AI2033	Credits	3		Class	II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	0	-	-			
	Total	3	3	3	39	50	50

COURSE OVERVIEW:

Game theory is the systematic study of this strategic interaction. It helps us to develop an understanding of how people actually behave and how they should be advised to behave in strategic situations. The formal mathematical structure allows us to trace the logical implications of our assumptions. Game theory emphasizes the role of conflicting or shared goals, timing, private information and its manipulation in determining outcomes

Course Objectives:

The objectives of this course are to:

1. Objective of the course is to make student understand the concepts of game theory and its applications to various discipline engineering
2. Construct the structure of interactive decision problems
3. Predict and describe how a certain game is going to be played by the players involved (i.e., their equilibrium behaviour) or how different firms or institutions behave every time they face an strategic interaction
4. Model economics and business topics covered in other courses using the formal tools that game theory provides.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	To Understand the concepts of game theory and its mathematical Foundation.	1,2,5	1,2
CO2	To Identify fields of application of game theory in real life	1,2,	1,4

CO3	To Design and implement game theoretic algorithms for automation	1,2,5	1,2
CO4	To Apply game theoretic strategies in industrial engineering problems	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	H	M	M					M		H	H	H
CO2	H	H	H	H	H					M		H	H	H
CO3	H	H	H	H	H					M		H	H	
CO4	H	H	H	H	H					M		H	H	

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Content:

UNIT-1

Introduction: Definitions, Utilities, Rationality, intelligence, common knowledge, von Neumann - Morgenstern utilities.

UNIT-2

Non-Cooperative Game Theory:Extensive Form Game, Strategic Form Games With Illustrative Examples, Dominant Strategy Equilibria, Pure Strategy Nash Equilibrium With Illustrative Examples And Key Results, Mixed Strategy Nash Equilibrium With Illustrative Examples And Key Results Such As The Nash Theorem, Computation Of Nash Equilibria And Introduction To Algorithmic Theory, Matrix Games: Saddle Points, Minimax Theorem, extensive form games subgame perfect equilibrium,

games with incomplete information Bayesian Games, Bayesian Nash Equilibrium, Evolutionary Game Theory (Ess Strategies), Repeated Game

UNIt-3

Mechanism Design: The Mechanism Design Environment, Social Choice Functions with Illustrative Examples, Implementation Of Social Choice Functions and properties, Incentive Compatibility, Revelation Theorem, Gibbard-Satterthwaite Theorem, Arrow Impossibility Theorem, Vickrey-Clarke-Groves (VCG) Mechanisms, Bayesian Mechanisms (Dagva), Revenue Equivalence Theorem, Myerson Optimal Auction, Further Topics In Mechanism Design

UNIT-4

Cooperative Game Theory: Correlated Strategies and Correlated Equilibrium, The Nash Bargaining Problem, Coalitional Games (Transferable Utility Games), The Core, The Shapley Value, Other Solution Concepts: Kernel, Nucleolus

SELF-LEARNING COMPONENTS:

Game Theory, Transferable Utility Game

TEXT BOOKS:

1. Martin J. Osborne.An Introduction to Game Theory. Oxford University Press.Indian Edition, 2003.
2. Roger B. Myerson.Game Theory: Analysis of Conflict. Harvard University Press, 1991.
3. Y. Narhari, Dinesh Garg, Ramasuri Narayanam, Hastagiri Prakash. Game Theoretic Problems in Network Economics and Mechanism Design Solutions. Springer, London, 2009.

REFERENCE BOOKS:

1. Martin, Osborne , Ariel Rubstein , A course in Game Theory, The MIT PressCambridge, MassachusettsLondon, England, 1994
2. Ken Binmore, Game Theory : A Very Short Introduction, Oxford University Press, 2007

SWAYAM/NPTEL/MOOCS:

1 https://www.coursera.org/learn/game-theory inroduction?
2. Dr Yadati Narahari,CSA,IISc,Bangalore : http://lcm.csa.iisc.ernet.in/gametheory/useful_links.html
3. Coursera : https://www.coursera.org/learn/game-theory-13
4. http://www.gametheory.net
5. http://www.gametheorysociety.org
6. http://william-king.www.drexel.edu/top/eco/game/game.html
7. http://levine.sscnet.ucla.edu/
8. http://plato.acadiau.ca/courses/educ/reid/games/General_Games_Links.htm

JOURNALS/MAGAZINES:

1. IEEE Transactions on Games
2. Elsevier Journal of Games and Economic Behaviours
3. Spirnger International Journal of ame Theory
4. Stanford University Certification : https://online.stanford.edu/courses/soe-ycs0002-game-theory
5. Course Era Certification : https://www.coursera.org/learn/game-theory-1
6. NPTEL Online Certifications :https://nptel.ac.in/noc/courses/noc16/SEM1/noc16-mg01/
7. Udemy Certification : https://www.udemy.com/course/leadership-science-evidence-and-research-based-leadership/?LSNPUBID=vedj0cWlu2Y&ranEAID=vedj0cWlu2Y&ranMID=39197&ranSiteID=vedj0cWlu2Y-XjsEo9Dn8.5Ixs2wI4Gd.g&utm_medium=udemyads&utm_source=aff-campaign
8. Open Yale University Certification: https://oyc.yale.edu/economics/econ-159
9. MIT Open Courseware Certification: https://ocw.mit.edu/courses/economics/14-126-game-theory-spring-2016/index.htm

Course Title	Blockchain Technology				Course Type		Integrated	
Course Code	M20AI2041	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	**4**	**5**	**5**	**39**	**26**	**50**	**50**

COURSE OVERVIEW:

This course introduces the concept of digital crypto currencies using Blockchain, which is fundamentally a public digital ledger to share information in a trustworthy and secure way. The course also discuss the concept and applications of Blockchain that have now spread from crypto currencies to various other domains, including business process management, smart contracts, IoT and so on. This includes the fundamental design and architectural primitives of Blockchain, the system and the security aspects, along with various use cases from different application domains.

Course Objectives:

The objective of the course is to:

1. Explain the underlying technology of transactions, blocks, proof-of-work, and consensus building
2. Discuss Hyperledger to build applications on blockchain
3. Describe the architecture of bit coins and to give the working of the bit coin
4. Illustrate the design and implementation of new ways of using blockchain technology

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Describe the usage of block chain in terms of the underlying technology	1,2,5	1,2
CO2	Make use of Hyperledger to build applications on blockchain	1,2,	1,4
CO3	Explore working of the bit coin	1,2,5	1,2

CO4	Implement new ways of using blockchain for applications in various aspects	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	M										H	H	
CO2			H		M							H	H	H
CO3	H	M										H	H	H
CO4	H									M		H	H	

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Introduction to Blockchain: History: Digital Money to Distributed Ledgers; Design Primitives: Protocols, Security, Consensus, Permissions, Privacy; Blockchain Architecture and Design: Basic crypto primitives: Hash, Signature; Hashchain to Blockchain; Basic consensus mechanisms; Consensus: Requirements for the consensus protocols, Proof of Work (PoW), Scalability aspects of Blockchain Consensus, consensus protocols.

UNIT-2

Permissioned Blockchains: Design goals, Consensus protocols for Permissioned Blockchains Hyperledger Fabric I: Decomposing the consensus process, Hyperledger fabric components, Chaincode Design and Implementation; Hyperledger Fabric II: Beyond Chaincode: Fabric SDK and Front End Hyperledger composer tool.

UNIT-3

Use case I: Blockchain in Financial Software and Systems (FSS): Settlements, KYC, Capital markets, Insurance; Use case II: Blockchain in trade supply chain: Provenance of goods, visibility, trade supply chain finance, invoice management discounting, etc Use case III: Blockchain for Government: Digital identity, land records and other kinds of record keeping between government entities, public distribution system, social welfare systems.

UNIT-4

Blockchain Cryptography, Privacy and Security on Blockchain; Research aspects I: Scalability of Blockchain consensus protocols, Case Study of various recent works on scalability; Research aspects II: Secure cryptographic protocols on Blockchain; Case Study of Secured Multi-party Computation, Blockchain for science: making better use of the data-mining network; Case Studies: Comparing Ecosystems - Bitcoin, Hyperledger, Ethereum and more.

SELF LEARNING COMPONENTS:

Explore the architecture and design of Ethereum

TEXT BOOKS:

1. Bitcoin and Cryptocurrency Technologies by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, Princeton University Press,2016
2. Mastering Bitcoin by Andreas Antonopoulos
3. https://github.com/bitcoinbook/bitcoinbook

REFERENCE BOOKS:

1. Hyperledger Fabric - https://www.hyperledger.org/projects/fabric
2. Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits
3. https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html
4. http://cs251crypto.stanford.edu/18au-cs251/syllabus.html

JOURNALS/MAGAZINES:

1. Elsevier Jounal on Block Chain : Research and Applications

SWAYAM/NPTEL/MOOCS:

1. https://onlinecourses.nptel.ac.in/noc20_cs01/preview
2. https://onlinecourses.nptel.ac.in/noc19_cs63/preview
3. https://nptel.ac.in/courses/106/105/106105184/
4. https://www.classcentral.com/course/swayam-introduction-to-blockchain-technology-and-applications-17656
5. https://www.my-mooc.com/en/categorie/blockchain-and-cryptocurrency
6. https://www.coursera.org/specializations/blockchain

7. https://www.coursera.org/courses?query=blockchain

PRACTICE:

Sl.No.	List of experiments
1	Develop your first program that prints “Hello Blockchain” using the remix sandbox for Etherium.
2.	Configure your machine and development environment to run hyper ledger fabric programs and test the set up by writing a program that computes squares of input numbers.
3.	Write a program that enables a user to send a signed message to other user on blockchain.
4.	Write a program that retrieves transaction details associated with a specific block on the chain.
5.	Write a program to demonstrate how to deploy a blockchain smart contract.
6.	Simulate a simple blockchain in python – demonstrating mining, transaction, communication between nodes.
7.	Write a program to simulate simplified steps in decentralized election process.
8.	Write a program to simulate creation your own crypto currency and demonstrate its usage in a transaction.
9.	Write a program to simulate agricultural supply chain from farmer to end customer.
10.	Write a program to create a very basic e-commerce platform for trading.
11.	Write a program to demonstrate creation of an asset like a car and demonstrate transfer of the asset to another user.
12.	Develop a DApp that generates your resume.

Course Title	Natural Language Processing				Course Type		Integrated	
Course Code	M20AI2042	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	**0**	-	-				
	Total	**4**	**5**	**5**	**39**	**26**	**50**	**50**

COURSE OVERVIEW:

The intent of the course is to give introduction to Natural Language Processing (NLP, a.k.a. computational linguistics), the study of computing systems that can process, understand, or communicate in human language. The primary focus of the course will be on understanding various NLP tasks as listed in the course syllabus, algorithms for effectively solving these problems, and methods for evaluating their performance. There will be a focus on statistical algorithms to acquire the knowledge needed to perform language processing.

Course Objectives:

The objectives of this course are to:

1. Explain the fundamentals of natural language processing and python
2. Discuss how to access the text corpora and Lexical Resources
3. Demonstrate the writing the structured programs to process the raw text
4. Describe role of Classifiers in Text processing.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Summarize the fundamentals of natural language processing and python	1,2,5	1,2
CO2	Learn how to access the text corpora and Lexical Resources	1,2,	1,4

CO3	Acquiring the skills for writing the structured programs to process the raw text	1,2,5	1,2
C04	Analyze the role of different classifiers in Text processing	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1			L					H				H	H	H
CO2					M						L	H	H	H
CO3			H		H			M				H	H	H
CO4								M			L	H	H	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

INTRODUCTION: Language Processing and python, Accessing Text corpora and Lexical Analysis: Computing with language: Texts and words,a closer look at python: texts as list of words, computing with language: simple statistics, Automatic natural language understanding; Accessing Text Corpora, Conditional Frequency Distributions, Lexical Resources, WordNet, Introduction to NLTK Tool.

UNIT-2

Processing Raw Text:Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode,Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation, Formatting: From Lists to Strings,

UNIT-3

Categorizing and Tagging words: Using a Tagger, Using a Tagger, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation-Based Tagging, How to Determine the Category of a Word.

UNIT-4

Classifying Text: Supervised Classification: Examples, Evaluation; Decision Trees, Naive Bayes Classifiers, Maximum Entropy Classifiers, Modelling Linguistic Patterns.

SELF- LEARNING COMPONENTS:

Extracting information from Text, Exploring the 20 Newsgroups with Text Analysis Algorithms, Stock Price prediction with Regression Algorithms, Best Practices: i) Data preparation stage ii)Training sets generation stage iii) Model training, evaluation and selection stage.

TEXT BOOKS:

1. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, OReilly Media, 2009.
2. Yuxi (Hayden) Liu, - Python Machine Learning by Example, First edition, Packt publisher, 2017.

REFERENCES:

1. James Allen, Natural Language Understanding, Benjamin-Cummings Publishing Co., Inc. Redwood City, CA, USA, 1995.
2. Christopher D. Manning and Hinrich Schutze, Foundations of Statistical Natural Language Processing, The MIT Press, 1999.
3. Randolf Quirk, Sidney Greenbaum, Geoffrey Leech, Jan Svartvik, A Comprehensive Grammar of English Language, Cambridge University Press, 1987.

JOURNALS/MAGAZINES:

1. IEEE Transactions on Audio, Speech, and Language Processing
2. Elsevier Journal on Computer Speech and Language
3. Springer Jounal on Natural Language and Linguistic Theory
4. ACM Transactions on Language Processing
5. Elsevier Journal of cognitive systems research

SWAYAM/NPTEL/MOOCS:

1. https://onlinecourses.nptel.ac.in/noc19_cs56/preview
2. https://www.classcentral.com/course/swayam-applied-natural-language-processing-13899
3. https://onlinecourses.nptel.ac.in/noc19_cs57/preview
4. https://nptel.ac.in/courses/106/105/106105158/

Practice:

Sl. No.	List of Programs
1	Write a python program to extract tokens from the input sentence of English language using python NLTK toolkit.
2	Develop a python program to create social network structure of LinkedIn profile using python NLTK toolkit.
3	Develop a program to analyze the review comments of a movie trailer to provide rating using Python NLTK Toolkit
4	Develop a program to cluster similar text documents using Python NLP Toolkit.
5	Develop a NLP program to convert simple sentences from one language to another.
6	Analyse twitter sentimental data set to predict the sentiments.
7	Develop program to recognize speech for authentication.
8	Perform document summarization using NLP toolkit.
9	Develop an IVR system for REVA University.
10	Develop a program to classify mails to spam.

Course Title	Virtual and Augmented Reality				Course Type		Integrated	
Course Code	M20AI2043	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	4	5	5	39	26	50	50

COURSE OVERVIEW:

This Course provides the knowledge on Virtual reality concepts, multiple modal interaction, visual-auditory-haptic, interaction inmersion and imagination, visual computation and environmental modeling; geometric behavior and physically based simulation; management of large scale environment, VR development tools, augmented reality, mixed reality, digital entertainment.

Course Objectives:

1. Explain the principles and multidisciplinary features of virtual reality.
2. Illustrate the technology for multimodal user interaction and perception in VR, in particular the visual, audial and haptic interface and behavior.
3. Describe the objects using technology for managing large scale VR environment in real time.
4. Demonstrate the design of the solutions using VR system framework and development tools.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Summarize the fundamentals of Augmented Reality and Virtual Reality.	1,2,5	1,2
CO2	Apply multimodal user interaction and perception techniques involved in Virtual Reality.	1,2,	1,4

CO3	Design different objects using Simulation and Interactive techniques for real world applications.	1,2,5	1,2
CO4	Develop innovative Virtual Reality solutions for industrial and Social relevant applications..	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	L	L	L	H	M	H	H	L	L	H	H	H
CO2	H	H	M	L	H	H	M	H	H	L	M	H	H	H
CO3	H	H	H	H	H	H	H	L	H	M	H	H	H	H
CO4	H	H	H	H	H	H	H	L	H	M	H	H	H	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Introduction to Virtual Reality (VR): Fundamental Concept and Components of VR, Primary Features and Present Development on VR.

Multiple Modals of Input and Output Interface in VR: Input – Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus and 3D Scanner. Output – Visual, Auditory, Haptic Devices.

UNIT-2

Visual Computation in VR: Fundamentals of Computer Graphics; Real time rendering technology; Principles of Stereoscopic Display; Software and Hardware Technology on Stereoscopic Display.

Environment Modeling in VR: Geometric Modeling, Behavior Simulation, Physically Based Simulation

UNIT- 3

Haptic & Force Interaction in Virtual Reality: Concept of haptic interaction; Principles of touch feedback and force feedback; typical structure and principles of touch/force feedback facilities in applications. Interactive Techniques in VR: Body Track, Hand Gesture, 3D Manus, Object Grasp.

Development Tools and Frameworks in VR: Frameworks of Software Development Tools in VR, X3D Standard, Vega, MultiGen, Virtools and Unity.

UNIT- 4

Augmented Reality: System Structure of Augmented Reality; Key Technology in AR; General solution for calculating geometric & illumination consistency in the augmented environment.

Application of VR in Digital Entertainment: VR Technology in Film and TV Production, VR Technology in Physical Exercises and Games, Demonstration of Digital Entertainment by VR.

SELF LEARNING COMPONENTS:

Unity 3D, Manus VR

TEXT BOOKS:

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEEPress, 2003/2006.

REFERENCE BOOKS:

2. Sherman, William R. and Alan B. Craig, Understanding Virtual Reality – Interface, Application, and Design, Morgan Kaufmann, 2002.
3. Fei GAO, Design and Development of Virtual Reality Application System, TsinghuaPress, March 2012.
4. Guangran LIU, Virtual Reality Technology, Tsinghua Press, Jan. 2011.

JOURNALS/MAGZINES:

1. Springer journal on Virtual Reality
2. International Journal of Virtual and Augmented Reality (IJVAR).

Practice:

Sl. No.	List of Programs

1	Setting up the GVR Viewer Main Prefab.
2	Adding texture in software
3	Adding text in game ARONE APP Introduction
4	Generating a License Key
5	Capturing an Image to use as Image Target
6	Uploading Image Targets inside Vuforia
7	Projecting Barbarian 3D Model on Image Target
8	Building the apk file for ARONE App
9	Adding shadow to Barbarian Model

Course Title	Knowledge Representation and Reasoning				Course Type		Integrated	
Course Code	M20AI2051	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	4	5	5	39	26	50	50

COURSE OVERVIEW:

This course is an introduction to Knowledge Representation and Reasoning. Explore First order logistics to represent knowledge, Identify reasoning problems and construct suitable representations and also study the algorithms for solving the relevant reasoning problems.

Course Objectives:

The objectives of this course are to:

1. Explain the key concepts of knowledge representation, Reasoning
2. Discuss the representation of knowledge of a domain formally.
3. Demonstrate the use of Knowledge based systems in real world applications.
4. Illustrate the limitations and complexity of reasoning algorithms.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Make use of the representation and reasoning of knowledge of a domain real world applications.	1,2,5	1,2
CO2	Develop real world applications using the first order Logic	1,2,	1,4
CO3	Apply the procedural control of reasoning for dynamic databases.	1,2,5	1,2
CO4	Design a simple Knowledge based Systems.	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M	L	M	-	-	-	-	-	-	-	-	H	H	-
CO2	M		L	M	L	-	-	L	-	-	-	-	H	H	-
CO3	L	-	L	M	M	-	-	L	-	-	-	-	H	H	-
CO4	L	L	-	M	L	-	-		-	-	-	-	H	H	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO-PO and CO-PSO.

Course Contents:

UNIT-1

Introduction: The Key Concepts: Knowledge, Representation, and Reasoning, Why Knowledge Representation and Reasoning? Knowledge-Based Systems, Why Knowledge Representation? Why Reasoning? , The Role of Logic.

The Language of First-Order Logic: Introduction, the Syntax, the -Semantics, Interpretation, Denotation. Satisfaction and Models, the Pragmatics, Logical Consequence, Why We Care, Explicit and Implicit Belief, an Example, Knowledge-Based Systems: Expressing Knowledge, Knowledge Engineering, Vocabulary, Basic Facts, Complex Facts, Terminological Facts, Entailments, Abstract Individuals, Other Sorts of Facts

UNIT-2

Resolution: The Propositional Case, Resolution Derivations, An Entailment Procedure , Handling Variables and Quantifiers , First-Order Resolution , Answer Extraction , Skolemization, Equality, Dealing with Computational Intractability , The First-Order Case , The Herbrand Theorem The Propositional Case ,The Implications ,SAT Solvers , Most General Unifiers , Other Refinements.

UNIT-3

Reasoning with Horn Clauses: Horn Clauses, Resolution Derivations with Horn Clauses, SLD Resolution, Goal Trees , Computing SLD Derivations , Backward Chaining , Forward Chaining , The First-Order Case,

Procedural Control of Reasoning : Facts and Rules Rule Formation and Search Strategy, Algorithm Design , Specifying Goal Order , Committing to Proof Methods , Controlling Backtracking, Negation as Failure , Dynamic Databases, The PLANNER Approach,

Rules in Production Systems, Production Systems: Basic Operation, Working Memory ,Production Rules , A First Example, A Second Example, Conflict Resolution, Making Production Systems More Efficient, Applications and Advantages, Some Significant Production Rule Systems .

UNIT-4

Structured Descriptions: Descriptions, Noun Phrases, Concepts, Roles, and Constants, A Description Language, Meaning and Entailment, Interpretations, Truth in an Interpretation, Entailment, Computing Entailments, Simplifying the Knowledge Base, Normalization, Structure Matching, The Correctness of the Subasumption Computation, Computing Satisfaction, Taxonomies and Classification, A Taxonomy of Atomic Concepts and Constants, Computing Classification, Answering the Questions, Taxonomies versus Frame Hierarchies, Inheritance and Propagation, Beyond the Basics, Extensions to the Language, Applications of Description Logics.

Inheritance Networks, Strict Inheritance, Defeasible Inheritance, Strategies for Defeasible Inheritance, The Shortest Path Heuristics, Problems with Shortest Path, Inferential Distance, A Formal Account of Inheritance Networks, Extensions, Some Subtleties of Inheritance Reasoning.

SELF LEARNING COMPONENTS:

Conditional probability, Conjuction, Disjunction.

TEXT BOOKS:

1. Knowledge Representation and Reasoning, Ronald J.Brachman, Hector J. Levesque, MorganKaufmann, 2004.
2. Language, Proof and Logic, Jon Barwise & John Etchemendy, CSLI Publications (1999).

REFERENCE BOOKS:

1. The Description Logic Handbook: Theory, implementation, and applications, Franz Baader, Deborah L. McGuinness, Daniele Nardi and Peter F. Patel-Schneider, Cambridge University Press (2010);
1. Computer science as empirical inquiry: symbols and search, Allen Newell & Herbert A Simon, Communications of the ACM 19 (1976).
2. A logic for default reasoning, R Reiter, Artificial Intelligence 13 (1980).
3. Knowledge Representation: Logical, Philosophical, and Computational Foundations, Brooks/Cole, Thomson Learning, 2000.

JOURNALS/MAGAZINES:

1. Elsevier Journal on Knowledge Based Systems

SWAYAM/NPTEL/MOOCS:

1. https://nptel.ac.in/courses/106/106/106106140/
2. https://onlinecourses.nptel.ac.in/noc21_cs26/preview
3. https://onlinecourses.nptel.ac.in/noc20_me88/preview
4. https://www.classcentral.com/course/swayam-ai-knowledge-representation-and-reasoning-7958
5. https://www.springer.com/gp/book/9783642020964

PRACTICE:

For logic programming with Python, install packages.

- **Kanren:** It lets us express logic as rules and facts and simplifies making code for business logic.
- **SymPy:** This is a Python library for symbolic mathematics. It is nearly a full-featured Computer Algebra System.

1. Consider the Fibonacci integer series, where in each Fibonacci number is the sum of the previous two numbers in the series. Write the predicates and implement the same using python programming (pgno: 102-103, Knowledge Representation and Reasoning, Ronald J.Brachman).

2. Implement in python to find the prime number from a list of numbers and also to generate the first 10 prime numbers.

3. Implement in python to find the matching mathematical Expressions.

4. Implement the Tower of Hanoi problem in Python. **Tower of Hanoi** is a mathematical puzzle where we have three rods and n disks. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules: Only one disk can be moved at a time.

5. Given a set of characters and a positive integer k, print all possible strings of length k that can be formed from the given set using python code.

6. **Power Set** Power set P(S) of a set S is the set of all subsets of S. For example S = {a, b, c} then P(s) = {{}, {a}, {b}, {c}, {a,b}, {a, c}, {b, c}, {a, b, c}}.If S has n elements in it then P(s) will have 2^n elements. Implement using python.

7. Solve the Travelling Salesman Problem using Python. The salesman travels in cities and return to the starting city with minimal cost. He is not allowed to cross a city more than once. In this problem, assume that all the cities are interconnected. The cost indicates the distance between the two cities.

8. The eight Queen's puzzle, or the eight Queen's problem specifies how to place eight queens on a chessboard without attacking each other. Write the code in Python.

9. The **zebra puzzle** is a well-known logic puzzle. The puzzle is often called **Einstein's Puzzle** or **Einstein's Riddle** because it is said to have been invented by Albert Einstein as a boy.

    a. There are five houses.

    b. The English man lives in the red house.

    c. The Swede has a dog.

    d. The Dane drinks tea.

    e. The green house is immediately to the left of the white house.

    f. They drink coffee in the green house.

    g. The man who smokes Pall Mall has birds.

    h. In the yellow house they smoke Dunhill.

    i. In the middle house they drink milk.

    j. The Norwegian lives in the first house.

    k. The man who smokes Blend lives in the house next to the house with cats.

    l. In a house next to the house where they have a horse, they smoke Dunhill.

    m. The man who smokes Blue Master drinks beer.

    n. The German smokes Prince.

    o. The Norwegian lives next to the blue house.

    p. They drink water in a house next to the house where they smoke Blend.

    q. The query to be solved is "**who owns zebra**" with the help of Python

10. **Sudoku** is one of the most popular **puzzle** games of all time. The goal of **Sudoku** is to fill a 9×9 grid with numbers so that each row, column and 3×3 section contain all of the digits between 1 and 9. As a logic **puzzle**, **Sudoku** is also an excellent brain game .Implement using python.

Course Title	Internet of Things				Course Type		Integrated	
Course Code	M20AI2052	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	**4**	**5**	**5**	**39**	**26**	**50**	**50**

COURSE OVERVIEW:

This course introduces the Concept of connecting processing devices together through a network using which things can communicate with each other using internet as means of communication between them. All the things should be IP protocol enabled in order to have this concept possible. Not one but multiple technologies are involved to make IoT a great success.

Course Objectives:

The objectives of this course are to:

1. Explain the basics of embedded systems and embedded system design.
2. Describe Internet-of-Things and design principles.
3. Demonstrate the use of prototyping in development of real world application.
4. Illustrate the use of internet principles and techniques for writing embedded code.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Summarize the foundation in the Internet of Things, including the components, tools, and analysis.	1,2,5	1,2
CO2	Apply Internet-of-Things and design principles in development of real-world applications.	1,2,	1,4

CO3	Design prototypes forimplementing IoT in Big Data and understand the utilization and modelling of extracted data development of real-world application.	1,2,5	1,2
CO4	Develop embedded IoT Solutions using sensors and components integration for the real time application	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	M	H	H							**H**		**H**
CO2	M	L	H	H	M							**H**	**H**	**H**
CO3	H	M	M	H	H							**H**	**H**	
CO4	H	M	M	H	H							**H**		**H**

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

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

UNIT-2

IoT and M2M: Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software Defined Networking, Network Function Virtualization, IoT

Platform Design Methodology, Introduction, IoT Design Methodology, Step1: Purpose and requirement specification, Step2: Process Specification, Step 3: Domain Model Specification, Step 4: Information Model Specification, Step 5: Service Specification, Step 6: IoT Level Specification, Step 7: Function View Specification, Step 8: Operational View Specification, Step 9: Device and Component Integration, Step 10: Application Development, IoT System

UNIT-3

Logical Design Using Python, Introduction, Installing Python, Python Data Types and Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date Time applications, Classes, Python Packages of Interest for IoT.
IoT Physical Devices and End Points: What is and IoT Device, Exemplary Device Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry pi interfaces, programming raspberry pi with python, other IoT devices.

UNIT-4

Case Study & advanced IoT Applications: IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipments. Use of Big Data and Visualization in IoT, Industry 4.0 concepts. Sensors and sensor Node and interfacing using any Embedded target boards.

SELF LEARNING COMPONENTS:

Various sensors available in market – application of various sensor – Their specifications – code used to connect these sensors into Microcontroller board – Various microcontroller boards available in market – Arduino IDE download – usage of this IDE to carryout projects.

TEXT BOOKS:

1. Arshdeep Bahga, Vijay audisetti,Internet of Things, A Hands on Approach, University Press, 2014.
2. The Internet of Things, by Michael Millen, Pearson, 2015.

REFERENCE BOOKS:

1. Adrian McEwen & Hakim Cassimally, Designing the Internet of Things, ISBN 978-81-265-5686-1 Wiley Publication, 2013
2. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013

JOURNALS/MAGAZINES:

1. IEEE Internet of Things Journal
2. Elsevier Interent of Thins Journal
3. Springer Journal on Internet of Things and Bigdata
4. IEEE Transactions on Wireless Communications
5. IEEE Sensors Journal
6. IEEE Internet of Things Journal

7. ACM Transactions on Internet Technology (TOIT)

Practice:

SL.NO	List of Programs
1	Design and construct a module to drive DC motor clockwise and anti-clockwise using L293D with Arduino board.
2	Design and construct a module to build a RFID based Access Control System or an RFID based Door Lock using Arduino and display lock status on LCD.
3	Design a module to control an LED from Webserver using NodeMcu or Esp8266 programming with Arduino IDE.
4	Design a module for non-contact object detection using Arduino and proximity sensor (Car proximity alert).
5	Design an intelligent Garden Computer with Arduino and soil moisture sensor that lights an LED to alert the user when it is time to water a potted plant.
	PART-B (IoT Projects)
6	Set up ArduinoYún to connect to WiFi
7	Build a smart temperature controller for your room
8	Build your own decision system based-IoT
9	Build a tracking vision system for moving objects
10	Build your own car robot based on GPS

Course Title	Cloud Computing Technologies				Course Type		Integrated	
Course Code	M20AI2053	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	4	5	5	39	26	50	50

COURSE OVERVIEW:

This course introduces the cloud computing is the delivery of computing services—including servers, storage, databases, networking, software, analytics, and intelligence—over the Internet ("the cloud") to offer faster innovation, flexible resources, and economies of scale.

Course Objectives:

The objective of this course is to:

1. Explain the use of knowledge in different layers of cloud computing, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS);
2. Describe different Cloud service delivery models.
3. Illustrate the use of various cloud computing technologies.
4. Discuss significance of Artificial Intelligence in Cloud

Course Outcomes:

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

CO#	Course Outcomes		POs	PSOs
CO1	Distinguish between Infrastructure, Platform and Software as a Service (IaaS, PaaS, SaaS) abstractions.		1,2,5	1,2
CO2	Analyze it for different scenarios. Analyze the advantages and disadvantages of Public and Private Clouds and apply it for different scenarios.		1,2,	1,4

CO3	Develop and deploy cloud application using popular cloud platforms		1,2,5	1,2
CO4	Outline the fusion of AI in Cloud models		2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H							H				H	H	H
CO2			M	M								H	H	
CO3			H			H			L		L	H	H	H
CO4			H	H								H	H	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Introduction to Cloud Computing: Origins and Influences; Basic Concepts and Terminology; Goalsand Benefits; Risks and Challenges.

Fundamental Concepts and Models: Roles and Boundaries; Cloud Characteristics; Cloud DeliveryModels; Cloud Deployment Models.

UNIT-2

Cloud Enabling Technologies: Broadband Networks and Internet Architecture; Data CenterTechnology; Virtualization Technology; Web Technology; Multitenant Technology; Service Technology.

Cloud Infrastructure Mechanisms: Logical Network Perimeter; Virtual Server; Cloud StorageDevice; Cloud Usage Monitor; Resource Replication; Ready-made environment

UNIT-3

Specialized Cloud Mechanisms: Automated Scaling Listener; Load Balancer; SLA Monitor;Pay-per-use Monitor; Audit Monitor; Failover System; Hypervisor; Resource cluster; Multi-device Broker; State Management Database

Cloud Management Mechanisms: Remote Administration System; Resource Management System; SLA Management System; Billing Management System.

UNIT-4

AI and Cloud Computing: Need of AI in Cloud Computing, AI Infrastructure for Cloud computing, AI Services for Cloud Computing.Research opportunities for AI in Cloud: Artificial intelligence in Cloud-based accounting information systems, Detection of distributed denial of service (DDoS) attacks using artificial intelligence on Cloud, VM scheduling strategies based on artificial intelligence in Cloud Testing,

TEXT BOOKS:

1. Thomas Erl, Ricardo Puttini, Zaigham Mahmood, “Cloud Computing: Concepts, Technology & Architecture”, PHI, 2013.
2. Kai Hwang, Geoffrey C. Fox, Jack J Dongarra, Distributed and Cloud Computing,MK, 2012.
3. DharanipragadaJanakiram, Grid and Cloud Computing, McGraw-Hill 2016.
4. Y. Zheng, L. Cai, S. Huang and Z. Wang, "VM scheduling strategies based on artificial intelligence in Cloud Testing," 15th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD*)*, Las Vegas, NV, 2014, pp. 1-7, doi: 10.1109/SNPD.2014.6888746.
5. S. Alzahrani and L. Hong, "Detection of Distributed Denial of Service (DDoS) Attacks Using Artificial Intelligence on Cloud," *2018 IEEE World Congress on Services (SERVICES)*, San Francisco, CA, 2018, pp. 35-36, doi: 10.1109/SERVICES.2018.00031.

REFERENCE BOOKS:

1. Dan C. Marinescu, Cloud Computing: Theory and Practice, MK
2. Michael Miller, Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, August 2008.
3. RajkumarBuyya, JamesBroberg, AndrzejGoscinski, Cloud Computing- Principles and Pradigms,Wiley.
4. Anthony T.Velte, Toby J.Velte, Robert Elsenpeter, Cloud Computing, A practical approach, TATA McGRAW HILL.
5. Gautam Shroff, Enterprise Cloud Computing- Technology, Architecture, Applications, CAMBRIDGE.

6. David Marshall, Wade A. Reynolds and Dave McCrory, Advanced Server Virtualization-VMware and Microsoft Platforms in the Virtual Data Center, AUERBACH Publications.

JOURNALS /MAGAZINES:

1. IEEE Transactions on Cloud Computing
2. Spinger joural on Cloud Computing
3. ACM jounal of Cloud Computing: Advnaces, Systems and Applications

SWAYAM/NPTEL/MOOCS:

1. https://onlinecourses.nptel.ac.in/noc19_cs64/preview
2. https://nptel.ac.in/courses/106/105/106105167/
3. https://www.classcentral.com/course/swayam-cloud-computing-10027
4. https://www.coursera.org/browse/information-technology/cloud-computing

Practice:

SL.NO	LISTOF PROGRAM
1	Programs on #pragrma using C.
2	Programs using Sections, omp for and omp single
3	Programs using thread private directives.
4	Programs on scheduling.
5	Programs using last private reduction, copying and shared.
6	Programs for Point to Point MPI calls
7	Login to the workshop cluster using user workshop username and OTP token. Copy the exercise files to user home directory. Familiarize user with LC's OpenMP environment. Write a simple "Hello World" OpenMP program. Successfully compile your program. Successfully run your program.Modify the number of threads used to run your program.
8	Login to the LC workshop cluster, if you are not already logged in. Sharing DO/for construct examples: review, compile and run. Work-Sharing SECTIONS construct example: review, compile and run.
9	Login to the workshop cluster. Orphaned directive example: review, compile, run. Get OpenMP implementation environment information .Hybrid OpenMP + MPI programs. Check out the "bug" program

Course Title	Predictive Analytics Using R Lab				Course Type		Practical	
Course Code	M20AI2060	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	2	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	**2**	**2**	**4**	**0**	**26**	**50**	**50**

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Explain the fundamentals of R Programming Language.	1,2,5	1,2
CO2	Apply and compare basic machine learning techniques using R for data analytics.	1,2,	1,4
CO3	Design and Implement algorithms to learn Regression techniques for data analysis.	1,2,5	1,2
CO4	Perform analytics and build models for real world ARTIFICAL INTELLIGENCE problems.	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			

CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1									H	M		H	H	H
CO2		H	M		L					H	H	H	H	H
CO3		M	H							M	M	H	H	H
CO4		M	H								M	H	H	

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

Sl. No.	Program
1	Write a program in R to demonstrate the use of Data frame Objects
2	Write a program in R which performs addition, subtraction, multiplication and division of two vectors. Create a Comma Separated Values file consisting of the following details: Employee ID, Employee Name, Employee Phone Number, Address, Salary Display the input as Data Frames and also print the maximum salary within the input CSV.
3	Given a scenario, identify the best regression to be applied and implement using R, and validate using proper test.
4	Implement Linear regression using R on suitable datasets.
5	Implement logistic regression using R on suitable datasets.
6	Apply Expectation Maximization algorithm to implement clustering.
7	Implement K means clustering using R on suitable datasets
8	Clustering could be hierarchical. Implement a hierarchical clustering technique on a suitable dataset taken from UCI repository.
9	Consider social media feeds and do a case study on sentiment analysis of social media feeds. Implement using Python
10	Do a Case study on targeted e-mail campaigns for vidhana sabha Elections of India

Course Title	Mini Project				Course Type	Practice	
Course Code	M20AI2050	Credits	2		Class	II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	0	0	0			
	Practice	2	2	2	Practical	CIE	SEE
	-	0	-	-			
	Total	2	2	2	26	50	50

COURSE OVERVIEW:

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 week.

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	M	M	M							H	H	H
CO2	M	H	H	H	H							H	H	H
CO3	M	H	H	H	H							H	H	H
CO4	L	L	M	L	M							H	H	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

Sample Mini Projects: (if any)

1. Consider a mini project that includes work in most disciplines, ending in a stable executable for a 3-week iteration (any example of software project of candidate choice). Construct a disciplines across iterations diagram considering the sample disciplines i.e., Requirements, Design, Implementation and Test.
2. Imagine there is ultimately be a 20-iteration project for evolutionary and iterative development. Design an evolutionary requirements analysis, and show the diagram for the same 20-iteration project for evolutionary and iterative development.

2nd Year

Detailed Syllabus

III Semester
Syllabus

Course Title	Swarm and Evolutionary Computation				Course type		Integrated	
Course Code	M20AI3011	Credits	4		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	4	5	5	39	26	50	50

COURSE OVERVIEW:

The course will focus on the established evolutionary paradigms as well as the most significant new developments, covering genetic algorithms, genetic programming, evolutionary programming, evolutionary strategies, ant-colony optimisation, artificial immune systems, swarm intelligence and artificial life, amongst other topics. Students will be taught how these approaches identify and exploit biological processes in nature, allowing a wide range of applications to be solved in business and industry. Key problem domains will be examined, such as design, scheduling, function regression, fraud detection, anomaly detection, robot control and some of the newer domains such as music composition and the generation of art may be covered.

Course Objectives:

The objectives of this course are to:

1. Particle Swarm Optimization;
2. Quantum computing
3. Random Search Technique
4. Swarm Intelligence
5. Artificial Life and Artificial Immune Systems

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Have Knowledge of Fundamentals of swarm intelligence.	1,2,5	1,2

CO2	Analysis of Swarm Intelligence Based Algorithms	1,2,	1,4
CO3	Have Knowledge of Swarm and multi-agent systems.	1,2,5	1,2
CO4	Exploring working of genetic algorithm	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	**Program Outcomes**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	H	H	H							H	H	H
CO2	H	H	H	H	H							H	H	H
CO3	H	H	H	H	H							H	H	
CO4	H	H	H	H	H							H	H	

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Fundamentals of swarm intelligence: Swarm stability and stability analysis, Swarm aggregation, Swarm in known environments, Swarm in unknown environments: Particle Swarm Optimization, Dynamic Optimization, Multi-Objective Particle Swarm Optimization

UNIT-2

Analysis of Swarm Intelligence: Based Algorithms for Constrained Optimization, Numerical examples. Swarm and multi-agent systems: Division of labor and task allocation, Swarm clustering and sorting, Ant systems and optimization

UNIT-3

Memetic Self-Adaptive: Firefly Algorithm, Swarm Algorithms

UNIT-4

Evolutionay Computation: A brief history of evolutionary computation, A simple genetic algorithm, how do genetic algorithm work, Evolving computer programs, evolving cellular automata, evolving neural networks.

TEXT BOOKS:

1. VeyselGazi and Kevin M. Passino, Swarm Stability and Optimization, Springer, 2011
2. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, Swarm Intelligence: From Natural to Artificial Systems, Oxford University Press, 1999
3. Melanie Mitchell, An Introduction to Genetic Algorithms, MIT Press, 5th edition, 1999
4. Xin-She Yang, Zhihua Cui, Renbin Xiao, Amir Hossein Gandomi, Mehmet Karamanoglu, "Swarm Intelligence and Bio-Inspired Computation", Elsevier, 1st Edition, 2013.
5. Felix Chan, Manoj Tiwar, "Swarm Intelligence: Focus on Ant and Particle Swarm Optimization", InTech, 2007

REFERENCE BOOKS:

1. James Kennedy and Russel Eberhart, Swarm Intelligence, Morgan Kaufmann, 2001
2. ZbigniewMichalewicz and David Fogel, How to solve it: Modern Heuristics, Springer, 2001
3. Marco Dorigo and Thomas Stützle, Ant Colony Optimization, The MIT Press, 2004
4. C. Solnon: Ant Colony Optimization and Constraint Programming. Wiley 2010
5. Gerhard Weiss, Multiagent Systems: A modern approach to distributed artificial systems, The MIT Press, 2000
6. Christian Müller-Schloer, HartmutSchmeck and Theo Ungerer, Organic Computing — A Paradigm Shift for Complex Systems, Springer, 2011

JOURNALS /MAGAZINES:

1. Elsevier Journal on Swarm and Evolutionary Computation
2. IEEE Transactions on Evolutionary Computtion
3. Springer Journal on Swarm Intelligence
4. Springer journal on Evolutionary Intelligence
5. MIT Press Evolutionary Computation

SWAYAM/NPTEL/MOOCS:

1. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-me43/
2. https://onlinecourses.nptel.ac.in/noc21_me43/preview
3. https://www.classcentral.com/course/swayam-evolutionary-computation-for-single-and-multi-objective-optimization-22973

PRACTICE:

1. Implement a simple GA with fitness−proportionate selection, roulettewheel sampling, population size 100, single−point crossover rate pc = 0.7, and bitwise mutation rate pm = 0.001. Try it on the following fitness function: *f*(x) = number of ones in x, where x is a chromosome of length 20. Perform 20 runs, and measure the average generation at which the string of all ones is discovered. Perform the same experiment with crossover turned off (i.e., pc = 0). Do similar experiments, varying the mutation and crossover rates, to see how the variations affect the average time required for the GA to find the optimal string. If it turns out that mutation with crossover is better than mutation alone, why is that the case?
2. Implement a simple GA with fitness−proportionate selection, roulettewheel sampling, population size 100, single−point crossover rate pc = 0.7, and bitwise mutation rate pm = 0.001. Try it on the fitness function *f*(x) = the integer represented by the binary number x, where x is a chromosome of length 20. Chapter 1: Genetic Algorithms: An Overview 24 Run the GA for 100 generations and plot the fitness of the best individual found at each generation as well as the average fitness of the population at each generation. How do these plots change as you vary the population size, the crossover rate, and the mutation rate? What if you use only mutation (i.e., pc = 0)?
3. Define ten schemas that are of particular interest for the fitness functions of computer exercises 1 and 2 (e.g., 1*···* and 0*···*). When running the GA as in computer exercises 1 and 2, record at each generation how many instances there are in the population of each of these schemas. How well do the data agree with the predictions of the Schema Theorem?
4. Implement a GA to search for strategies to play the Iterated Prisoner's Dilemma, in which the fitness of a strategy is its average score in playin 100 games with itself and with every other member of the population. Each strategy remembers the three previous turns with a given player. Use a population of 20 strategies, fitness−proportional selection, single−point crossover with pc = 0.7, and mutation with pm = 0.001.
5. Implement a GA to search for strategies to play the Iterated Prisoner's Dilemma as in computer exercise 5a, except now let the fitness of a strategy be its score in 100 games with TIT FOR TAT. Can the GA evolve strategies to beat TIT FOR TAT?
6. Write a genetic algorithm to replicate Hinton and Nowlan's experiment. Make plots. Do a run that goes for 2000 generations. At what frequency and at what generation do the question marks reach a steady state? Could you roughly predict this frequency ahead of time?
7. Write a program to simulate a two−armed bandit with given ¼1, ¼2, Ã1 2 , Ã2 2 (which you should set). Test various strategies for allocating samples to the two arms, and determine which of the strategies you try maximizes the overall payoff. (Use N 1000 to avoid the effects of a small number of samples.)
8. Implement SUS and use it on the fitness function How does this GA differ in behavior from the original one with roulette−wheel selection? Measure the "spread" (the range of possible actual number of offspring, given an expected number of offspring) of both sampling methods.
9. Implement a GA with inversion and test it on Royal Road function R1. Is the performance improved?
10. Design a fitness function on which you think inversion will be helpful, and compare the performance of the GA with and without inversion on that fitness function.
11. Implement Schaffer and Morishima's crossover template method and see if it improves the GA's performance on R1. Where do the exclamation points end up?
12. Compare the performance of GAs using one−point, two−point, and uniform crossover on R1.

<table>
<tr><td>Course Title</td><td colspan="4">Advanced Java Programming</td><td colspan="2">Course Type</td><td colspan="2">Integrated</td></tr>
<tr><td>Course Code</td><td>M20AI5012</td><td>Credits</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2">III Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of ClassesPer Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>-</td><td>0</td><td>-</td><td>-</td></tr>
<tr><td>Total</td><td>4</td><td>5</td><td>5</td><td>39</td><td>26</td><td>50</td><td>50</td></tr>
</table>

COURSE OVERVIEW:

Advanced Java is everything that goes beyond Core Java – most importantly the APIs defined in Java Enterprise Edition, includes Servlet programming, Web Services, the Persistence API, etc. It is a Web & Enterprise application development platform which basically follows client & server architecture. Advance Java i.e. JEE (Java Enterprise Edition) gives you the library to understand the Client-Server architecture for Web Application Development. This course focuses on advanced concepts in the java programming starting from basic concepts of classes, objects, java database connection, servlets- The technology is used to create a web application (resides at server side and generates a dynamic web page) and java server pages, using which windows, web applications can be developed

Course Objectives:

The objectives of this course are to:

1. Describe the advanced concepts of java programming.
2. Explain the concepts used for developing web application.
3. Discuss different session management techniques used in web pages.
4. Demonstrate the establishment of communication between application and databases.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Summarize the fundamentals of Java like object oriented programming, exception handling and multithreading to solve real world problems.	1,2,5	1,2

CO2	Choose proper component, like java servlets, java server pages etc., to develop a web application using J2EE	1,2,	1,4
CO3	Apply advanced java concepts to manage sessions and cookies for optimal performance	1,2,5	1,2
CO4	Develop an application to establish communication between application and database..	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

	Bloom's Level					
CO#	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	M	M	H	L	M				H	H	L	H	H	H
CO2	M	M	L	M	M					L		H	H	H
CO3	M	M	L	M	M				L		L	H	H	H
CO4	M	M	L	L	M						M	H	H	H

Where, M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Introduction to Java: Java and Java applications; Java Development Kit (JDK); Java is interpreted, Byte Code, JVM; Object-oriented programming; Classes: Classes in Java; Inheritance: Simple, multiple, and multilevel inheritance; Overriding, overloading. Exception handling: Exception handling in Java

Multi-Threaded Programming: What are threads? How to make the classes threadable; Extending threads; Implementing runnable; Synchronization; Changing state of the thread;

UNIT-2

Java 2 Enterprise Edition Overview, Database Access : Overview of J2EE and J2SE The Concept of JDBC; JDBC Driver Types; JDBC Packages; A Brief Overview of the JDBC process; Database Connection; Associating the JDBC/ODBC Bridge with the Database; Statement Objects; Resultset; Transaction Processing; Metadata, Data types; Exceptions.

UNIT-3

Servlets : Background; The Life Cycle of a Servlet; Using Tomcat for Servlet Development; A simple Servlet; The Servlet API; The Javax.servlet Package; Reading Servlet Parameter; The Javax.servlet.http package; Handling HTTP Requests and Responses; Using Cookies; Session Tracking.

UNIT-4

JSP, RMI: Java Server Pages (JSP): JSP, JSP Tags, Tomcat, Request String, User Sessions, Cookies, Session Objects. Java Remote Method Invocation: Remote Method Invocation concept; Server side, Client side. IDE: Eclipse IDE, Netbeans IDE & Myeclipse IDE; Servers: ApacheTomcat, Glassfish Server,JBoss Server & Weblogic Server.

SELF-LEARNING COMPONENTS:

JAVA Model-View-Controller Pattern & Spring Framework.

TEXT BOOKS:

1. Head First Servlets & JSP, Bryan Basham, Kathy Sierra & Bert Bates, 2nd Edition.
2. Barry J. Holmes and Daniel T. Joyce, Object-Oriented Programming With Java; Second Edition; Jones And Bartlett Publishers,2000
3. Dale Skrien; Object-Oriented Design Using Java; McGraw-Hill Higher Education; 2009
4. Danny Poo; Object-Oriented Programming and Java; Second Edition; Springer; 2008.

REFERENCE BOOKS:

1. Cay Horstmann; Big Java; 2nd Edition ; John Wiley and Sons
2. Herbert Schildt; The Complete Reference Java J2SE; 5th Edition; TMH Publishing Company Ltd, New Delh

JOURNALS/MAGAZINES:

1. Elsevier Journal on Computer Languages,Systems, and Strucutres
2. ACM Transactions on Programming Languages and Systems

SWAYAM/NPTEL/MOOCS:

1. https://onlinecourses.nptel.ac.in/noc19_cs84/preview
2. https://nptel.ac.in/courses/106/105/106105191/

3. https://www.classcentral.com/course/swayam-programming-in-java-12930
4. https://www.edureka.co/java-j2ee-training-course?utm_source=Google-Search-Brand&utm_medium=cpc&utm_campaign=Brand-Course-Search-India-BMM&gclid=CjwKCAiArbv_BRA8EiwAYGs23Bmy1KNwihzys0c4pT91Prn1UDqx0nfME2nr7Tgwt5UsU3Vr_66OdBoCQ_UQAvD_BwE
5. https://www.coursera.org/courses?query=advanced%20java

PRACTICE:

Sl. No.	Program
1	The City mall has customer name and mobile number stored in a text file which has to be read and printed on the display screen so implement the above functionality using java programming language.
2	The college authority has decided to store the database of students so that faculty and parents can access the student's information. Hence develop student management system application using Java programming language and any database tool to perform insert, delete and update operations.
3	The City mall management has decided to store customer name and mobile number which is stored in a text file to be inserted into database. Develop java application to read from text file and store it in a database.
4	User authentication is essential to access any system so develop a login page for the student management system and provide suitable access for authenticated user and relevant messages if not valid.
5	A jewelry showroom plans to go online providing the customer with 24x7 access to the information about jewelry. Hence develop a dynamic html using JAVA Servlet.
6	The jewelry showroom further wants to provide current gold rate with Auto Web Page Refresh to display the current gold rate so implement the same.
7	An automobile manufacturing industry is keen on customer feedback hence develop an application to provision the same using Java Servlet GET and POST methods.
8	Cookies are useful for tracking user preferences hence develop JAVA program to display Cookie id.
9	JSP technology may enable the web developer and designers to rapidly develop and easily maintain, information rich, dynamic web pages that leverage existing business system. Develop a simple page that contains plain HTML, except for couple of the JSP directives and tags. The first one in the reva.jsp is a page directive that defines the content type and character set of the entire page. Java method println () to print output.
10	An organization wants to migrate to JSP technology considering the benefits, thereby it is required to perform insert database operation in jsp to store the product information.

Course Title	Multi Agent Systems				Course type		Integrated	
Course Code	M20AI5013	Credits	4		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	4	5	5	39	26	50	50

COURSE OVERVIEW:

A multi-agent system (MAS or "self-organized system") is a computerized system composed of multiple interacting intelligent agents. Multi-agent systems can solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. Intelligence may include methodic, functional, procedural approaches, algorithmic search or reinforcement learning.

Course Objectives:

1. Describe the basics of Multi Agent Systems.
2. Illustrate the auctions and determinations using learning in Multi Agent Systems.
3. Explain negotiation problems and networks in Multi Agent Systems.
4. Demonstrate goal and plan theories in Multi Agent Systems.

Course Outcomes:

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

CO#	Course Outcomes	POs	PSOs
CO1	Apply basic knowledge of Multi Agent Systems to solve real world problems.	1,2,5	1,2
CO2	Analyse the auction and determinations using learning in Multi Agent Systems.	1,2,	1,4
CO3	Construct the solution concepts and strategies to solve real world problems.	1,2,5	1,2

CO4	Make use of algorithms and theories in Multi Agent systems to solve real world problems	2,4,5	1,2,6

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			

COURSE ARTICULATION MATRIX

Course Outcomes	**Program Outcomes**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	H	H	H							H	H	H
CO2	H	H	H	H	H							H	H	H
CO3	H	H	H	H	H							H	H	
CO4	H	H	H	H	H							H	H	

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Contents:

UNIT-1

Introduction to Multi Agent Systems:

Multi Agent Problem Formulation: Utility, Markov Decision Processes, Planning – Hierarchical Planning

Distributed Constraints: Distributed Constraint Satisfaction – Filtering Algorithm, Hyper-resolution based consistency algorithm, Asynchronous backtracking, Asynchronous weak-commitment search, Distributed breakout, Distributed Constraint Optimization – Adopt, OptAPO**.**

UNIT-2

Learning in Multi Agent Systems: The Machine Learning Problem, Cooperative Learning, Repeated Games – Fictitious play, Replicator dynamics, The AWESOME Algorithm, Stochastic Games – Reinforcement Learning, General Theories for Learning Agents – CLRI Model, N-level Agents, Collective Intelligence

Auctions: Valuations, Simple Auctions, Combinatorial Auctions – Centralized Winner Determination, Distributed Winner Determination, Bidding Languages, Preference Elicitation, VCG Payments.

UNIT-3

Negotiation: The Bargaining Problem – Axiomatic Solution Concepts, Strategic Solution Concepts, Monotonic Concession Protocol – The Zeuthen Strategy, One-step protocol, Negotiation as Distributed Search, Ad-hoc Negotiation Strategies, The Task Allocation Problem – Payments, Lying about Tasks, Contracts, Complex Deals – Annealing over complex deals, Argumention-based negotiation, Negotiation networks – Network exchange theory

UNIT-4

Voting and Mechanism Design: The Voting problem, Mechanism design.

Coordination using Goal and Plan theories: TAEMS, GPGP – Agent Architecture, Coordination, Design-to-criteria scheduler

Nature-Inspired Approaches: Ants and Termites, Immune System, Physics

SELF-LEARNING COMPONENTS:

Form Games and Coalition formation

TEXT BOOKS:

1. Jose M Vidal, Fundamentals of Multiagent Systems, 2007.

REFERENCE BOOKS:

1. Yoav Shoham, Kevin Leyton-Brown., Multiagent Systems, Cambridge University Press, 2010.
2. Munindar P. Singh, Michael N. Huhns, Multiagent Systems, Springer-Verlag, 1994.
3. http://web.stanford.edu/class/cs224m/

JOURNALS/MAGAZINES:

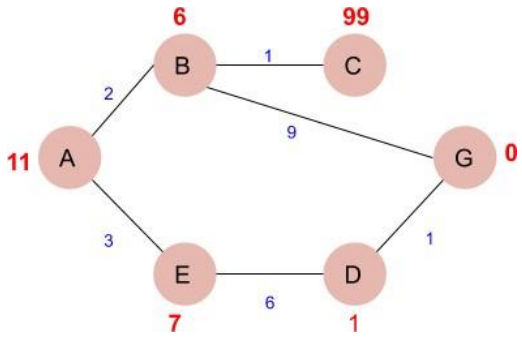
1. Springer Journal on Autonoumous Agents and Multi Agent Systems

SWAYAM/NPTEL/MOOCS:

1. https://nptel.ac.in/courses/106/105/106105077/

PRATICE:

Sl. No.	Program

1	Consider the following graph below The numbers written on edges represent the distance between the nodes while the numbers written on nodes represent the heuristic values. Find the most cost-effective path to reach from start state A to final state G using A* Algorithm. 
2	Design a simulation of a self-driving cab. The major goal is to demonstrate, in a simplified environment, how you can use Reinforcement Learning techniques to develop an efficient and safe approach for tackling the below problem. “Here are 4 locations (labeled by different letters R, G, Y, B), and our job is to pick up the passenger at one location and drop him off at another. We receive +20 points for a successful drop-off and lose 1 point for every time-step it takes. There is also a 10 point penalty for illegal pick-up and drop-off actions.”
3	Find-S algorithm finds the most specific hypothesis that fits all the positive examples. Implement and demonstrate the FIND-S Algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
4	The candidate elimination algorithm incrementally builds the version space given a hypothesis space H and a set E of examples. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
5	The ID3 algorithm builds decision trees using a top-down, greedy approach. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
6	Backpropagation algorithm as an algorithm that trains some given feed-forward Neural Network for a given input pattern where the classifications are known to us. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
7	Naive Bayes classifiers are a collection of classification algorithms based on Bayes’ Theorem where every pair of features is being classified as independent of each other. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
8	Assuming a set of documents that need to be classified, use the Naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the precision, and recall for your data set.
9	A Bayesian network is a probabilistic graphical model which represents a set of variables and their conditional dependencies using a directed acyclic graph. Write a program to construct a Bayesian Network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.
10	The Expectation Maximization (EM) algorithm is used to find (local) maximum likelihood parameters of a statistical model in cases where the equations cannot be solved directly. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

11	KNN is a model that classifies data points based on the points that are most similar to it. Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.

Course Title	Open Elective				Course Type	THEORY	
Course Code	M20AI5020	Credits	4		Class	I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	4	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	**0**	-	-			
	Total	**4**	**3**	**3**	**52**	**50**	**50**

Course Title	Project Work Phase – I				Course Type	Practice	
Course Code	M20AI5050	Credits	4		Class	I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	0	3	3			
	Practice	4	0	0	Practical	CIE	SEE
	-	**0**	-	-			
	Total	**4**	**3**	**3**	**48**	**50**	**50**

COURSE OVERVIEW:

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 week.

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	M	M	M							H	H	H
CO2	M	H	H	H	H							H	H	H
CO3	M	H	H	H	H							H	H	H
CO4	L	L	M	L	M							H	H	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO

Course Title	**Internship/Global Certification**				**Course Type**	**Practice**	
Course Code	M20AI3040	**Credits**	**4**		**Class**	**I Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	0	3	3			
	Practice	4	0	0	Pratical	CIE	SEE
	-	**0**	**-**	**-**			
	Total	**4**	**3**	**3**	**48**	**50**	**50**

COURSE OVERVIEW:

Experience is becoming a crucial factor for employers when deciding who gets their foot in the door. It's strongly advised that students and graduates take the opportunity to complete a period of work experience to ensure they have a competitive advantage over their peers; and that's where an internship can make all the difference.

An internship is a period of work experience offered by an employer to give students and graduates exposure to the working environment, often within a specific industry, which relates to their field of study. Internships can be as short as a week or as long as 12 months. They can be paid or voluntary; however, before you start an internship it's important to know your rights with regards to getting paid.

Internships can be done in a range of sectors, including sales, marketing, engineering, graphic design, management, I.T. and many, many more. Throughout an internship you will develop a variety of soft skills, including communication skills, personal effectiveness, presentation skills, creative problem solving and influencing skills.

'On-the-job' experience can be as valuable as anything learned in your studies. After all, you cannot really understand what a job is all about until you have worked in that environment. Internships are great opportunities to speak directly to people who have experience in the role you aspire to; and their knowledge of the job and working environment will give you a greater understanding of what it's all about and what you need to do to progress.

Information technology is a highly dynamic and ever-changing field. As the industry evolves, new types or sets of certifications continue to crop up. Getting certified is a surefire way to advance your career in the IT industry. Whether you work for an enterprise, a small business, government, healthcare or any other place that employs IT professionals, your best bet for career advancement is to validate your skills and knowledge through a carefully chosen combination of certifications.

Certification training can help you cover new areas while also reinforcing the skills you already have. Think of it as a refresher course that can help you identify and overcome your problem areas. Certifications do more than just validate your skills and experience. It also shows potential employers that you are committed to the IT field by spending the money and time to obtain your certifications. IT certifications also make career advancement more likely. The plain truth is that, in general, IT certifications can help you get a pay raise or a promotion.

IV Semester

Syllabus

Course Title	Project Work Phase – 2 and Dissertation				Course Type	Practice	
Course Code	M20AI4010	Credits	16		Class	I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of ClassesPer Semester	Assessment in Weightage	
	Theory	0	3	3			
	Practice	16	0	0	Pratical	CIE	SEE
	-	0	-	-			
	Total	16	3	3	48	50	50

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	M	M	M							H	H	H
CO2	M	H	H	H	H							H	H	H
CO3	M	H	H	H	H							H	H	H
CO4	L	L	M	L	M							H	H	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO

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:

- **Willingness to learn**
- **Self motivation**
- **Team work**
- **Communication skills and application of these skills to real scenarios**
- **Requirement of gathering, design and analysis, development and testing skills**

- **Analytical and Technical skills**
- **Computer skills**
- **Internet searching skills**
- **Information consolidation and presentation skills**
- **Role play**
- **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 improve 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 Commerce is efficient leaders of repute, who can deal the real time problems with 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, leadership, and strategic management 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 University has recognized skill development and industry relationship as its very important activities. Therefore, the University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director has been established 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 various skill/certification programs identified are as follows:

- Big-data and Cloud Computing, Internet of Things (IOT), ORACLE, MYSQL, Advanced Java and Internals of LINUX/UNIX
- Red-hat certified programs on LINUX,
- Management related programs like SAP,ERP and Business Analytics
- Open Source software/hardware, Software Testing
- Advanced networking based CISCO / Microsoft technology.
- Web designing, System administration
- IBM certified programs.

The University has 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.

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