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| Institute of Technology  **CURRICULUM**  **Outcome Based Education**  **Academic year 2024 – 2025**  **ARTIFICIAL INTELLIGENCE AND**  **DATA SCIENCE** |
| **V & VI SEMESTER B.E.** |
| **RAMAIAH INSTITUTE OF TECHNOLOGY**  (Autonomous Institute, Affiliated to VTU) Bangalore – 560054. |

**About the Institute:**

Dr. M. S. Ramaiah a philanthropist, founded ‘Gokula Education Foundation’ in 1962 with an objective of serving the society. M S Ramaiah Institute of Technology (MSRIT) was established under the aegis of this foundation in the same year, creating a landmark in technical education in India. MSRIT offers 18 UG programs and 13 PG programs. All these programs are approved by AICTE. All eligible UG and PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with **‘A+’ grade by NAAC in March 2021** for 5 years. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs since 2007. The institute has also been conferred autonomous status for Ph.D. program since 2021. The institute is a participant to the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. The institute has 380 competent faculty out of which 70% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility for all faculty members, all research departments active with sponsored funded projects and more than 300 scholars pursuing Ph.D. To promote research culture, the institute has established Centre of Excellence for Imaging Technologies, Centre for Advanced Materials Technology, Centre for Antennas and Radio Frequency Systems (CARFS), Center for Cyber Physical Systems, Schneider Centre of Excellence & Centre for Bio and Energy Materials Innovation. **Ramaiah Institute of Technology has obtained All India Rank 182 in “Scimago Institutions Rankings” for the year 2024.**

The Entrepreneurship Development Cell (EDC) and Section 8 company “Ramaiah Evolute” have been set up on campus to incubate startups. MSRIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with good collection of book volumes and subscription to International and National Journals. The Digital Library subscribes to online e-journals from Elsevier Science Direct, IEEE, Taylor & Francis, Springer Link, etc. The Institute is a member of DELNET, CMTI and VTU E-Library Consortium. The Institute has a modern auditorium, recording studio, and several hi-tech conference halls with video conferencing facilities. The institute has excellent hostel facilities for boys and girls. MSRIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association.

**As per the National Institutional Ranking Framework (NIRF), MoE, Government of India, Ramaiah Institute of Technology has achieved 75th rank among 1463 top Engineering Institutions & 21st Rank for School of Architecture in India among 115 Architecture Institutions, for the year 2024.**

### About the Department

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| **Year of Establishment** | 2021 |
| **Names of the Programme offered** | UG: B.E. in Artificial Intelligence and Data Science |

The department of Artificial Intelligence and Data Science (AI & DS) was established in 2021 with an objective of producing high quality professionals to meet the demands of the emerging field of Artificial Intelligence and Data Science. The department has highly qualified and competent faculty members committed to innovative teaching learning and quality research. The department is equipped with state-of-the-art laboratories and classrooms that meets the requirement of curriculum, innovation and research. Collaboration with industries has made a significant impact on the curriculum, computing infrastructure, teaching & learning and research. Department of AI & DS utilizes innovative learning methods including project-based, simulation-based and skill-based learning. This ensures students learn the most relevant and up-to-date challenges in the field of Artificial Intelligence, Machine Learning and Data Science. Further department frequently Conducts technical events like: seminars, workshops, hackathons etc., to allow students to gain critical skill sets in AI and DS. Curriculum and the teaching learning process ensure that the students demonstrate technical competence, ethical reasoning, creativity in identification & formulation of the problems and develop solutions by using appropriate tools & techniques. The department focuses on the application of Artificial Intelligence, Data Analysis, Machine Learning, and various Statistical techniques to extract insights, hidden talent of young minds and a supportive system for sustainable socio-economic impact. Department has established technical clubs/ professional student chapters to provide collaborative learning platform for the students. Echo system has been built to initiate start-ups/Innovation at the department level along with the mentorship program. Such activities of the department leads to high profile placements, motivation to become an entrepreneur, and encouragement for higher learning.

# VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio- economic needs

# MISSION OF THE INSTITUTE

#### MSRIT shall meet the global socio-economic needs through

1. Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
2. Establishing research clusters in emerging areas in collaboration with globally reputed organizations
3. Establishing innovative skills development, techno-entrepreneurial activities, and consultancy for socio-economic needs

# QUALITY POLICY

We at M. S. Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

# VISION OF THE DEPARTMENT

To build strong technical environment and enhance problem solving abilities in the domain of Artificial Intelligence and Data Science to generate professionals who are capable of handling social and technical problems

# MISSION OF THE DEPARTMENT

1. To facilitate students with latest tools and techniques by providing professionally committed faculty and staff
2. To develop ethical values, leadership and research capabilities in students to face the global challenges
3. To establish state of the art laboratories, MOU with leading industries in order to promote research and innovation activities in Artificial Intelligence and Data Science domain among students

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

A B.E (Artificial Intelligence and Data Science) graduate of Ramaiah Institute of Technology should, within three to five years of graduation

**PEO1:** Excel with professional skills to become data science leaders, AI research scientists, or entrepreneur

**PEO2:** Be aware of the development in the field of Artificial intelligence and data science, enhance knowledge through research or pursue graduate studies

**PEO3:** Will engage in life-long earning, work effectively in multidisciplinary teams with social awareness and responsibilities

## PROGRAM OUTCOMES (POs):

The Outcomes of the Bachelor of engineering in Artificial Intelligence and Data Science Programme are as follows:

Engineering Graduates must be able to:

**PO1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2: Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3: Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. **PO5: Modern tool usage:** Create, select, 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.

**PO6: The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7: Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9: Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11: Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12: Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## PROGRAM SPECIFIC OUTCOMES (PSOs):

**PSO1:** Understand the principles, and architecture of computers, concepts of intelligent systems, and data analytic technologies

**PSO2:** Apply the concepts of AI and data science in modelling and design of intelligent

Systems

**PSO3:** Apply appropriate AI & DS tools and techniques to develop software and hardware solutions for Sustainable Socio-Economic applications like Healthcare, Education, Agriculture, Industry and Automation etc.

## Semester wise Credit Breakdown for B.E Degree Curriculum Batch 2022-26

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Semester**    **Course Category** | **First** | **Second** | **Third** | **Fourth** | **Fifth** | **Sixth** | **Seventh** | **Eighth** | **Total Credits** |
| **Basic Sciences (BSC)** | **08** | **08** | **03** | **03** | **--** | **--** | **--** | **--** | **22** |
| **Engineering Sciences (ESC)** | **09** | **08** | **--** | **--** | **--** | **--** | **--** | **--** | **17** |
| **Humanities, Social Sciences and Management (HSMC)** | **02** | **02** | **--** | **--** | **03** | **03** | **--** | **--** | **10** |
| **Ability Enhancement Course (AEC)** | **01** | **02** | **01** | **01** | **01** | **--** | **03** | **--** | **09** |
| **Universal Human Values (UHV)** | **--** | **--** | **02** | **--** | **--** | **--** | **--** | **--** | **02** |
| **Professional Core Courses (PCC)** | **--** | **--** | **11** | **12** | **12** | **06** | **04** | **--** | **45** |
| **Integrated Professional Core Course (IPCC)** | **--** | **--** | **04** | **04** | **03** |  | **04** | **--** | **15** |
| **Professional Elective Courses (PEC)** | **--** | **--** | **--** | **--** | **03** | **06** | **03** | **--** | **12** |
| **Institutional Open Elective Courses (IOE)** | **--** | **--** | **--** | **--** | **--** | **03** | **03** | **--** | **06** |
| **Internship (INT)** | **--** | **--** | **--** | **** | **--** | **--** | **--** | **05** | **05** |
| **Mini Project / Project Work (PW)** | **--** | **--** | **--** | **--** | **--** | **04** | **--** | **13** | **17** |
| **Non Credit Mandatory Courses (NCMC)** | **--** | **--** | **--** | **--** | **** | **--** | **--** | **** | **--** |
| **Total Credits** | **20** | **20** | **21** | **20** | **22** | **22** | **17** | **18** | **160** |

#### SCHEME OF TEACHING V SEMESTER

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Course Code** | **Course Name** | **Teaching**  **Department** | **Category** | **Credits** | | | | **Total contact**  **hours /week** |
| **L** | **T** | **P** | **Total** |  |
| 1 | AD51 | Data Mining and Machine Learning | AIDS | PCC | 3 | 0 | 0 | 3 | 3 |
| 2 | AD52 | Operating Systems | AIDS | IPCC | 2 | 0 | 1 | 3 | 4 |
| 3 | AD53 | Data Storage Techniques | AIDS | PCC | 3 | 0 | 0 | 3 | 3 |
| 4 | AD54 | Fundamentals of Data Science | AIDS | PCC | 3 | 1 | 0 | 4 | 5 |
| 5 | ADE55x | Program Elective Course – 1 | AIDS | PEC | 3 | 0 | 0 | 3 | 3 |
| 6 | ADL56 | Machine Learning Laboratory | AIDS | PCC | 0 | 0 | 1 | 1 | 2 |
| 7 | ADL57 | Parallel Programming Laboratory | AIDS | PCC | 0 | 0 | 1 | 1 | 2 |
| 8 | AL58 | Research Methodology & Intellectual property rights | Humanities | HSMC | 3 | 0 | 0 | 3 | 3 |
| 9 | AEC510 | AEC – V: Any Dept | CSE | AEC | 1 | 0 | 0 | 1 | 1 |
| **Total** | | | | | 18 | 1 | 3 | **22** | **26** |
| 10 | HS59 | Environmental Studies \* |  | NCMC | 0 | 0 | 0 | 0 | 1 |

\* Environmental Studies is under the category of NCMC, 1 hour teaching per week has to be allocated in the time table.

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| **ADE55x: Program Elective Course – 1** | | | | | | | | | |
| **Sl.**  **No.** | **Course**  **Code** | **Course Name** | **Teaching Department** | **Category** | **Credits** | | | | **Total contact**  **hours /week** |
| **L** | **T** | **P** | **Total** |  |
| 1 | ADE551 | Augmented Reality/Virtual Reality | AIDS | PEC | 3 | 0 | 0 | 3 | 3 |
| 2 | ADE552 | Computer Vision | AIDS | PEC | 3 | 0 | 0 | 3 | 3 |
| 3 | ADE553 | Computer Organization and Architecture | AIDS | PEC | 3 | 0 | 0 | 3 | 3 |
| 4 | ADE554 | Internet of Things | AIDS | PEC | 3 | 0 | 0 | 3 | 3 |
| 5 | ADE555 | Software Engineering with DevOps | AIDS | PEC | 3 | 0 | 0 | 3 | 3 |

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| **Nomenclature: IPCC:** Integrated Professional Core Course**, PCC:** Professional Core Course**, HSMC:** Humanity and Social Science & Management Courses**, PEC:** Professional Elective Courses**, AEC–**Ability Enhancement Courses,  **NCMC**: Non-credit Mandatory Course |
| **L –Lecture, T – Tutorial, P- Practical/ Drawing** |
| **Note:** ADE55x, where x=1,2,3,4,5 |
| **Integrated Professional Core Course (IPCC):** Refers to Professional Theory Core Course Integrated with practical of the same course. Credit for IPCC is 03 and its Teaching–Learning hours (L : T : P) can be considered as (2 : 0 : 1). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated only by CIE **(no SEE).** However, questions from the practical part of IPCC can be included in the SEE question paper. |
| **Professional Elective Courses:** A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in Engineering and Technology curriculum. Multidisciplinary courses that are added to supplement the latest trend and advanced technology in the selected stream of engineering. Each group provides an option to select one course out of five courses. The minimum student’s strength for offering professional electives is 10. |
| **AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):**  Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years degree program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points; VIII semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card. |

**SCHEME OF TEACHING VI SEMESTER**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Subject Code** | **Subject** | **Teaching Department** | **Category** | **Credits** | | | | **Total contact** |
| **L** | **T** | **P** | **Total** | **Hours / week** |
| 1 | AL61 | Management & Entrepreneurship | AIDS | HMSC | 3 | 0 | 0 | 3 | 3 |
| 2 | AD62 | Deep Learning | AIDS | PCC | 3 | 1 | 0 | 4 | 5 |
| 3 | ADE63x | Program Elective Course – 2 | AIDS | PEC | 3 | 0 | 0 | 3 | 3 |
| 4 | ADE64x | Program Elective Course – 3 | AIDS | PEC | 3 | 0 | 0 | 3 | 3 |
| 5 | ADL65 | Data Science Laboratory | AIDS | PCC | 0 | 0 | 1 | 1 | 2 |
| 6 | ADL66 | Deep Learning Laboratory | AIDS | PCC | 0 | 0 | 1 | 1 | 2 |
| 7 | ADOE0x\* | Institutional Open Elective – 1 | AIDS | IOE | 3 | 0 | 0 | 3 | 3 |
| 8 | ADP67 | Mini Project | AIDS | PW | 0 | 0 | 4 | 4 | - |
| **Total** | | | | | **15** | **1** | **6** | **22** | **21** |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ADE63x: Program Elective Course – 2** | | | | | | | | | | | | | |
| **Sl.**  **No.** | **Course**  **Code** | **Course Name** | **Teaching Department** | **Category** | **Credits** | | | | | | **Total contact**  **hours /week** | | |
| **L** | **T** | **P** | | **Total** | |  | | |
| 1 | ADE631 | Robotics Process Automation - Design and Development | AIDS | PEC | 3 | 0 | 0 | | 3 | | 3 | | |
| 2 | ADE632 | Data Engineering and MLOps | AIDS | PEC | 3 | 0 | 0 | | 3 | | 3 | | |
| 3 | ADE633 | Advanced Artificial Intelligence | AIDS | PEC | 3 | 0 | 0 | | 3 | | 3 | | |
| 4 | ADE634 | Data Warehousing | AIDS | PEC | 3 | 0 | 0 | | 3 | | 3 | | |
| **ADE64x: Program Elective Course – 3** | | | | | | | | | | | | |
| **Sl.**  **No.** | **Course**  **Code** | **Course Name** | **Teaching Department** | **Category** | | **Credits** | | | | | | **Total contact**  **hours /week** | |
| **L** | **T** | **P** | | **Total** | |  | |
| 1 | ADE641 | Information and Network Security | AIDS | PEC | | 3 | 0 | 0 | | 3 | | 3 | |
| 2 | ADE642 | Advanced Algorithms | AIDS | PEC | | 3 | 0 | 0 | | 3 | | 3 | |
| 3 | ADE643 | Optimization Methods in Machine Learning | AIDS | PEC | | 3 | 0 | 0 | | 3 | | 3 | |
| 4 | ADE644 | NoSQL Databases | AIDS | PEC | | 3 | 0 | 0 | | 3 | | 3 | |
| 5 | ADE645 | Information Retrieval | AIDS | PEC | | 3 | 0 | 0 | | 3 | | 3 | |

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| **Nomenclature, PCC:** Professional Core Course**, PEC:** Professional Elective Courses, **IOE:** Institutional Open Elective, **PW:** Mini Project, **INT –**Internship |
| **L –Lecture, T – Tutorial, P- Practical/ Drawing** |
| **Note:** ADOE63x, where x=1,2,3,4  ADOE64x, where x=1,2,3,4,5  ADOE0x\*, where x=1,2,3,4,5,… continued from previous |
| **L –Lecture, T – Tutorial, P- Practical/ Drawing/ Project work** |
| **Professional Elective Courses:** A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in Engineering and Technology curriculum. Multidisciplinary courses that are added to supplement the latest trend and advanced technology in the selected stream of engineering. Each group provides an option to select one course out of five courses. The minimum student’s strength for offering professional electives is 10. |
| **Institutional Open Elective Courses:**  Students belonging to a particular stream of Engineering and Technology are not entitled for the open electives offered by their parent department. However, they can take an elective offered by other departments, provided they satisfy the prerequisite condition, if any. Registration to open electives shall be documented under the guidance of the Proctor.  **Selection of an open elective shall not be allowed if,**   1. The candidate has studied the same course during the previous semesters of the program. 2. The syllabus content of open electives is similar to that of the Departmental core courses or professional electives. 3. A similar course, under any category, is prescribed in the higher semesters of the program. 4. The minimum students strength for offering open electives is 10. |
| **Mini-project work:** Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to a group having **not more than 4 students.** The CIE marks shall be awarded by a committee constituted by of the Head of the concerned department. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill, and question and answer session as per the rubrics defined by the department. SEE will be conducted by the two examiners appointed by the Institute. SEE marks awarded for the mini project shall be based on the evaluation of project work report, project presentation skill and question and answer session. |
| **Internship -** All the students admitted shall have to undergo mandatory internship of 6 - 8 weeks during the intervening vacation of the IV & V semesters / intervening vacation of VI & VII semesters/ VIII semester. **A Viva-Voce CIE examination** shall be conducted during VIII semester as per the rubrics defined by the department and the prescribed credits shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent examination after satisfying the internship requirements. |
| **AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):**  Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years degree program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points; VIII semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card. |

### V SEMESTER

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| **DATA MINING AND MACHINE LEARNING** | |
| **Course Code: AD51** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42L** |
| **Course Coordinator: Dr. Sowmya BJ** | |

**Course Content**

**Unit I**

Data Mining Introduction – Data – Types of Data – Data Mining Functionalities – Classification of Data Mining Systems – Issues –Data Preprocessing. Association Rule Mining Mining Frequent Patterns – Apriori Algorithm Description.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://www.youtube.com/watch?v=dUm3ptTQr0Q>

**Unit II**

Classification: Basic Concepts, Decision Tree Induction, Bayes Classification Methods, Model Evaluation and Selection, Techniques to Improve Classification Accuracy. Classification and Prediction: Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: https://www.youtube.com/watch?v=pXdum128xww

**Unit III**

Machine Learning Introduction: Learning, Types of Machine Learning, Types of Machine Learning, Supervised Learning, The Machine Learning Process. Cluster Analysis: Basic concepts and methods: Cluster Analysis, Partitioning methods, Hierarchical Methods, Evaluation of clustering.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: https://www.youtube.com/watch?v=RDZUdRSDOok

**Unit IV**

Machine Learning Preliminaries: Terminology - Weight Space, The Curse of Dimensionality; Testing Machine Learning Algorithms – Over-fitting, Training, Testing and Validation Sets, The Confusion Matrix, Accuracy Metrics, ROC Curve, Unbalanced Dataset, Measuring Precision Turning Data into Probabilities: Minimizing Risk, maximum a posteriori hypothesis; Basic Statistics: Averages, Variance and Covariance, The Gaussian; Bias-Variance Trade-off

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links:<https://www.youtube.com/watch?v=Kc-D455GVoQ&list=PLupD_xFct8mH9Sg1Lnav2eEA8Unf4l3b4>

**Unit V**

Dimensionality Reduction - Unsupervised: Introduction, Subset Selection, PCA (Principal Component Analysis) – Technique, Examples as Numerical. Mining different types of data: Mining the World Wide Web - Page Rank Algorithm, Text mining, Mining Time Series Data, Ensemble methods-Increasing the Accuracy.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://www.youtube.com/watch?v=Kc-D455GVoQ&list=PLupD_xFct8mH9Sg1Lnav2eEA8Unf4l3b4>

**Text Books:**

1. Jiawei Han and Micheline Kamber: Data Mining Concepts and Techniques,Elsevier, 2nd Edition, 2009.
2. Stephen Marsland, “Machine Learning - An AlgorithmicPerspective”,Second Edition, CRC Press - Taylor and Francis Group, 2015
3. Ethem Alpaydin, “Introduction to Machine Learning”, Second Edition, MITPress, Prentice Hall of India (PHI) Learning Pvt. Ltd. 2010
4. Xindong Wu and Vipin Kumar: The top ten Algorithms in Data Mining, Chapman and Hall/CRC press
5. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, “Introduction to Data Mining”, Pearson Education, 2007.
6. DISCOVERING KNOWLEDGE IN DATA, An Introduction to Data Mining Second Edition Daniel T. Larose • Chantal D. Larose

**Reference Books:**

1. K.P. Soman, ShyamDiwakar and V. Aja, “Insight into Data Mining Theory and Practice”, Eastern Economy Edition, Prentice Hall of India, 2006.
2. G. K. Gupta, “Introduction to Data Mining with Case Studies”, Eastern Economy Edition, Prentice Hall of India, 2006.

**Course Outcomes (COs):**

At the end of the course the student will be able to:

1. Recognize the preliminary concepts associated with data mining and machine learning such as its need, types, statistical terms and algorithms (PO-2, 4, 10, 11, 12, PSO-3)
2. Differentiate between different classification and prediction techniques. (PO-1 ,2, 3, 4, 10, 11, 12, PSO-3)
3. Identify the clustering methods that can be used for a given data set and the need of unsupervised learning using Partitional, Hierarchical Clustering. (PO-1, 2, 3, 4, 10, 11, 12, PSO-3)
4. Get an introduction to machine learning and its types and appreciate the need for dimensionality reduction and use the same. (PO-1, 2, 3, 10, 11, 12, PSO-3)
5. Illustrate the use of data mining techniques in various fields like world wide web, time series data and genomic data. (PO-1, 2, 3, 4, 10, 11, 12, PSO-3)

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| **OPERATING SYSTEMS** | |
| **Course Code: AD52** | **Credits: 2:0:1** |
| **Pre – requisites: Nil** | **Contact Hours: 28L+14P** |
| **Course Coordinator: Dr. Vaneeta M** | |

**Course Content**

**Unit I**

**Introduction to Operating Systems**- What operating systems do, Operating System operations, Process management, Memory management, Storage management, Protection and security. **System Structures**- Operating System Services, System calls, Operating System design and implementation, Operating System structure, Virtual machines. **Process Management - Process concept, Process scheduling, Operations on processes, Inter-process communication**

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: [https://nptel.ac.in/courses/106106144,](https://nptel.ac.in/courses/106106144) <https://nptel.ac.in/courses/106102132> <https://www.youtube.com/watch?v=vBURTt97EkA>

#### Unit II

**Multi-threaded Programming:** Overview; Multithreading models**,** Threading issues. **Process Scheduling**- Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple-Processor scheduling. **Process Synchronization**-Background, The Critical section problem, Synchronization hardware, Semaphores, Classical problems of synchronization.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: https://nptel.ac.in/courses/106106144 <https://nptel.ac.in/courses/106102132> <https://www.youtube.com/watch?v=OrM7nZcxXZU>

#### Unit III

**Deadlocks**- System model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection and recovery from deadlock. **Memory Management Strategies**- Background, Swapping, Contiguous memory allocation, Paging, Structure of page table, Segmentation. **Virtual Memory Management**- Background, Demand paging, Page replacement,

Thrashing.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: https://nptel.ac.in/courses/106106144 <https://nptel.ac.in/courses/106102132> <https://www.youtube.com/watch?v=rWFH6PLOIEI>

#### Unit IV

**File System**- File concept, Access methods, Directory structure, Protection. Implementing File System- File system structure, File system implementation, Directory implementation, Allocation methods, Free space management. Secondary Storage Structures-Mass storage structures, Disk structure, Disk scheduling.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: https://nptel.ac.in/courses/106106144 <https://nptel.ac.in/courses/106102132> <https://www.youtube.com/watch?v=Uro0GDMR2A8>

#### Unit V

**Dockers**-Docker Basics and Architecture, what is containerization, how are containers different from physical machines and VMs, Docker evolution and architecture, Developments in Docker world, Docker tooling, Basic Docker commands. **Docker Networking**- Introduction, Types of Docker networks, Using

Networks, Identifying container networks.

**Docker Volumes**-Managing data in Docker containers with volumes, Volume file systems and basic Docker image file systems, Creating and managing volumes.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://www.youtube.com/watch?v=pTFZFxd4hOI> <https://docs.docker.com/>

#### Lab Component:

1. Working with s Linux commands
2. Implement of simple System programs.
3. Implement CPU Scheduling algorithms
4. Illustrate producer consumer problem using semaphore
5. Illustrate Inter process communication using suitable method
6. Illustrate Bankers algorithm for deadlock avoidance
7. Develop Paging technique for memory management
8. Illustrate page replacement algorithms
9. Implement any two file allocation strategies
10. Working with Docker commands

#### Text Book:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne: Operating System Principles, 9th edition, Wiley-India, 2012.

#### Reference Books:

1. William Stallings: Operating systems Internals and Design Principles, Ninth Edition, Pearson Education, 2018.
2. Remzi H. Arpaci-Dusseau and Andrea C. Arpaci- Dusseau, Operating, systems: Three easy pieces, URL: [http://pages.cs.wisc.edu/~remzi/OSTEP/.](http://pages.cs.wisc.edu/~remzi/OSTEP/)
3. James Turnbull: The Docker Book: Containerization is the new virtualization Kindle Edition, Kindle Edition,2014**.**

#### Course Outcomes (COs):

At the end of the course students should be able to:

1. Describe operating system operations and operating system structures.(PO- 1, 2, 3, PSO-1)
2. Assess different scheduling algorithms and concurrency control techniques to provide co-ordination among threads and processes. (PO-1, 2, 3, 4, 5, PSO-1,2)
3. Illustrate various methods for handling deadlocks and memory management Techniques. (PO-1, 2, 3, 4, 5, PSO-1,2)
4. Demonstrate different directory structure, file allocation methods and disk scheduling algorithms used for managing the disk. (PO-1, 2, 3, 4, 5, PSO-1,2)
5. Illustrate Dockers techniques for various networking and file system applications. (PO-1, 2, 3, 4, 5, PSO-1,2,3)

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| **FUNDAMENTALS OF DATA SCIENCE** | |
| **Course Code: AD54** | **Credits: 3:1:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42 L** |
| **Course Coordinator: Swetha B N** | |

**Course Content**

**Unit I**

What is Data Science? Visualizing Data, matplotlib, Bar Charts, Line Charts, Scatterplots, Linear Algebra, Vectors, Matrices, Statistics, Describing a Single Set of Data, Correlation, Simpson‟s Paradox, Some Other Correlational Caveats, Correlation and Causation. Probability, Dependence and Independence, Random Variables, Continuous Distributions, The Normal Distribution.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: https://nptel.ac.in/courses/106106179

https://nptel.ac.in/courses/106106212

**Unit II**

Statistical Hypothesis Testing, Example: Flipping a Coin, p-Values, Confidence Intervals, p-Hacking, Example: Running an A/B Test, Bayesian Inference, Gradient Descent, The Idea Behind Gradient Descent, Estimating the Gradient, Using the Gradient, Choosing the Right Step Size, Using Gradient Descent to Fit Models, Minibatch and Stochastic Gradient Descent

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://nptel.ac.in/courses/106106179>

https://nptel.ac.in/courses/106106212

**Unit III**

Getting Data, stdin and stdout, Reading Files: The Basics of Text files, Delimited files, Scraping the Web, HTML and the Parsing Thereof, Example: Keeping Tabs on Congress, Using APIs, JSON (and XML), Using an Unauthenticated API, Finding APIs, Example: Using the Twitter APIs, working with Data, Exploring Your Data, Using Named Tuples, Data classes, Cleaning and Munging, Manipulating Data, Rescaling, An Aside: tqdm, Dimensionality Reduction.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: https://nptel.ac.in/courses/106106179 https://nptel.ac.in/courses/106106212

**Unit IV**

Modeling, What Is Machine Learning? Overfitting and Underfitting, Correctness, The Bias-Variance Tradeoff, Feature Extraction and Selection, The Model, Example: The Iris Dataset, The Curse of Dimensionality, A Really Dumb Spam Filter, A More Sophisticated Spam Filter, Implementation, Testing Our Model, Using Our Model, The Model, Using Gradient Descent, Maximum Likelihood Estimation.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: https://nptel.ac.in/courses/106106179

https://nptel.ac.in/courses/106106212

**Unit V**

Multiple Regression, The Model, Further Assumptions of the Least Squares Model, Fitting the Model, Interpreting the Model, Goodness of Fit, Digression: The Bootstrap, Standard Errors of Regression Coefficients, Regularization, Logistic Regression, The Problem, The Logistic Function, Applying the Model, Goodness of Fit. Random Forests, Clustering, The Idea, The Model, Example: Meetups,

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: https://nptel.ac.in/courses/106106179 <https://nptel.ac.in/courses/106106212>

**Suggested Learning Resources**

**Text Books:**

1. Joel Grus, “Data Science from Scratch”, 2nd Edition, O’Reilly Publications/Shroff Publishers and Distributors Pvt. Ltd., 2019. ISBN-13: 978- 9352138326

**Reference Books:**

1. Emily Robinson and Jacqueline Nolis, “Build a Career in Data Science”, 1st Edition, Manning Publications, 2020. ISBN: 978-1617296246.
2. AurélienGéron, “Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems”, 2nd Edition, O'Reilly Publications/Shroff Publishers and Distributors Pvt. Ltd., 2019. ISBN-13: 978-1492032649.
3. François Chollet, “Deep Learning with Python”, 1st Edition, Manning Publications, 2017. ISBN-13: 978-1617294433
4. Jeremy Howard and Sylvain Gugger, “Deep Learning for Coders with fastai and PyTorch”, 1st Edition, O'Reilly Publications/Shroff Publishers and Distributors Pvt. Ltd., 2020. ISBN-13: 978- 1492045526
5. Sebastian Raschka and Vahid Mirjalili, “Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2”, 3rd Edition, Packt Publishing Limited, 2019.ISBN-13: 978-1789955750

**Course Outcomes (COs) :**

The students will be able to:

1. Demonstrate data using visualization tools. (PO- 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, PSO- 1, 2)
2. Interpret Statistical hypothesis tests to choose the properties of data, curate and manipulate data. (PO- 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, PSO- 1, 2)
3. Interpret the data and dimensionality reduction. (PO- 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, PSO- 1, 2)
4. Illustrate the machine learning algorithms and techniques to develop models. (PO- 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, PSO- 1, 2)
5. Demonstrate the construction of decision tree and data partition using clustering (PO- 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, PSO- 1, 2)

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| **DATA STORAGE TECHNIQUES** | |
| **Course Code: AD53** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42L** |
| **Course Coordinator: Dr. Siddesh G M** | |

**Course Content**

**Unit I**

Introduction: Information Storage, Evolution of Storage Architecture, Data Centre Infrastructure, Virtualization and Cloud Computing.

Data Centre Environment: Application, DBMS, Host, Connectivity, Storage, Disk Drive Components, Disk Drive Performance, Host Access to Data, Direct-Attached Storage, Storage Design Based on Application, Disk Native Command Queuing, Introduction to Flash Drives.

**Unit II**

Data Protection: RAID Implementation Methods, Array Components, Techniques, Levels, Impact on Disk Performance, Comparison, Hot Spares. Intelligent Storage System: Components, Storage Provisioning, Types.

**Unit III**

Fibre Channel Storage Area Networks: FC Overview, Evolution, Components, FC Connectivity, Ports, FC Architecture, Fabric Services, Login Types, Zoning, FC Topologies, Virtualization in SAN. IP SAN and FCoE: iSCSI, FCIP, FCoE.

**Unit IV**

Network-Attached Storage: Benefits, Components, NAS I/O Operation, Implementations, File Sharing Protocols, Factors Affecting NAS Performance, File-Level Virtualization.Object Based and Unified Storage: Object Based Storage Devices, Content Addressed Storage, CAS Use Cases, Unified Storage.

**Unit V**

Business Continuity: Information Availability, Terminology, Planning Lifecycle, Failure Analysis, Impact Analysis, Solutions. Cloud Computing: Cloud Enabling Technologies, Characteristics, Benefits, Service Models, Deployment Models, Infrastructure, Challenges, Adoption Considerations. Securing the Storage Infrastructure: Framework, Risk Triad, Domains. Managing the Storage Infrastructure: Monitoring, Management Activities, Management Challenges, Information Lifecycle Management, Storage Tiering.

**Text Book:**

1. Somasundaram G., Alok Shrivastava, (EMC Education Services); Information Storage and Management, 2e, Wiley India, 2012, ISBN 9788126537501.

**Reference Books:**

1. Robert Spalding; Storage Networks: The Complete Reference, Tata McGraw Hill, 2003.

**Course Outcomes (COs) :**

The students will be able to:

1. Describe storage architectures, and the logical and physical components of storage infrastructure including storage subsystems (PO- 1, 2, 4, 9, 10, PSO- 1, 2)
2. Describe RAID and intelligent storage systems (PO- 1, 2, 4, 9, 10, PSO- 1,2)
3. Illustrate storage networking technologies such as FC SAN, IP SAN, and FCoE (PO- 1, 2, 4, 9, 10, PSO- 1,2)
4. Discuss NAS, and object-based and unified storage (PO- 1, 2, 4, 9, 10, PSO- 1, 2)
5. Describe business continuity, cloud computing, storage security, storage monitoring and management activities (PO- 1, 2, 4, 9, 10, PSO- 1, 2, 3)

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| **AUGMENTED REALITY/VIRTUAL REALITY** | |
| **Course Code: ADE551** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42 L** |
| **Course Coordinator: Dr. Sowmya BJ** | |

**Course Content**

**Unit I**

History of AR, Augmented reality characteristics, Difference between Augmented Reality and Virtual Reality, AR technological components, Technologies used in AR, Feature Extraction, Hardware components, AR devices, Importance of AR, Real world uses of AR, AR types, Software tools available for AR.

* Pedagogy: Chalk and Talk, PowerPoint Presentations.

#### Unit II

Hardware technology, virtual scenes, 3D objects, AR components, Display, HMD, Eyeglasses Contact Lenses, significance of AR, AR powered devices, AR application development drawbacks, Compatibility, Performance, AR libraries, Motion tracking, Environmental understanding, Anchors.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos

#### Unit III

Technology use and integration in industrial settings, Assistive training to faculty members, Planning and administration for implementation, AR implications, Practical data, AR labs, Platforms to form AR content, Coordinated utilization of AR applications**.**

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos

#### Unit IV

Introduction: Definition of VR, modern experiences, historical perspective. Hardware, sensors, displays, software, virtual world generator, game engines, human senses, perceptual psychology, psychophysics. Geometric Modeling, transforming rigid bodies, yaw, pitch, roll, axis-angle representation, quaternions, 3D rotation inverses and conversions, homogeneous transforms, transforms to displays, look-at and eye transforms, canonical view and perspective transforms, viewport transforms.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos

#### Unit V

Light propagation, lenses and images, diopters, spherical aberrations, optical distortion; more lens aberrations; spectral properties; the eye as an optical system; cameras; visual displays. Parts of the human eye, photoreceptors and densities, scotopic and photopic vision, display resolution requirements, eye movements, neural vision structures, sufficient display resolution, other implications of physiology on VR. Depth perception, motion perception, vection, stroboscopic apparent motion, color perception

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos

## Suggested Learning Resources

#### Text Book:

1. Steven M. LaValle., virtual reality‘ Steven M. LaValle. Cambridge University Press 2016.
2. Kaliraj, P., Devi, T. (2021). Innovating with Augmented Reality: Applications in Education and Industry (P. Kaliraj, Ed.) (1st ed.). CRC Press, Taylor & Francis Group, Boca Raton, ebook ISBN 9781003175896 Auerbach Publications. https://doi.org/10.1201/9781003175896.

#### Course Outcomes (COs):

At the end of the course, the student should be able to:

1. Understand the concepts of Computer Graphics with respect to AR requirements (PO- 1, 9, 10, 12 PSO- 1)
2. Analyze the 3D viewing process & pipelines related to AR models. (PO- 1, 2, 9, 10, 12 PSO- 1)
3. Understand Computer Architecture and contextual knowledge of AR system (PO- 1, 9, 10, 12, PSO- 1)
4. Describe fundamentals of virtual reality systems. (PO- 1, 2, 3 PSO- 1, 2)
5. Understand the concepts of shading, image warping and interaction mechanisms. (PO- 1, 2, 3, PSO- 1,2)

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| **COMPUTER VISION** | |
| **Course Code: ADE552** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42 L** |
| **Course Coordinator: Dr. Sowmya B J** | |

**Course Content**

**Unit I**

**Introduction to Computer Vision:** Image representation and analysis, Image Formation – geometric primitives and transformations, photometric image formation, digital camera, Image Processing – point operators, linear filtering, segmentation, Features and object recognition, Image segmentation.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links**:** <https://onlinecourses.nptel.ac.in/noc23_ee78/preview> <https://nptel.ac.in/courses/108103174>

#### Unit II

**Binary Machine Vision:** Thresholding, hierarchical segmentation, spatial clustering, split & merge, rule-based segmentation, motion-based segmentation. Area Extraction: Concepts, Data-structures, Edge, Line-Linking, Hough transform, Line fitting, Curve fitting (Least-square fitting).

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Link**:** <https://nptel.ac.in/courses/117105101> <https://www.youtube.com/watch?v=vaS6rS8ZpkU>

#### Unit III

**Object motion and tracking**, Optical flow and feature matching, Robot localization, Graph slam, Object detection, face recognition, instance recognition, category recognition, Stereo Correspondence – Epipolar geometry, correspondence, 3D reconstruction.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://www.youtube.com/watch?v=W5mLa8p9xaw> <https://www.youtube.com/watch?v=6hr6xpOU-uw>

#### Unit IV

Image formation, projective geometry, lighting, Practical linear algebra, Image processing, descriptors, Image warping, Linear models with optimization.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links**:** <https://www.youtube.com/watch?v=IzXBT9GkzJ4> <https://archive.nptel.ac.in/courses/106/106/106106198/>

#### Unit V

CNN architecture, Recurrent neural networks, Attention mechanisms, Image captioning, Neural networks, Applications of neural networks, Motion and flow, Single-view geometry, multi-view geometry, Applications, Course Project.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://nptel.ac.in/courses/108103174> <https://nptel.ac.in/courses/117105101>

## Suggested Learning Resources

#### Text Book:

1. Computer Vision: Algorithms and Applications by Richard Szeliski.
2. Szeliski R., “Computer Vision: Algorithms and Applications”, Springer, 2010
3. Computer Vision: A Modern Approach (Second Edition) by David Forsyth and Jean Ponce.
4. Multiple View Geometry in Computer Vision (Second Edition) by Richard Hartley and Andrew Zisserman.

#### References:

1. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.

#### Course Outcomes (COs):

At the end of the course, the student should be able to:

1. Understand the fundamental image processing techniques required for computer vision. (PO-1, 2, 3, PSO-1, 2)
2. Understand the shape analysis (PO-1, 2, 3, PSO-1, 2)
3. Understand motion related techniques and 3D vision techniques. (PO-1, 2, 3, PSO-1, 2)
4. Apply CNN concepts in computer vision (PO-1, 2, 3, 4, 5, PSO-1, 2, 3)
5. Apply the knowledge of computer vision techniques to solve the real-life problem. (PO-1, 2, 3, 4, 5, PSO-1, 2, 3)

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| **COMPUTER ORGANIZATION AND ARCHITECTURE** | |
| **Course Code: AD553** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42 L** |
| **Course Coordinator: Dr. Sowmya B J** | |

**Course Content**

**Unit I**

**Basic Structure of Computers:** Basic Operational Concepts, Bus Structures, Performance – Processor Clock, Basic Performance Equation, Clock Rate, Performance Measurement. Machine Instructions and Programs: numbers, arithmetic operations and characters, Memory Location and Addresses, Memory Operations

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://youtu.be/4TzMyXmzL8M>

#### Unit II

**Instructions and Instruction Sequencing:** register transfer notation, assembly language notation, basic instruction types, branching, condition codes, generating memory address, **Addressing Modes:** variables and constants, indirection and pointers, indexing and arrays, relative addressing, Basic Input and Output Operations

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://youtu.be/4TzMyXmzL8M>

#### Unit III

**Arithmetic unit:** Multiplication of two numbers, A signed operand multiplication, Booth algorithm, Bit pair recoding and CSA – integer division, IEEE standard for floating point numbers, Operations, Guard bits and truncation.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://youtu.be/4TzMyXmzL8M>

#### Unit IV

**The Processor:** Introduction, a basic MIPS Implementation, Logic Design

Conventions: Clocking methodology, building a data path, an overview of pipelining: Designing instruction sets for pipelining, Pipeline hazards, Pipelined data path and control: Graphically representing pipelines, Data hazards: Forwarding versus stalling.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://youtu.be/4TzMyXmzL8M> <https://youtu.be/MIWTxHbPBA0>

#### Unit V

**Memory system:** cache memory, mapping functions, replacement algorithms, Performance Considerations: interleaving, hit rate and miss penalty, virtual memories, address translation.

**Input Output Unit:** Accessing I/O devices, Interrupts: Interrupt hardware, Enabling and disabling of interrupts

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos.
* Links: <https://youtu.be/4TzMyXmzL8M> <https://youtu.be/MIWTxHbPBA0>

#### Text Book:

1. Carl Hamacher, ZvonkoVranesic, SafwatZaky: Computer Organization, 5th Edition, Tata McGraw Hill, 2002.
2. David A. Petterson, John L. Hennessy: Computer Organization and Design, M.K Publishers, 4th edition, 2010
3. John L Hennessy, David A Patterson: Computer Architecture A Quantitative Approach, Elsevier, 5 th Edition 2012.

#### Reference Books:

* 1. W. Stallings: Computer Organization and Architecture: Designing For Performance, 8th edition, Prentice hall, 2012.
  2. L L Wear: Computer - An introduction to hardware and software design, McGraw Hill international edition, 1991.

#### Course Outcomes (COs):

1. Describe an overview of computer hardware and software which includes the basic functional units, interconnection (PO-1, 2, 3, PSO-1)
2. Illustrate Instruction sequencing and Addressing modes (PO-1, 2, 3, PSO-1).
3. Appraise different algorithms used to perform fast multiplication, division and to represent floating point numbers in binary. (PO-1, 2, 3, PSO-1)
4. Illustrate building a datapath for MIPS architecture and the advantages of pipelining to achieve instruction level parallelism. (PO-1, 2, 3, 4, PSO-1, 2)
5. Illustrate cache memory mapping techniques, various memory architectures and assessing the cache performance and Summarize the basics concepts of I/O, interrupts (PO-1, 2, 3, 4, PSO-1, 2)

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| **INTERNET OF THINGS** | |
| **Course Code: ADE554** | **Credits: 3:0:0** |
| **Pre – requisites: NIL** | **Contact Hours: 42 L** |
| **Course Coordinator: Dr. Vaneetha M** | |

**Course Content**

**Unit I**

**Introduction to Internet of Things**: 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, Communication Protocols, Embedded Systems IoT Levels & Deployment Templates, IoT Levels.

* + Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
  + Links: https://archive.nptel.ac.in/courses/106/105/106105166

**Unit II**

**Smart Objects**: The “Things” in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies

* + Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
  + Links: https://archive.nptel.ac.in/courses/106/105/106105166

**Unit III**

**RaspberryPi:** Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout and Pinouts, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi, Connecting Raspberry Pi via SSH, Remote access tools, Interfacing DHT Sensor with Pi, Pi as Webserver, Pi Camera, Image & Video Processing using Pi.

* + Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
  + Links: https://archive.nptel.ac.in/courses/106/105/106105166

**Unit IV**

Implementation of Microcomputer RaspberryPi and device Interfacing, Edge to Cloud Protocols- Protocols, MQTT, MQTT publish-subscribe, MQTT architecture details, MQTT state transitions, MQTT packet structure, MQTT data types, MQTT communication formats, MQTT 3.1.1 working example.

* + Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
  + Links: https://archive.nptel.ac.in/courses/106/105/106105166

**Unit V**

**IoT and Edge Computing Definition and Use Cases:** Introduction to Edge Computing Scenario's and Use cases - Edge computing purpose and definition, Edge computing use cases, Edge computing hardware architectures, Edge vs Fog Computing, Communication Models - Edge, Fog and M2M. **Case Study**: An IoT Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples.

* + Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
  + Links: https://archive.nptel.ac.in/courses/106/105/106105166

**Text Book:**

1. Internet of Things (A Hands-on-Approach) by Arshdeep Bagha, Vijay Madisetti University press 2015.
2. IoT and Edge Computing for Architects - Second Edition, by Perry Lea, Publisher: Packt Publishing, 2020, ISBN: 9781839214806
3. 2 Raspberry Pi Cookbook, 3rd Edition, by Simon Monk, Publisher: O'Reilly Media,
4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, 1st Edition, Pearson Education (Cisco Press Indian Reprint).

**References:**

1. Fog and Edge Computing: Principles and Paradigms by Rajkumar Buyya, Satish
2. Narayana Srirama, wiley publication, 2019, ISBN: 9781119524984.

David Jensen, “Beginning Azure IoT Edge Computing: Extending the Cloud to the Intelligent Edge, MICROSOFT AZURE

**Course Outcomes (COs):**

At the end of the course the students should be able to:

1. Understand the design issues and fundamentals of IoT (PO-1, 2, 3, PSO-1, 2)
2. Compare and contrast the deployment of smart objects and the technologies to connect them to network. (PO-1, 2, 3, PSO-1, 2)
3. Illustrate the architecture and programming essentials of RaspberryPi. (PO-1, 2, 3, 5, PSO-1, 2)
4. Demonstrate the implementation of MQTT protocol. (PO-1, 2, 3, 5, PSO-1, 2)
5. Identify the need, communication models and comparison between of Edge, Fog computing and the applications of IoT in Industry (PO-1, 2, 3, PSO-1, 2)

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| **SOFTWARE ENGINEERING WITH DEVOPS** | |
| **Course Code: ADE555** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42 L** |
| **Course Coordinator: Dr. Sowmya BJ** | |

**Course Content**

**Unit I**

**Evolution of Software Engineering,** Process Models– Waterfall Model, incremental model, Spiral Model, prototyping model, Agile Process and Principles, Scrum, Test-driven development, Rational Unified Process, maturity models, Critical Analysis of Process Models.

* Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
* Links: https://www.youtube.com/watch?v=qxv6vPlx2Cs&list=PLmAmHQ-\_5ySyCjVtHdSjJ64QU2x5TH8Dy

#### Unit II

**DevOps** – Introduction, DevOps life cycle, Principles, benefits, Roles, Responsibilities and skills for a DevOps engineer, DevOps versus Agile, Continuous Integration and Deployment, Tools at various stages of DevOps. MLOps - Processes and Tools.Requirements Engineering - Product versus service requirements engineering. Functional and Non- functional requirements, Requirements engineering process**.**

* Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
* Link: https://www.youtube.com/watch?v=1BSwYlJUxK0

#### Unit III

**Software Architecture Models**, Software Design – Concepts, Design principles, Object Oriented Design with UML, Software Design Patterns, Universal Design in Software Engineering. User Interface Design – Introduction, Golden rules, interface analysis and design process, Interface design steps, WebApp interface design.

* Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
* Link:https://www.youtube.com/watch?v=8UlLgOf20Ho&list=PL4JxLacgYgqTgS8qQPC17fM-NWMTr5GW6

#### Unit IV

**Coding**: Programming Principles &amp; Guidelines, Incrementally Developing Code, Managing Evolving Code.**Unit Testing and Testing:** Unit Testing, Code Inspection, Metrics Testing Concepts, Testing Process, Black-box Testing, White-box Testing, Metrics.

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| **MACHINE LEARNING LABORATORY** | |
| **Course Code: ADL56** | **Credits: 0:0:1** |
| **Pre – requisites: Basic Programming** | **Contact Hours: 14P** |
| **Course Coordinator: Dr. Sowmya BJ** | |

**Course Content**

1. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Find-S algorithm to output a description of the set of all hypotheses consistent with the training examples.
2. 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.
3. 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.
4. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
5. Write a program to implement the naive Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
6. 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 Python ML library classes/API.
7. 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 Python ML library classes/API in the program.
8. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
9. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs
10. Implement and demonstrate the working of SVM algorithm for classification.

## Suggested Learning Resources

**Text Books:**

Tom M Mitchell, “Machine Lerning”,1st Edition, McGraw Hill Education, 2017.

* 1. Nello Cristianini, John Shawe-Taylor, An Introduction to Support Vector Machines and Other Kernel-based Learning Methods, Cambridge University Press, 2013.
  2. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, 2nd Edition, Green Tea Press, 2015. (Available under CC-BY-NC license at <http://greenteapress.com/thinkpython2/thinkpython2.pdf)>

#### Course Outcomes (COs):

At the end of the course the student will be able to:

1. Understand the Importance of different classification and clustering algorithms. (PO-1, 2, 3, 4, 5, 9, 12, PSO-1, 2, 3)
2. Demonstrate the working of various algorithms with respect to training and test data sets. (PO-1, 2, 3, 4, 5, 9, 12, PSO-1, 2, 3)
3. Illustrate and analyze the principles of Instance based and Reinforcement learning techniques, Elicit the importance and Applications of Supervised and unsupervised machine learning, and Compare and contrast the Bayes theorem principles and Q learning approaches. (PO-1, 2, 3, 4, 5, 9, 12, PSO-1, 2, 3)

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| **PARALLEL PROGRAMMING LABORATORY** | |
| **Course Code: ADL57** | **Credits: 0:0:1** |
| **Pre – requisites: Basic Programming** | **Contact Hours: 14P** |
| **Course Coordinator: Dr. Vinay T R** | |

**Course Content**

The Students are required to perform

1. OpenMp parallel programs on using #pragma directive in C.
2. OpenMp parallel programs on using #pragma directive using work sharing constructs in C
3. OpenMp programs using sections like omp for and omp single.
4. OpenMp programs on parallel constructs.
5. OpenMp programs on task construct.
6. OpenMp programs using thread private directives.
7. OpenMp programs using thread private directives.
8. OpenMp programs on threads scheduling.
9. OpenMp programs using last private reduction, copying and shared.
10. Programs for Point to Point MPI calls.
11. Programs for Message passing MPI calls.
12. CUDA programs on message passing.
13. CUDA programs on broadcasting
14. Graph Processing with GPU

**Suggested Learning Resources**

**Text Books:**

1. Rubin H Landau, Oregon State University, http://science.oregonstate.edu/ ubin/
2. Ananth Grama,Anshul Gupta,Vipin kumar, George Karypis Introduction to parallel computing, second edition, Pearson education publishers.
3. David B Kirk, Wen-mei W. Hwu, “Programming Massively Parallel Processors – A Hands-on Approach”, First Edition, Elsevier and nvidia Publishers, 2010.

**Reference Books:**

1. Thomas Rauber and Gudula Runger Parallel Programming for Multicore and cluster systems,Springer International Edition, 2009 .
2. Hennessey and Patterson Computer Architecture: A quantitative Approach, Morgan Kaufman Publishers
3. Michael J.Quin “Parallel Programming in C with MPI and Open MP”, McGraw Hill.
4. Madisetti Universities Press (India) Private Limited

**Course Outcomes (COs):**

At the end of the course, students will be able to:

#### Design and develop parallel programs using OpenMP programming interface. (PO-1, 2, 3, 4, 5, 9, 12, PSO-1, 2, 3)

#### Elaborate the principles and architecture of message-passing programming paradigm for solving real world problems. (PO-1, 2, 3, 4, 5, 9, 12, PSO-1, 2, 3)

#### Analyze the features of GPUs, their functionalities and also Design parallel applications using CUDA-C. (PO-1, 2, 3, 4, 5, 9, 12, PSO-1, 2, 3)

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| **RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS** | |
| **Course Code: AL58** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42L** |
| **Course Coordinator: Dr. Siddesh G M** | |

**Course Content**

**Unit I**

**Introduction:** Meaning of Research, Objectives of Research, Types of Research, Ethics in Research, Types of Research Misconduct.

Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art, Bibliographic Databases, Conceptualizing Research, Critical and Creative Reading.**Citations:** Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge flow through Citations, Acknowledgments, and Attributions.

* Pedagogy: Chalk and Talk, PowerPoint Presentations
* Links: <https://onlinecourses.nptel.ac.in/noc22_ge08/preview>

#### Unit II

**Research Design:** Need for Research Design, Important Concepts Related to Research Design: Dependent and Independent Variables, Extraneous Variable, Variable, Common Control, Confounded Relationship, Research Hypothesis, Experimental and Control Groups, Treatments.**Experimental Designs:** Introduction to Randomised Block Design, Complete Randomised Design, Latin Square Design, and Factorial Design.

* Pedagogy: Chalk and Talk, PowerPoint Presentations
* Links: <https://onlinecourses.nptel.ac.in/noc22_ge08/preview>

#### Unit III

**Method of Data Collection:** Primary and Secondary Data Collection.

**Sampling Design:** Sampling fundamentals, Measurement, and Scaling Techniques, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, and Types of Sample Design.**Data Analysis:** Testing of Hypotheses: Null Hypothesis, Alternative Hypothesis, Type I and Type II Errors, Level of Significance. Procedure for Hypothesis Testing: Mean, Variance, Proportions. Chi-square Test, Analysis of Variance (One Way

ANOVA), and Covariance (ANOCOVA)

* Pedagogy: Chalk and Talk, PowerPoint Presentations
* Links: <https://onlinecourses.nptel.ac.in/noc23_ge36/preview>

#### Unit IV

**Introduction to IPR:** Different forms of IPR, Role of IPR in Research and Development. TRIPS Agreement, Patent Cooperation Treaty (PCT).

**Patents:** Brief history of Patents-Indian and Global Scenario, Principles Underlying Patent Law, Types of Patent Applications in India, Procedure for Obtaining a Patent. Non Patentable Inventions. Rights Conferred to a Patentee, Basmati Rice Patent Case.

* Pedagogy: Chalk and Talk, PowerPoint Presentations
* Links: <https://archive.nptel.ac.in/courses/110/105/110105139/>

#### Unit V

**Design:** What is a Design? Essential Requirements for a Registrable Design, Procedure of Registration of a Design,

**Trademarks:** Essentials of a Trademark, Registration, and Protection of Trademarks, Rights Conferred by Registration of Trademarks, Infringements, Types of Reliefs, Case Studies.

**Copyrights:** Characteristics of Copyrights, Rights Conferred by Registration of Copyrights, Registration of Copyrights, Infringements, Remedies against Infringement of Copyrights, Case studies

* + Pedagogy: Chalk and Talk, PowerPoint Presentations
  + Links: <https://archive.nptel.ac.in/courses/110/105/110105139/>

## Suggested Learning Resources

#### Text Books:

1. C. R Kothari, Gourav Garg, Research Methodology – Methods and Techniques. New Age International Publishers.
2. Dr. B L Wadehra – Law relating to Intellectual property. Universal Law Publishing Co.
3. Dipankar Deb, Rajeeb Dey, Valentina E. Balas “Engineering Research Methodology”, ISSN 1868-4394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13-2946-3 ISBN 978-981-13-2947- 0 (eBook), [https://doi.org/10.1007/978-981-13-2947-0.](https://doi.org/10.1007/978-981-13-2947-0)

#### Reference Book:

1. David V. Thiel “Research Methods for Engineers” Cambridge University Press, 978-1-107-03488-4

#### Course Outcomes (COs):

At the end of the course, the student will be able to:

1. Understand the knowledge of research and conduct a literature review**.**(PO- 8,10,12. PSO-2)
2. Apply the knowledge of research design and design of experiments. (PO-3, 4,8, 10, 12, PSO-2,3)
3. Analyse data collection methods, analysis, and sampling design. (PO-4, 8, 10, 12, PSO-2)
4. Understand the global and Indian scenarios of patents and patent applications. (PO-8, 10, 12, PSO-3)
5. Acquire the requirements of registration and infringements related to trademarks, copyrights, and designs. (PO-8, 10, 12, PSO-3)

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| **ABILITY ENHANCEMENT COURSE – V** | |
| **Subject Code: AEC510** | **Credits: 1:0:0** |
| **Pre requisites: Nil** | **Contact Hours: 14L** |
| **Course Coordinator: Any Dept** | |

**Course Content**

Ability Enhancement Courses (AEC) are the generic skill courses which are basic and needed by all to pursue any career. These courses are designed to help students enhance their skills in communication, language, and personality development. They also promote a deeper understanding of subjects like social sciences and ethics, culture and human behaviour, human rights and the law.

Every student shall register for AEC course under the supervision of his/her proctor. For III, IV & V semester, the student shall select the Ability Enhancement Course online such that the selected course does not overlap with any professional core/ elective course offered by the parent department of the student. After selection, the registration of the course has to be done by the student at his/her parent department.

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| **ENVIRONMENTAL STUDIES** | |
| **Course Code: HS59** | **Credits: 0:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 14L** |
| **Course Coordinator: -** | |

#### Course Content

#### Unit I

**Environment, Ecology and Biodiversity:** Definition, scope and importance. Multidisciplinary nature of Environmental studies. Food chain and food web. Energy flow and material cycling in ecosystem. Biodiversity and threats to biodiversity. Concept of sustainable development: Definition, objectives and applications.

* Pedagogy / Course delivery tools: Chalk and Talk, Power point presentations, Videos, Models
* Link: https://youtu.be/I\_bnGkviWOU https://youtu.be/Ar04qG1P8Es

#### Unit II

**Natural resources:** Forest resources: Ecological importance of forests. Water resources: Global water resources distribution. Mineral resources: Environmental effects of extracting and processing Mineral resources. Food resources: Effects of modern agriculture. Land resources: Soil erosion and Desertification.

* Pedagogy / Course delivery tools: Chalk and Talk, Power point presentations, Videos, Models
* Link: <https://youtu.be/vsXv3anIBSU> https://youtu.be/1rOVPqaUyv8

#### Unit III

**Energy sources:** Growing energy needs. Conventional and non-conventional / Renewable and Non-renewable energy sources. Bio Energy-Ethanol and Bio mass energy. Energy of the future – Hydrogen fuel cells and Nuclear energy. Environmental Impact Assessment (EIA): Definition, Objectives and benefits. Step by step procedure of conducting EIA.

* Pedagogy/Course delivery tools: Chalk and Talk, Power point presentations, Animations, Models
* Link: https://youtu.be/mh51mAUexK4 https://youtu.be/XS-eXqppf\_w

#### Unit IV

**Environmental pollution:** Definition, Causes, Effects and control measures of Water pollution, Air pollution and Soil/ land pollution. Management of Municipal Solid Waste and treatment methods of municipal solid waste.

* Pedagogy/Course delivery tools: Chalk and Talk, Power point presentations, Videos
* Link: https://youtu.be/NRoFvz8Ugeo https://youtu.be/DAQapF-F4Vw

#### Unit V

**Environmental protection:** Global warming and Climate change, Acid rain, Ozone layer depletion. Salient features of Environmental Protection Act, Air & Water Acts. Functions of Central and State Pollution Control Boards.

* Pedagogy/Course delivery tools: Chalk and Talk, Power point presentations, Opens source softwares
* Link: https://youtu.be/iV-BvYwl4Y8
* Link: https://youtu.be/BYqLRGawoH0

#### Text Books:

1. **Dr. S M Prakash**–Environmental Studies, Elite Publishers, 2007.

#### Reference Books:

1. **P. Venugopala Rao**–Principles of Environmental Science & Engineering Prentice Hall of India, 1st edition, 2006.

#### Web links and video Lectures (e- Resources):

1. https://youtu.be/I\_bnGkviWOU
2. https://youtu.be/vsXv3anIBSU
3. https://youtu.be/mh51mAUexK4
4. https://youtu.be/NRoFvz8Ugeo
5. <https://youtu.be/iV-BvYwl4Y8>

#### Course Outcomes (COs):

At the end of the course, the student will be able to:

1. Describe the importance of environmental studies, sustainable development and biodiversity (PO-1, 7)
2. Explain the importance and conservation of impacts of natural resources (PO-1, 7)
3. Distinguish the energy sources and identify the alternative energy sources for sustainable development (PO-1, 7)
4. Identify the causes, effects and control measures of pollution in developmental activities (PO-1, 7)
5. Outline the current environmental issues and the role of the agencies for environmental protection (PO-1, 7)

# VI SEMESTER

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| **MANAGEMENT & ENTREPRENEURSHIP** | |
| **Course Code: AL61** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42L** |
| **Course Coordinator: Dr. M Shilpa/ Dr. M Rajesh** | |

**Course Content**

**Unit I**

**Introduction to Management:** Definition of Management, Its nature and purpose, Contributions of F.W. Taylor and Henry Fayol to management theory, Functions of managers.

**Planning:** Types of plans, Steps in planning, the planning process, Management by Objectives (MBO)

**Organizing:** The nature and purpose of organizing, Formal and informal organization.

Organization levels and Span of management, Principle of span of management, the structure and process of organizing

* Pedagogy: Chalk and Talk, PowerPoint Presentations
* Links: https://onlinecourses.nptel.ac.in/noc23\_mg33/preview

https://www.digimat.in/nptel/courses/video/110107150/L01.html

**Unit II**

**Staffing:** Situational factors affecting staffing.

**Leading:** Human factors in managing, definition of leadership, Ingredients of leadership

**Controlling:** Basic control process, Critical control points and standards, Control as a

feedback system, Feed forward control, Requirements for effective controls.

* Pedagogy: Chalk and Talk, PowerPoint Presentations
* Links: https://nptel.ac.in/courses/110107150

**Unit III**

**Introduction to Entrepreneurship:** The Foundations of Entrepreneurship: What is an Entrepreneurship? The benefits of Entrepreneurship, The potential drawbacks of Entrepreneurship; Inside the Entrepreneurial Mind: From Ideas to Reality: Creativity, Innovation and Entrepreneurship, Creative Thinking, Barriers to Creativity

* Pedagogy: Chalk and Talk, PowerPoint Presentations
* Links:https://www.youtube.com/watch?v=Hgj\_kRrvbhQ&list=PL7oBzLzHZ1  
   wXW3mtolxV5nIGn48NLKwrb

**Unit IV**

**The Entrepreneurial Journey:** Crafting a Business Plan: The benefits of creating a business plan, the elements of a business plan; Forms of Business Ownership and Buying an Existing Business: Sole proprietorships and partnership.

**Launching the Business:** Franchising and the Entrepreneur: Types of Franchising, the benefits of buying a Franchise

* Pedagogy: Chalk and Talk, PowerPoint Presentations
* Links:https://www.youtube.com/watch?v=Tzzfd6168jk&list=PLyqSpQzTE6M  
  8EGZbmNUuUM7Vh2GkdbB1R

https://www.youtube.com/watch?v=5RMqxtMwejM&list=PLyqSpQzTE  
6M9zMKj\_PSm81k9U8NjaVJkR

**Unit V**

**Small Scale Industry:** Definition, Characteristics, types, role of SSI in Economic Development, steps to start SSI- Govt. Policy towards SSI, Institutional support- TECKSOK, KIADB, KSSIDC, KSIMC, DIC, NSIC, SIDBI, KSFC.

* Pedagogy: Chalk and Talk, PowerPoint Presentations
* Links:https://www.nptel.ac.in/courses/110/105/110105067/

**Text Books:**

1. Harold Koontz, H. Weihrich, and A.R. Aryasri, Principles of Management, Tata McGraw-Hill, New Delhi, 2004.
2. Essentials of Entrepreneurship and Small Business Management – Norman Scarborough & Jeffrey Cornwall (Pearson, 2016)
3. Management and Entrepreneurship by K. R. Phaneesh, Sudha Publications, Bangalore

**References:**

1. Innovation & Entrepreneurship – Peter Drucker (Harper, 2006)
2. Entrepreneurship: The Art, Science, and Process for Success – Charles Bamford & Garry Bruton (McGraw-Hill, 2015)
3. Managent and Enterpreneuship-NVR Naidu, T Krishna Rao, I.K. International Publishing House Pvt. Ltd.@ 2008
4. Poornima M Charantimath, Entrepreneurship Development and Small Business Enterprises, Pearson Education, 2006.

**Course Outcomes (COs):**

At the end of the course, student will be able to

1. Plan and organize for the manpower in the given type of organization (PO-6, 9, 11)
2. Use staffing Leading and controlling functions for the given organization. (PO-6, 8, 9, 10)
3. Analyze the advantages and potential drawbacks of Entrepreneurship. (PO-6, 7, 8)
4. Develop a basic business plan and analyze the benefits of buying Franchise. (PO-3, 5, 7, 8, 11)
5. Identify the various institutions that provide financial support to small scale industries. (PO-6, 11)

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| **DEEP LEARNING** | |
| **Course Code: AD62** | **Credits: 2:1:0** |
| **Pre – requisites: Machine Learning Concepts** | **Contact Hours: 28L+14T** |
| **Course Coordinator: Dr. Sowmya B J** | |

**Course Content**

**Unit I**

[**Introduction to Deep Learning**](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/92f3c897-c0d4-40f8-8f63-bd11240f2189.xhtml)**:** [What is deep learning?](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/cdca0908-e953-4818-a66b-827620069a1b.xhtml) [Biological and artificial neurons](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/aea69155-506c-4a9d-b1ce-e6a0d7df9144.xhtml), XOR Problem, [ANN and its layers](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/b2edb74f-c2b9-433f-9530-a82e131fdd67.xhtml), [Exploring activation functions](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/29426301-d1c4-44d6-8095-8e2c247f11cb.xhtml), [Forward propagation in ANN](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/d7949388-a662-4dd3-8682-4523a3cc0d36.xhtml), [How does ANN learn?](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/202129ce-475e-4229-b2b9-7c2856ab85a4.xhtml), [Debugging gradient descent with gradient checking](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/9c6c2264-4704-45be-ade3-fbce1d926347.xhtml), [Building a neural network from scratch](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/39807511-5311-4114-bbad-1e996a8756aa.xhtml), Handwritten Digit Image Classification using Neural Networks.

* Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
* Links: <https://onlinecourses.nptel.ac.in/noc20_cs62/preview>

#### Unit II

**Regularization for Deep Learning**: Parameter Norm Penalties - L2 Parameter Regularization, Dataset Augmentation, Semi-Supervised Learning. Optimization for Training Deep Models: Challenges in Neural Network Optimization – Ill Conditioning, Local Minima, Plateaus, Saddle Points and Other Flat Regions.

* Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
* Links: <https://onlinecourses.nptel.ac.in/noc20_cs62/preview>

#### Unit III

[**Convolutional Networks**](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/af0b9e75-a9a0-4bc7-ad23-92d2ac4a2629.xhtml)**:** [What are CNNs?](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/b98b5648-5362-4c77-8f7b-e1739b40ec8f.xhtml)The [architecture of CNNs](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/610cf6ac-7c9a-4795-93a6-13a59fe86bf7.xhtml), [Forward propagation](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/a6f2899b-f50c-4047-9b13-4cc66a71ee26.xhtml), [Backward propagation](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/27fcab65-b3e3-4a8f-a940-386940be0089.xhtml), [CNN architectures](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/e8e9ba9b-c315-444e-aedc-14a1db54ac05.xhtml)-[LeNet architecture](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/cadf8d4b-b458-4d6b-a5a3-b312613c1b2c.xhtml), [Understanding AlexNet](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/fd256361-9b3b-473c-a5b7-ac63247125e9.xhtml), [Architecture of VGGNet](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/2f916949-1615-4354-a59e-bdd79d0981b5.xhtml), [GoogleNet](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/06351dec-9879-4c85-994f-384652aaee62.xhtml), [Capsule networks](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/6bff99d6-7745-4c72-8570-254a9e4f1953.xhtml), [Building Capsule networks](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/88a6f911-badb-4385-ba20-176824662b44.xhtml).

[**Learning Text Representations**](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/d184e022-0b11-492a-8303-37a6021c4bf6.xhtml)**:** [Understanding the word2vec model](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/ce1790f9-bebc-40a8-894f-ac9043a19e0a.xhtml), [Building the word2vec model using gensim](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/f4464cb6-c874-4810-bb3d-860ded20fea4.xhtml), [Visualizing word embeddings](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/c1744948-ec92-4b6b-88f3-735a78f3f5a7.xhtml), [Doc2vec](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/06852f19-9859-4d27-a1fb-77e9fddf15c1.xhtml), [Understanding skip-thoughts algorithm](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/83baae71-5381-40f6-8094-cea925ca5881.xhtml), [Quick-thoughts for sentence embeddings](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/c41b7437-c213-465b-9f3d-5887732ddbae.xhtml).

* Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
* Links: <https://onlinecourses.nptel.ac.in/noc20_cs62/preview>

#### Unit IV

**Recurrent Neural Network:** [Introducing RNNs](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/06e27ac0-db0d-45d7-84bd-cb4349b2eea6.xhtml), [The difference between feedforward networks and RNNs](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/ec119c16-3fd0-4515-9433-0e75c47a8b4a.xhtml), [Forward propagation in RNNs](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/557dc017-14a5-4188-b366-151b1d75fd48.xhtml), [Backpropagation through time](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/717a440d-1288-49de-99c5-aa9362172351.xhtml), [Vanishing and exploding gradients problem](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/ef56a261-b312-4505-9980-251c4ed52725.xhtml), [Different types of RNN architectures](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/18e4198e-94fe-409e-8e47-0fcfc946fddd.xhtml), [One-to-one architecture](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/10ce2c2c-27fd-4f5b-a314-4aec5db04fa6.xhtml), [One-to-many architecture](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/db4d03d3-1db6-41a5-8daf-07e58ff7f544.xhtml), [Many-to-one architecture](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/bfa4e3e0-75a5-47a0-8c6e-c63a32a7a046.xhtml), [Many-to-many architecture](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/c4a64a5b-a02d-49f4-a434-9ea910932b97.xhtml), [Generating song lyrics using RNNs](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/43132166-b4e7-4183-adcf-1fb627c6dc7e.xhtml)

**Long Short Term Memory** : Improvements to the RNN - [LSTM to the rescue](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/1ae22beb-43f9-44ec-a642-23e6eacc3faf.xhtml), [Understanding the LSTM cell](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/92757c12-d05b-46d7-bf9d-b69be471fcc4.xhtml), [Forward propagation in LSTM](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/4aff7d51-f9a3-46bb-abaa-35e680ae7706.xhtml), [Backpropagation in LSTM](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/6e0fa514-146e-443b-85b0-ce4cf1faa5aa.xhtml), [Predicting Bitcoin prices using LSTM model](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/caf7a4e4-7054-4105-81a0-09b111efb8cd.xhtml), [Gated recurrent units](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/06a59097-0d80-40c4-8f84-f41367b6c9c6.xhtml), [Bidirectional RNN](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/2da56c39-e66f-4870-9d52-57651b4c7292.xhtml), [Going deep with deep RN](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/67e3657b-3bf6-46b6-a6b4-d6e51cf3f651.xhtml)N, [Language translation using the seq2seq model](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/3066ec5f-53aa-471a-8240-dc29a6ae3867.xhtml).

* Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
* Links: <https://onlinecourses.nptel.ac.in/noc20_cs62/preview>

#### Unit V

**Deep Unsupervised Learning**: Generative Adversarial Networks (GANs), Difference between Discriminative Models and Generative Models, [Architecture of a GAN](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/1887470e-18b3-48ac-9b47-e25d29654fea.xhtml), [Demystifying the loss function](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/e249b015-2cd4-41ff-a010-4dfc32f02ac4.xhtml), [Generating images using GANs](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/bfe6c8a3-86b3-4465-b6f5-55a09a06e014.xhtml), [DCGAN – Adding convolution to a GAN](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/8c7f39e2-b35b-4afd-9cdc-d65203766bd2.xhtml), [Least squares GAN](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/6343dc6c-386d-4108-b85c-e27b49160a9f.xhtml), [GANs with Wasserstein distance](https://learning.oreilly.com/library/view/hands-on-deep-learning/9781789344158/11f342a7-2f65-44af-8e9c-b50c36c9294d.xhtml).

**Advance Topic in Deep Learning:** What is an Autoencoder? Autoencoders with Convolutions, Exploring denoising autoencoders, Understanding sparse Autoencoders, What is few-shot Learning?

Detection and Segmentation : YOLO, Faster R-CNNs, Single Shot Detectors (SSDs).

* Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
* Links: <https://onlinecourses.nptel.ac.in/noc20_cs62/preview>

## Suggested Learning Resources

### Text Books:

1. Ravichandiran, S. (2019). Hands-On Deep Learning Algorithms with Python: Master deep learning algorithms with extensive math by implementing them using TensorFlow. Packt Publishing Ltd.
2. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT press.

### Reference Book:

1. Gulli, A., & Pal, S. (2017). Deep learning with Keras. Packt Publishing Ltd.

2. Balas, V. E., Roy, S. S., Sharma, D., & Samui, P. (Eds.). (2019). Handbook of deep learning applications (Vol. 136). New York: Springer.

### 

### Course Outcomes (COs):

At the end of the course, the student will be able to:

1. Understand the concepts and applications of neural networks and deep learning. (PO-1, 2, 3, 4, 5, 7, 9, 10, PSO-2, 3)
2. Analyze the concepts of regularization and optimization of neural networks for better performance. (PO-1, 2, 3, 4, 5, 6, 7, 10, PSO-2,3)
3. Illustrate various types of architectures such as Convolutional Neural Network and Deep Neural Network. (PO-1, 2, 3, 4, 5, 6, 7, 10, PSO-2, 3)
4. Assessing the Deep Sequence Models and Modern Recurrent Neural Networks for language translation. (PO-1, 2, 3, 4, 5, 6, 7, 10, PSO-1, 2, 3)
5. Apply Deep Unsupervised Learning to solve practical problems using Generative Adversarial Networks and Demonstrate applications of Deep Learning for Detection and Segmentation (PO-1, 2, 3, 4, 5, 6, 7, 12, PSO-1, 2, 3)

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| **ROBOTIC PROCESS AUTOMATION DESIGN AND DEVELOPMENT** | |
| **Course Code: ADE631** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42L** |
| **Course Coordinator: Dr. Sowmya B J** | |

**Course Content**

**Unit I**

**Programming Basics:** Introduction to Programming, Data and Data Structure, Algorithms**,** Variables and Arguments**,** Software Application and Software Development Life Cycle (SDLC)**,** Frameworks and Languages .**Automation and RPA**: History of Automation, Automation and its benefits, Introduction to RPA, Automation vs RPA, Process and Flowchart, RPA Programming Constructs, Robots in RPA, Introduction to Robots, Types of Robots, Benefits and Implementation of RPA.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: [https://www.uipath.com/rpa/robotic-process-automation.](https://www.uipath.com/rpa/robotic-process-automation)

#### Unit II

**RPA Tool Introduction and Basics:** RPA Development Life Cycle, How does RPA Work, Challenges in RPA, Variables and Types of Variables, Variables vs. Arguments, Namespaces, and Importing New Namespace.

**Control Flow Activity:** Sequences, Control Flow and its types, Decision control-IF, Switch, IF vs Switch, Loops-Do While, While, For each, Other control flow activities

* Delay, Break, Assign, Continue and Parallel.
* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: [https://www.uipath.com/rpa/robotic-process-automation.](https://www.uipath.com/rpa/robotic-process-automation)

#### Unit III

**Data Manipulation:** Data Manipulation and Its Importance, String Manipulations, Data Table Manipulations, Collection, Its Types and Manipulations.

**UI Automation & Selectors**: UI interactions, Input actions and Input methods, Containers, Recording & its types, Selectors, Types of Selectors- Full and Partial, Containers and Partial Selectors, Dynamic Selectors.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: [https://www.uipath.com/rpa/robotic-process-automation.](https://www.uipath.com/rpa/robotic-process-automation)

#### Unit IV

**Automation Concepts and Techniques:** Desktop and Web Recording, extraction and its techniques- Screen scraping, Data scraping and PDF Extraction. Automation Techniques- Workbook and Excel automation (read/write). **Email Automation:** Incoming Email automation - Sending Email automation.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: [https://www.uipath.com/rpa/robotic-process-automation.](https://www.uipath.com/rpa/robotic-process-automation)

#### Unit V

**Error and Exception Handling:** Errors, Error handling approach, Try Catch, Retry Scope, Exception Handling, Types of Exceptions, Global Exception Handler, Best Practice for Error Handling.

**Orchestrator:** Overview, Orchestrator Functionalities, Orchestrator User Interface- Automations, Management and Monitoring.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: [https://www.uipath.com/rpa/robotic-process-automation.](https://www.uipath.com/rpa/robotic-process-automation)

## Suggested Learning Resources

#### Text Book:

1. Alok Mani Tripathi, Learning Robotic Process Automation, Publisher: Packt Publishing .March 2018.

#### Reference Books:

1. Frank Casale (Author), Rebecca Dilla (Author), Heidi Jaynes (Author), Lauren Livingston (Author), Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation.
2. Richard Murdoch, Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant.
3. Srikanth Merianda, Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation.

#### Course Outcomes (COs):

At the end of the course, students should be able to:

1. Describe the History of Automation , Advent of Automation and Benefits of RPA (PO-2, 3, 4, 5, PSO-2)
2. Demonstrate the use of Sequence, Flowchart, and Control Flow Activities to build Workflow in Automation. (PO-2, 3, 4, 5, PSO-2)
3. Examine the RPA Techniques for Data Manipulation and UI automation.(PO- 2, 3, 4, 5, PSO-2)
4. Experiment the Automation Concepts and Techniques to interact with Desktop, Web and Email Applications. (PO-2, 3, 4, 5, 9, PSO-2)
5. Test the Bot using Orchestration server and Use Exception Handling Techniques for Error free Applications. (PO-2, 3, 4, 5, 9, PSO-2)

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| **DATA ENGINEERING AND MLOPS** | |
| **Course Code: ADE632** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42L** |
| **Course Coordinator: Dr. Sowmya BJ** | |

**Course Content**

**Unit I**

**Data Engineering**: Definition, The Data Engineering Lifecycle, Evolution of the Data Engineer, Data Engineering and Data Science, Data Engineering Skills and Activities, Data Maturity and the Data Engineer, The Background and Skills of a Data Engineer, Business Responsibilities, Technical Responsibilities, The Continuum of Data Engineering Roles, Data Engineers Inside an Organization , Internal-Facing Versus External-Facing Data Engineers, Data Engineers and Other Technical Roles, Data Engineers and Business Leadership.**Data Engineering Lifecycle:** The Data Lifecycle Versus the Data Engineering Lifecycle, Generation: Source Systems, Major Undercurrents Across the Data Engineering Lifecycle

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos

#### Unit II

**Data Architecture:** Enterprise Architecture Defined, Data Architecture Defined, “Good” Data Architecture, Principles of Good Data Architecture, Major Architecture Concepts, Domains and Services , Distributed Systems, Scalability, and Designing for Failure ,Tight Versus Loose Coupling: Tiers, Monoliths, and Microservices , User Access: Single Versus Multitenant , Event-Driven Architecture , Examples and Types of Data Architecture Choosing Technologies Across the Data Engineering Lifecycle: Team Size and Capabilities, Speed to Market, Interoperability, Cost Optimization and Business Value, Total Cost of Ownership Total Opportunity Cost of Ownership, FinOps, Today Versus the Future: Immutable Versus Transitory Technologies: Hybrid Cloud, Multicloud , Decentralized: Blockchain and the Edge ,Monolith Versus Modular , Serverless Versus Servers, Server Versus Serverless evaluation

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos

#### Unit III

**MLOps Challenges**, MLOps to Mitigate Risk, Risk Assessment,Risk Mitigation, MLOps for Responsible AI,MLOps for Scale. Key MLOps Features: Model Development, Establishing Business Objectives, Data Sources and Exploratory Data Analysis, Feature Engineering and Selection, Training and Evaluation, Reproducibility, Responsible AI, Productionalization and Deployment, Model Deployment Types and Contents, Model Deployment Requirements, Monitoring

Developing Models: Machine Learning Model, Required Components, Different ML Algorithms, Different MLOps Challenges, Data Exploration, Feature Engineering and Selection, Feature Engineering Techniques, How Feature Selection Impacts MLOps Strategy, Experimentation, Evaluating and Comparing Models, Choosing Evaluation Metrics, Cross- Checking Model Behavior, Impact of Responsible AI on Modeling, Version Management and Reproducibility

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos

#### Unit IV

**Preparing for Production:** Runtime Environments, Adaptation from Development to Production Environments, Data Access Before Validation and Launch to Production, Final Thoughts on Runtime Environments, Model Risk Evaluation, The Purpose of Model Validation, The Origins of ML Model Risk, Quality Assurance for Machine Learning

**Deploying to Production**: CI/CD Pipelines, Building ML Artifacts, The Testing Pipeline, Deployment Strategies, Categories of Model Deployment, Considerations When Sending Models to Production, Maintenance in Production, Containerization, Scaling Deployments, Requirements and Challenges.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos

#### Unit V

**Monitoring and Feedback Loop**: Models Be Retrained, Understanding Model Degradation, Ground Truth Evaluation, Input Drift Detection, Drift Detection in Practice, Example Causes of Data Drift, Input Drift Detection Techniques, The Feedback Loop, Logging, Model Evaluation, Online Evaluation

**Model Governance:** Governance the Organization Needs, Matching Governance with Risk Level, Current Regulations Driving MLOps Governance, Pharmaceutical Regulation in the US: GxP Financial Model Risk Management Regulation, GDPR and CCPA Data Privacy Regulations, The New Wave of AI-Specific Regulation, The Emergence of Responsible AI, Key Elements of

Responsible AI (Element 1 to element 5), A Template for MLOps Governance (Step 1 to 8**)**

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos

#### Text Books:

1. Joe Reis, Matt Housley Fundamentals of Data Engineering: Plan and Build Robust Data Systems, O’Reilly, 2022
2. Mark Treveil and the Dataiku Team. Introducing MLOps How to Scale Machine Learning in the Enterprise, O’Reilly, 2020

#### Course Outcomes (COs):

At the end of the course the student will be able to:

1. Define the key concepts, roles, and responsibilities within the data engineering lifecycle and explain the relationship between data engineering and data science. (PO-2, 3, 4, 5, PSO-2)
2. Analyze the evolution, skills, and activities of data engineers, assessing their business and technical responsibilities within an organization. (PO-2, 3, 4, 5, PSO-2)
3. Evaluate principles and concepts of good data architecture, including distributed systems, scalability, and event-driven architecture, and their application in data engineering. (PO-2, 3, 4, 5, PSO-2)
4. Develop and implement MLOps strategies to mitigate risks, ensure responsible AI, and manage the lifecycle of machine learning models from development to production. (PO-2, 3, 4, 5, PSO-2)
5. Monitor and maintain production models by detecting data drift, managing feedback loops, and ensuring compliance with data governance regulations and standards. (PO-2, 3, 4, 5, PSO-2)

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| **ADVANCED ARTIFICIAL INTELLIGENCE** | |
| **Course Code: ADE633** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42L** |
| **Course Coordinator: Dr. Vaneetha M** | |

**Course Content**

**Unit I**

**Intelligent Agents:** Agents and Environments, Good Behavior: The Concept of 10 Rationality, The Nature of Environments, The Structure of Agents Problem Solving: Game Paying

* + Pedagogy: Chalk and Talk, PowerPoint Presentations
  + Link: <https://nptel.ac.in/courses/112105249>

**Unit II**

**Uncertain knowledge and Reasoning:** Quantifying **Uncertainty**, Acting under Uncertainty **Basic Probability Notation**, Inference **Using** Full Joint Distributions, Independence **Bayes 'Rule** and Its Use The Wumpus World Revisited.

* + Pedagogy: Chalk and Talk, PowerPoint Presentations
  + Link: <https://nptel.ac.in/courses/112105249>

**Unit III**

**Probabilistic Reasoning,** Representing Knowledge in an Uncertain Domain, The 10 Semantics of **Bayesian Networks, Efficient Representation** of Conditional Distributions Exact **Inference** in **Bayesian Networks,** Approximate Inference **in Bayesian** Networks.

* + Pedagogy: Chalk and Talk, PowerPoint Presentations
  + Link: <https://nptel.ac.in/courses/112105249>

**Unit IV**

**Definition of morality and ethics in AI-Impact on society**-Impact on human psychology-Impact on the legal system-Impact on the environment and the planet-Impact on trust

* Pedagogy: Chalk and Talk, PowerPoint Presentations
  + Link: <https://nptel.ac.in/courses/112105249>

**Unit V**

**Introduction to responsible AI**, Need for ethics in AI. AI for Society and Humanity, Fairness and Bias, Sources of Biases, Exploratory data analysis, limitation of a dataset, Preprocessing, inprocessing and postprocessing to remove bias, Group fairness and Individual fairness, Counterfactual fairness

* + Pedagogy: Chalk and Talk, PowerPoint Presentations
  + Link: <https://nptel.ac.in/courses/112105249>

**Suggested Learning Resources**

**Text Books:**

1. Stuart Russell, Peter Norvig, ―Artificial Intelligence: A modern approach‖, Pearson Education, India, 2016.
2. Negnevitsky, M, ―Artificial Intelligence: A guide to Intelligent Systems‖,. Harlow: Addison Wesley, 2002.
3. Virginia Dignum, “Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way” Springer Nature, 04-Nov-2019;ISBN-10 : 3030303705, ISBN-13 : 978-3030303709
4. y. Eleanor Bird, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield ,The ethics of artificial intelligence: Issues and initiatives, EPRS | European Parliamentary Research Service Scientific Foresight Unit (STOA) PE 634.452 – March 2020

#### Reference Books:

1. David Jefferis, ―Artificial Intelligence: Robotics and Machine Evolution‖, Crabtree Publishing Company, 1992.
2. Robin Murphy, Robin R. Murphy, Ronald C. Arkin, ―Introduction to AI Robotics‖, MIT Press, 2000.
3. Francis. X. Govers, ―Artificial Intelligence for Robotics‖, Packt Publishing, 2018.

#### Course Outcomes (COs):

At the end of the course, the student will be able to:

1. Demonstrate the fundamentals of Intelligent Agents. (PO-1, 2, 3, PSO-1, 2, 3)
2. Illustrate the reasoning on Uncertain Knowledge. (PO-1, 2, 3, PSO-1, 2, 3)
3. Explore the explanation-based learning in solving AI problems. (PO-1, 2, 3, 4, 5, PSO-1, 2, 3)
4. Demonstrate the applications of Rough sets and Evolutionary Computing algorithms. (PO- 1, 2, 3, 4, 5, PSO-1, 2, 3)
5. Design and perform an empirical evaluation of different algorithms on a problem formalization. (PO-1, 2, 3, 4, 5, 9, 10, 11, 12, PSO-1, 2, 3)

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| **DATA WAREHOUSE** | |
| **Course Code: ADE634** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42L** |
| **Course Coordinator: Swetha B N** | |

**Course Content**

**Unit I**

**Introduction to Data WareHouse**, Differences between operational data base systems and data Ware House, Data Ware House characteristics, Delivery Process: Data warehouse delivery method.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point

Presentation, Videos

* Links : <https://onlinecourses.nptel.ac.in/noc22_cs90/preview>

#### Unit II

**Architecture**: A multitier Architecture; Data warehouse models: Enterprise warehouse, Data mart and virtual warehouse, Extraction, Transformation and loading,

**Design**: Database Schema **,**Partitioning Strategy, Aggregations, Data Marting,MetaData,Sytem and Data Warehouse Process Managers.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links : <https://onlinecourses.nptel.ac.in/noc22_cs90/preview>

#### Unit III

**Data Cube**: A multidimensional data model, Stars, Snowflakes and Fact constellations: Schemas for multidimensional Data models, Dimensions: The role of concept Hierarchies,Measures:TheirCategorizationand computation, Typical OLAP Operations.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links : <https://onlinecourses.nptel.ac.in/noc22_cs90/preview>

#### Unit IV

**Hardware and Operational Design:** Introduction, Process, Server hardware, Client hardware; Physical Layout; Security; Backup and Recovery; Service Level Agreement; Operating the Data Warehouse.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point

Presentation, Videos

* Links : <https://onlinecourses.nptel.ac.in/noc22_cs90/preview>

#### Unit V

**Capacity Planning:** Introduction, Process, Estimating the load.

**Tuning the Data Warehouse:** Accessing performance, Tuning the data load, Tuning queries. **Testing the DataWarehose**: Developing the test plan, testing backup recovery and operational environment, testing the database and application, Logistics of the test.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links : <https://onlinecourses.nptel.ac.in/noc22_cs90/preview>

## Suggested Learning Resources

**Text Books:**

1. Sam Anahory and Dennis Murray, “Data Warehousing in the Real World” .
2. Pang-Ning Tan, Michael Steinbach, Vipin Kumar: Introduction to Data Mining, Pearson, First impression,2014..
3. Jiawei Han, Micheline Kamber, Jian Pei: Data Mining -Concepts and Techniques, 3rd Edition, Morgan Kaufmann Publisher, 2012.

#### Reference Book:

#### Michael.J. Berry,Gordon.S.Linoff: Mastering Data Mining , Wiley Edition, second edtion,2012

#### Course Outcomes (COs):

At the end of the course the students should be able to:

1. Demonstrate the functionality of the various data warehousing component.

(PO-1, 2, PSO-2)

1. Demonstrate the Architecture and Design of Data warehouse (PO-1, 2, PSO-2)
2. Design Multidimensional data model for data warehouse and analyze the market needs by applying suitable OLAP operations. (PO-1, PSO-2)
3. Demonstrate the tools/Hardware for server/client and understanding the security concept of data warehouse (PO-1, 2, 3, 4, 5, 9, 10, 12, PSO-2)
4. Developing the test plan for Data warehouse (PO-1, 2, 3, sPSO-2)

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| **INFORMATION AND NETWORK SECURITY** | |
| **Course Code: ADE641** | **Credits: 3:0:0** |
| **Pre – requisites: Basics of Computer Networks** | **Contact Hours: 42L** |
| **Course Coordinator: Swetha B N** | |

**Course Content**

**Unit I**

**Symmetric Ciphers:** Symmetric cipher model, cryptography, cryptanalysis, Substitution techniques, Transposition Techniques.

**Block Ciphers and the Data Encryption Standard**: Simplified DES, Block Cipher Principles, DES, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles, Block Cipher modes of operation

* Pedagogy/Course delivery tools: Chalk and talk, Power Point

Presentation, Videos

* + Links https://youtu.be/q0uUpf7w93A?feature=shared

#### Unit II

**Public Key Algorithms**: Introduction, Modular Arithmetic, RSA, Diffie-Hellman, Digital Signature Standards, How Secure are RSA and Diffie-Hellman, Elliptic Curve Cryptography.

**Hash and MAC Algorithms**: Secure Hash Algorithm, Whirlpool, HMAC and CMAC

* + Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
  + Links : <https://youtu.be/q0uUpf7w93A?feature=shared>

#### Unit III

**Passive information Gathering**: starting at the source, Mining Job ads and analyzing

Financial Data, Using Google to Mine sensitive information, Exploring Domain wnership.

**Detecting Live Systems:** Detecting Active Systems, Port Scanning, OS fingerprinting, Scanning countermeasures.

**Enumerating systems:** Enumerating systems, Advanced Enumeration

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links https://youtu.be/q0uUpf7w93A?feature=shared

#### Unit IV

**Automated Attack and Penetration Tools:** Why attack and penetration Tools are Important, Automated Exploit Tools, Determining Which Tools to use

**Defeating Malware:** Evolving threat, viruses, and Worms, Trojans.

**Malicious Software**: Viruses and Related Threats, Virus Countermeasures, DDoS Attacks

**Firewalls**: Firewall Design Principles, Trusted Systems

* Pedagogy/Course delivery tools: Chalk and talk, Power Point

Presentation,Videos

* Links : <https://youtu.be/q0uUpf7w93A?feature=shared>

**Unit V**

**Securing Wireless Systems**: Wi-Fi Basics, Wi-Fi Security, Wireless LAN threats, Exploiting wireless networks, Securing wireless Networks

**Intrusion Detection:** Overview ID detection and Prevention, IDS Types and Components, anoverview of Snort, Installing Snort on windows System, and Building snort rules and interface

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links : https://youtu.be/q0uUpf7w93A?feature=shared

**Suggested Learning Resources**

**Text Books:**

1. William Stallings, “Cryptography and Network Security principles and practices” 4thEdition PHI.
2. Charlie Kaufman et. al, Network Security, 2nd Edition PHI.
3. Michael Gregg, “Building your own Security LAB, A field Guide for Network Testing”Wiley India 2012.

#### Reference Book:

#### Forouzan, “Cryptography and Network Security” 3rd Edition, Tata McGraw Hill

#### Course Outcomes (COs):

At the end of the course the students should be able to:

1. Apply symmetric and block cipher technique to provide message confidentially. (PO-1, 2, PSO-2)
2. Apply asymmetric key algorithms to preserve message authentication and

confidentiality. (PO-1, 2, PSO-2)

1. Understand the different passive information gathering techniques. (PO-1, PSO-2)
2. Use the automated tools to detect various types of attacks. (PO-1, 2, 3, 4, 5, 9, 10, 12, PSO-2)
3. Understand the security concepts of wireless networks. (PO-1, PSO-2)

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| **ADVANCED ALGORITHMS** | |
| **Course Code: ADE642** | **Credits: 3:0:0** |
| **Pre – requisites: Nil** | **Contact Hours: 42L** |
| **Course Coordinator: Dr. Sowmya B J** | |

**Course Content**

**Unit I**

**Analysis Techniques**: Growth of Functions, Asymptotic notations, Standard notations and common functions, Recurrences and Solution of Recurrence equations – The Substitution method, The recurrence – tree method, The master method, Amortized Analysis: Aggregate, Accounting and Potential Methods.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: [https://pages.cs.wisc.edu/~shuchi/cou res/787-F07/about.html](https://pages.cs.wisc.edu/~shuchi/cou%20res/787-F07/about.html) [https://www.youtube.com/watch?v=0JUN9aDxVmI&list=PL2SOU6wwxB0uP](https://www.youtube.com/watch?v=0JUN9aDxVmI&list=PL2SOU6wwxB0uP4rJgf5ayhHWgw7akUWSf) [4rJgf5ayhHWgw7akUWSf](https://www.youtube.com/watch?v=0JUN9aDxVmI&list=PL2SOU6wwxB0uP4rJgf5ayhHWgw7akUWSf)

#### Unit II

**Graph Algorithms**: Bellman-Ford Algorithm, Single source shortest paths in a DAG, Johnson‟s Algorithm for sparse graphs, Maximum bipartite matching.

Trees: B-trees, Red- Black trees.

Hashing: General Idea, Hash Function, Separate Chaining, Open addressing, Rehashing, Extendible hashing.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: [https://pages.cs.wisc.edu/~shuchi/cou res/787-F07/about.html](https://pages.cs.wisc.edu/~shuchi/cou%20res/787-F07/about.html) <https://www.youtube.com/watch?v=tWVWeAqZ0WU>

#### Unit III

**Number** – Theoretic Algorithms: Elementary notations, GCD, Modular Arithmetic, Solving modular linear equations, The Chinese remainder theorem, Powers of an element, RSA cryptosystem. Heaps: Heaps, Priority Queues, Binomial Heaps, Fibonacci Heaps.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: [https://pages.cs.wisc.edu/~shuchi/cou res/787-F07/about.html](https://pages.cs.wisc.edu/~shuchi/cou%20res/787-F07/about.html) https://www.youtube.com/watch?v=0JUN9aDxVmI&list=PL2SOU6wwxB [uP4rJgf5ayhHWgw7akUWSf](https://www.youtube.com/watch?v=0JUN9aDxVmI&list=PL2SOU6wwxB0%20%20%20%20uP4rJgf5ayhHWgw7akUWSf)

#### Unit IV

**String Matching Algorithms**: Naïve string matching, Rabin – Karp algorithm, String matching with finite automata, Knuth-Morris-Pratt algorithm, Boyer- Moore Algorithms.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: [https://pages.cs.wisc.edu/~shuchi/cou res/787-F07/about.html](https://pages.cs.wisc.edu/~shuchi/cou%20res/787-F07/about.html) <https://www.youtube.com/watch?v=NkivfrexTw8>

#### Unit V

**Algorithmic Puzzles**: Magic Square, n-queens problem, Glove Selection, Ferrying Soldiers, Jigsaw Puzzle Assembly, A Stack of Fake Coins, Maximum Sum Descent, Hats of Two Colors, Pluses and Minuses, Searching for a Pattern, Locker Doors, Palindrome Counting, Inverting a Coin Triangle, Sorting 5 in 7.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: [https://pages.cs.wisc.edu/~shuchi/cou res/787-F07/about.html](https://pages.cs.wisc.edu/~shuchi/cou%20res/787-F07/about.html)

## Suggested Learning Resources

#### Text Books:

1. T H Cormen, C E Leiserson, R L Rivest and C Stein: Introduction to Algorithms 3/e, PHI, 2011.
2. Mark Allen Weiss: Data Structures and Algorithm Analysis in C++, 3rd Edition, Pearson Education, 2011.
3. Anany Levitin and Maria Levitin: Algorithmic Puzzle, Oxford University Press, 2011.

#### Reference Books:

1. Ellis Horowitz, Sartaj Sahni, S Rajasekharan: Fundamentals of Computer Algorithms, University Press, 2007.
2. Alfred V Aho, John E Hopcroft, J D Ullman: The Design and Analysis of Computer Algorithms, Pearson Education, 2011.

#### Course Outcomes (COs):

At the end of the course the student will be able to:

1. Devise recurrence relations and amortized cost of various operations. (PO- 1, 2, 3, 4, PSO-1, 2, 3)
2. Illustrate graph algorithms such as Bellman-Ford, Shortest path, and bipartite matching, B-trees, Red-Black trees and hashing techniques. (PO-1, 2, 3, 4, PSO- 1, 2, 3)
3. Identify the methods for solving modular linear equations, Chinese remainder theorem and RSA cryptosystem, Describe types of heaps such as Binomial and Fibonacci heaps. (PO-1, 2, 3, 4, 5, PSO-1, 2, 3)
4. Assess the string-matching algorithms such as Boyer-Moore and Knuth- Morris- Pratt algorithm. (PO-1, 2, 3, 4, 5, PSO-1, 2, 3)
5. Create mathematical models, objective functions and constraints to solve algorithmic puzzles. (PO-1, 2, 3, 4, 5, PSO-1, 2, 3)

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| **OPTIMIZATION TECHNIQUES FOR MACHINE LEARNING** | |
| **Course Code: ADE643** | **Credits: 3:0:0** |
| **Pre – requisites: Linear Algebra, Calculus,**  **Basic Programming** | **Contact Hours: 42L** |
| **Course Coordinator: Dr. Siddesh G M** | |

**Course Content**

**Unit I**

Basics of Linear Algebra and Calculus: Subspaces, EigenValue Decomposition, Singular Value Decomposition - Algorithms and Methods, PSD Matrices and Kernel Functions, Vector Calculus.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://onlinecourses.nptel.ac.in/noc23_cs64/preview>

#### Unit II

Convex Functions, First and Second Order Conditions for Optimizations, Convex and Non Convex Optimization problems in Machine Learning

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links : <https://onlinecourses.nptel.ac.in/noc23_cs64/preview>

#### Unit III

Gradient Descent: math, programming basic optimization problems and their solutions.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links : <https://onlinecourses.nptel.ac.in/noc23_cs64/preview>

#### Unit IV

Variants of Gradient Descent: Projected, Stochastic, Proximal, Accelerated, Coordinate

Descent, Training a Neural Network: Theory.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: https://onlinecourses.nptel.ac.in/noc23\_cs64/preview

#### Unit V

Newton‟s Method, Optimization for ML in practice: Pytorch/Tensor Flow. Training a Neural Network, Implementation.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links : <https://onlinecourses.nptel.ac.in/noc23_cs64/preview>

## Suggested Learning Resources

**Text Books:**

1. Linear Algebra and Learning from Data, Gilbert Strang
2. Convex Optimisation by Stephen Boyd
3. Optimisation for Machine Learning by Suvrit Sra, MIT Press.

#### Reference Book:

1. Foundations of Data Science, Avrim Blum and Ravi Kannan, Hindustan Book Agency/Cambridge University Press

#### Course Outcomes (COs):

At the end of the course the students should be able to:

1. Illustrate the foundations of Subspaces, EigenValue Decomposition, Singular Value Decomposition - Algorithms and Methods, required for solving optimization problems in the context of machine learning. (PO-1, 2, PSO-1)
2. Illustrate the foundations of PSD Matrices and Kernel Functions, Vector Calculus. (PO-2, 3, PSO-1)
3. Demonstrate optimization algorithms like stochastic gradient descent and its various variants to solve machine learning problems. (PO-3, 4, PSO-2)
4. Illustrate use of standard problem formulations as convex (SVM etc). (PO- 1, 2, PSO-1)
5. Illustrate use of standard problem formulations as non-convex (PO-1, 2, PSO-1)

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| **NOSQL DATABASES** | |
| **Course Code: ADE644** | **Credits: 3:0:0** |
| **Pre – requisites: NIL** | **Contact Hours: 42L** |
| **Course Coordinator: Dr. Vinay T R** | |

**Course Content**

**Unit I**

**Introduction to NoSQL:** Why NoSQL, RDBMS: Impedance mismatch, Application and Integration Database, Attack of the Clusters, The Emergence of NoSQL, Characteristics of NoSQL, Knowing when to use NoSQL versus a relational

Database, Deciding when to use a NoSQL database, Aggregate Data Models, Four Types of Data Model, its features and Example Databases: Key-Value, Document, Column-Family, Graph databases.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation,

Links: https://nptel.ac.in/courses/106104135

#### Unit II

**Introduction to Graph Database and Neo4J** –What is Graph?, A High level view of Graph Space, Power of graph databases, Graph Databases Embrace Relationships; **Neo4j CQL ─ Introduction:** Graph creation and querying - cypher query language - CREATE, MATCH, WHERE and RETURN clauses. Case study: Movies Database.

* Pedagogy/Course delivery tools: Power Point Presentation, Demonstration.
* Links: https://www.youtube.com/watch?v=oRtVdXvtD3o

#### Unit III

# Graph Data Modeling and Data Importing: CQL Functions, Graph Modeling Guidelines, Translating an RDBMS Schema to Graph, Refactoring the Graph, Data Import, Importing CSV files, Case Study: Importing Northwind Dataset.

* Pedagogy/Course delivery tools: Power Point Presentation, Demonstration
* Links: <https://www.youtube.com/watch?v=oRtVdXvtD3o>

**Unit IV**

**Introduction to Redis**: Redis ─ Overview, Five types of Data types, Keys, Redis Keys Commands – 16 commands usage, Patterns and Data Structures, Redis Modules, Connecting to Redis using Python and performing adding elements to list, fields to Hash, creating a transaction.

* Pedagogy/Course delivery tools: Power Point Presentation, Demonstration
* Links: <https://www.youtube.com/watch?v=-5r6PxFwv14>

#### Unit V

## Advance tools in Redis: Working with GEO: ADD, DIST in python, Sorted Sets, HyperLogLog, Publish and Subscribe,  Partitioning, Connecting Redis in Java, Steps to Deploying Redis in the Cloud - AWS, Azure.

* Pedagogy/Course delivery tools: Power Point Presentation, Demonstration.
* Links: https://www.youtube.com/watch?v=TR1GUDj9FFE

**Suggested Materials**

**Text Book:**

1. Graph Databases, By Ian Robinson, Jim Webber and Emil Eifrem Publisher: O'Reilly Media.
2. NoSQL Distilled, by Pramod J. Sadalage and Martin Fowler, Copyright 2013 Pearson Education, Inc.
3. Redis for Dummies by Steve Suehring Published byJohn Wiley & Sons, Inc. 2021.

#### Reference Book:

1. Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement, 2nd edition, Luc Perkins, Jim Wilson, Eric Redmond, 2018.

**Course Outcomes (COs):**

At the end of the course, students will be able to:

1. Distinguish the different types of NoSQL databases. (PO-1, 2, 4, 5 & PSO-1, 3)
2. Understand the benefits and use cases of graphs and graph databases (PO-2, 3, 5 & PSO-1, 3)
3. Use Cypher to load, query, and manipulate data in a graph database (PO-3, 5 & PSO-1, 3)
4. Gain proficiency in managing data effectively using Redis. (PO-2, 5 & PSO-1, 3).
5. Use Redis with Python, Java to design and build applications. (PO-2, 5 & PSO-1, 3).

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| **INFORMATION RETRIEVAL** | |
| **Course Code: ADE645** | **Credits: 3:0:0** |
| **Pre – requisites: NIL** | **Contact Hours: 42L** |
| **Course Coordinator: Dr. Siddesh G M** | |

**Course Content**

**Unit I**

**Introduction:** Overview, History of IR, **Text Operations:** Document preprocessing, Document Clustering, Text Compression, **Indexing:** Inverted files, **Mathematics for IR:** Set Theory, Mathematical Logic, Probability and Linear algebra, **Classic IR Models:** Boolean Model, Vector space model: tf-idf weighing, Probabilistic Model. **Language models for IR:** The language model and the query likelihood model.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://youtu.be/44XmuZgGgzI>

#### Unit II

**Evaluation Measures:** Precision, Recall, Alternative Measures, **Reference Collections:** TREC, **Relevance Feedback and Query Expansion**, **Text Classification:** The text classification problem, **Flat clustering:** Clustering in information retrieval, Problem Statement, **Hierarchical clustering:** Hierarchical agglomerative clustering, Single-link and Complete-link clustering.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://youtu.be/44XmuZgGgzI>

#### Unit III

**String Matching algorithms:** Knuth Morris Pratt and Rabin Karp, **Stemming algorithm:** Porter, **Map reduce algorithms:** tf- idf calculation and indexing**, Classification:** Naive Bayes algorithm, **Clustering:** k-means algorithm. **Machine learning Algorithms:** Machine- learned scoring, Result ranking by machine learning.

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://youtu.be/44XmuZgGgzI>

#### Unit IV

**Web search basics:** web characteristics**, Architecture of web search engine, Web Crawling and Indexing:** Overview, Crawling, Distributing Indexes, and Connectivity Servers. **Link analysis:** Web as a graph**,** Page Rank, Hubs and Authorities.

#### Unit V

**XML Retrieval:** Basic XML Concepts, Challenges in XML retrieval, a vector space model for XML retrieval, **Introduction to Semantic Web:** Purpose, Semantic Web Stack, RDF, RDFS, Ontology, Web ontology language (OWL) and ontology tools**.**

* Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
* Links: <https://youtu.be/44XmuZgGgzI>

## Suggested Learning Resources

#### Text Books:

1. Ricardo Baeza-Yates, Berthier Ribeiro-Neto: Modern Information Retrieval, Pearson Education, 1999.
2. Introduction to Information Retrieval. C.D. Manning, P. Raghavan, H. Schütze. Cambridge UP, 2008.

#### Reference Books:

1. William B Frakes, Ricardo Baeza Yates: Information Retrieval Data Structures and Algorithms, PH PTR, 1992.
2. David A Grossman, Ophir Frieder: Information Retrieval Algorithms and Heuristics, 2e, Springer, 2004
3. Mathematics for Classical Information Retrieval: Roots and Applications: Dariush Alimohammadi,
4. <http://www.dcc.fc.up.pt/~zp/aulas/1213/pde/geral/bibliografia/MIT.Press.A> Semantic. Web.Primer.eBook-TLFeBOOK.pdf

#### Course Outcomes (COs):

At the end of the course, student should be able to

1. Describe text operations and various information retrieval models. (PO-3, PSO-1)
2. Evaluate an IR system using various evaluation measures. (PO-2, 3, 4, PSO-1)
3. Apply various algorithms such as string matching, map reduce, classification and clustering. (PO-2, 3, PSO-3)
4. Design web search engine, web crawling and link analysis techniques.(PO- 3, 4, PSO-2)
5. Explain XML Retrieval and various semantic web technologies. (PO-2, 3, 4, PSO-2)

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| **DATA SCIENCE LABORATORY** | |
| **Course Code: ADL65** | **Credits: 0:0:1** |
| **Pre – requisites: NIL** | **Contact Hours: 14P** |
| **Course Coordinator: Dr. Sowmya B J** | |

**Course Content**

List of problems for which student should develop program and execute in the Laboratory

1. Setting up the DATAQ hardware, configuring the software, acquiring data from sensors, and analyzing the collected data.
2. The use of Apache Kafka for real-time data ingestion by setting up a Kafka environment, creating topics, producing and consuming messages, and monitoring Kafka topics.
3. Setting up Apache Flume, configuring sources, channels, and sinks, and ingesting data from a file source to a Hadoop Distributed File System (HDFS) sink.
4. Setting up a dataset, performing various What-If analysis scenarios using spreadsheet software (such as Microsoft Excel or Google Sheets), and interpreting the results to make informed decisions.
5. Setting up Apache Airflow, creating and scheduling DAGs (Directed Acyclic Graphs), and orchestrating a simple data pipeline that involves extracting data from a source, transforming it, and loading it into a destination.
6. Setting up AIF360, loading a dataset, assessing bias, and applying bias mitigation techniques.
7. Setting up Tableau, importing data, performing data transformation and analysis, and visualizing the results
8. Setting up Apache Cassandra, creating a keyspace and tables, performing CRUD operations, and running CQL (Cassandra Query Language) queries to analyze data.
9. Creating visualizations, and building interactive dashboards to gain insights from the data using Tableau

**Text Books:**

1. Michael Berthold, David J. Hand, ―Intelligent Data Analysis‖, Springer, 2007.
2. Tom White ―Hadoop: The Definitive Guide‖ Third Edition, O‘reilly Media, 2012.

**Course Outcomes (COs):**

At the end of the course, the student should be able to:

1. Demonstrate Data Acquisition and Data Ingestion Techniques (PO-1, 2, 3, 5, 9, 10, 11, 12, PSO- 1, 3)
2. Analyze data using Apache Airflow and AIF 360 for Bias mitigation. (PO-1, 2, 3, 5, 9, 10, 11, 12, PSO-1, 3)
3. Demonstrate the Visualization of the analysis using various tools. (PO-1, 2, 3, 5, 9, 10, 11, 12, PSO-1, 3)

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| **DEEP LEARNING LABORATORY** | |
| **Course Code: ADL66** | **Credits: 0:0:1** |
| **Pre – requisites: NIL** | **Contact Hours: 14P** |
| **Course Coordinator: Dr. Swetha B N** | |

**Course Contents**

**List of Exercises / Experiments:**

1. Implementation of different activation functions to train Neural Network.
2. Implementation of different Learning Rules
3. Implementation of Perceptron Networks
4. Implement basic image processing operations.
5. Apply style transfer for an images
6. Implement in python SVM/Softmax classifier for CIFAR-10 dataset
7. To build multi-layer neural networks
8. Image segmentation using mask RCNN
9. Study the effect of batch normalization and dropout in neural network classifier
10. Chatbot using bidirectional LSTMs
11. Image captioning with LSTMs
12. Object detection with single-stage and two-stage detectors (Yolo)
13. Implement image captioning with vanilla RNN using seq2seq model
14. To Learn and implement the DCGAN model to simulate realistic image

**Suggested Learning Resources**

**Text Books:**

1. Simon Haykin, Neural networks and Learning Machines, Third Edition, Pearson, 2016
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.

**Reference Book:**

1. Neural Networks and Deep Learning by Michael Nielsen <http://neuralnetworksanddeeplearning.com/>

**Course Outcomes (COs):**

At the end of the course, students will be able to-

1. Implement the various deep learning algorithms in Python. (PO-3, 5, 9, 12, PSO-2, 3)
2. Demonstrate with different deep learning frameworks like Keras, Tensor flow, PyTorch, Caffe etc. (PO-3, 5, 9, 12, PSO-2, 3)
3. Demonstrate recurrent, recursive nets function and practical problems can be mapped to these functions. (PO-3, 5, 9, 12, PSO-2, 3)

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| **INNOVATION/SOCIETAL/ENTREPRENEURSHIP BASED INTERNSHIP** | |
| **Course Code: INT68** | **Credits: 0:0:2** |
| **Pre – requisites: Nil** | **Contact Hours: -** |
| **Course Coordinator: Artificial Intelligence and Data Science Faculty** | |

**Course Content**

Students are required to carry out training in an Artificial Intelligence and Data Science industry or research organization or with a start-up or firm super specialty hospital for not less than four weeks after 4th or during 5th semester. The internship addresses innovation/societal contributions or should evolve a student's entrepreneurial skill sets. Students are required to submit a report on the same in the format provided by the internship committee at the department. The students will be evaluated by the training committee based on the rubrics informed to students by the committee.

#### Course Outcomes (COs):

On successful completion of this course, students will be able to

1. Analyze the functional aspects of Artificial Intelligence and Data Science (PO-2, 4, 7, 11, 12, PSO-1, 2, 3)
2. Enhance the communication skills to work in interdisciplinary teams in industry/organization. (PO-9, 10, PSO-2, 3)
3. Realize the professional and ethical responsibility. (PO-6, 7, 8, PSO-2, 3)

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| **MINI PROJECT** | |
| **Course Code: ADP67** | **Credits: 0:0:3** |
| **Pre – requisites: NIL** |  |
| **Course Coordinator: Dr. Sowmya BJ** | |

**Course Content**

Based on the curriculum learnt by the students, they are advised to choose suitable project topics and propose the methodologies involved in it. Students are required to carry out this mini project work for a duration of approximately 42 hours during their sixth semester particularly in the domain of artificial intelligence and Data Science. Based on their experiences in intra internship, as well as inter internships, which they carried out previously, they can propose its extension, as mini-project work.

# Guidelines:

As a part of Mini Project, students must carry out the following activities:

1. Students should form a group to carry out their project. The minimum group size is 3 and maximum group size is 4.
2. The groups will be attached to one Internal Guide by the Department.
3. Students can carry out their project in-house once guide approves the topic.
4. Identify the problem statement based on the current state of Art and trends in the area of Artificial Intelligence and Data Science.
5. Based on the survey, identify the project requirements and do feasibility study.
6. Identify and draw a system level architecture by showing subsystems and their input/output need.
7. Implement the programs using step by step for each module.
8. Integrate and examine the implementation and test the project scope and the requirements.
9. Prepare the demonstration of the Project documents and the presentation.
10. The evaluation is based on presentation and report.

# Assessment:

* CIE - Minimum 2 reviews of the project + any other relevant components (for 50 Marks)
* SEE - Project Demonstration + any other component as decided by Internal Examination (for 50 Marks)
* The evaluation will be done by the internal guide and a co-examiner twice during the semester.
* Mid-semester evaluation: Students must do a group presentation and produce documents of system requirements, and system design (during 6th week).
* Final Evaluation: At the End of the semester students must do a group presentation, demonstrate the project work and submit the complete report. (During 13th week).

# Course Outcomes (COs):

At the end of the course, student should be able to

1. Formulate a real-world problem and its requirements in the field of Artificial Intelligence and Data Science. (PO-1, 2, 3, 4, 6, 11, 12, PSO-1, 2, 3)
2. Develop a design document for a set of requirements. (PO-1, 2, 3, 4, 5, 11, 12, PSO-1, 2, 3)
3. Test and validate the conformance of the developed prototype against the original requirements of the problem. (PO-1, 2, 3, 4, 5, 11, 12, PSO-1, 2, 3)
4. Appraise the Contribution of an individual or in a team in development of the project. (PO-8, 9, 11, 12, PSO-1, 2, 3)
5. Develop effective communication skills for presentation of project related activities (PO-8, 9, 10, 11, 12, PSO-1, 2, 3)