*Course Information*

## GENERAL GUIDELINES

**Do's:-**

- Students should be on time for every lecture.
- Students are advised to show due respect to all faculty members.
- Students should keep the Classrooms, Laboratories and Workshops clean and tidy.
- Students must maintain absolute discipline and decorum, while on campus.
- **Students should come prepared with algorithm / flowchart / program / procedure for all the experiments before attending the laboratory session.**
- Students are advised to clarify their doubts in the respective courses with the faculty.
- Students have to inform their parents that they should follow up the progress of their wards by being in touch with the institution authorities at regular intervals.
- **Students are advised to be present for the mentor meetings conducted by their respective Faculty Advisors, failing which appropriate disciplinary action will be taken.**

**Don'ts:-**

- Students are not permitted to attend the class without the identity card, once issued.
- Ragging is strictly prohibited because it is punishable under Karnataka Education Act. Any student involved in ragging, will be severely punished – which includes handing over the case to Police, rustication from the college etc.
- Writing on desks and walls is strictly prohibited, failing which the students will be fined heavily. If the identity of the individual is not established the entire class / students in the block will be fined.
- Students must not use their cell phones during class hours. If any student is found using their cell phone during class hours it will be confiscated.
- Students are not supposed to alter the configuration of the system / any software on the systems.

## VI - SEMESTER (2022-26 BATCH)

| Sl. No | Course Code | Course Title | Hours per week | | | | CreditsC | Tools / Languages | Course Type |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | S | | | |
| 1 | UE22CS351B | Cloud Computing@@ | 4 | 0 | 2 | 5 | 5 | Amazon AWS (or equivalent), AWSSkill Builder, AWSEducate, Qwiklabs,Docker, Kubernetes, Jenkins, Zookeeper, Github, NoSQL database, Flask, Python, Go Lang. | CC |
| 2 | UE22CS352B | Object Oriented Analysis and Design | 4 | 0 | 2 | 5 | 5 | Star UML, Object Oriented Programming Language (Java/C++) | CC |
| 3 | UE22CS341B | Compiler Design! | 4 | 0 | 0 | 4 | 4 | Lex/flexandYACC/ Bison. | CC |
| 4 | UE22CS342BAX | Elective III | 4 | 0 | 0 | 4 | 4 | | EC |
| 5 | UE22CS343BBX | Elective IV | 4 | 0 | 0 | 4 | 4 | | EC |
| 6 | UE22CS320B | Capstone Project Phase-2 | 0 | 0 | 24 | 24 | 6 | | PW |
| **Total** | | | **20** | **0** | **26** | **46** | **28** | | |
| **Elective – III** | | | | | | | | | |
| 7 | UE22CS342BA1 | Supply Chain Management for Engineers | 4 | 0 | 0 | 4 | 4 | SCM applications and tools, ML tools, Case studies, Web resources. | EC-Independent |
| 8 | UE22CS342BA2 | Algorithms for Information Retrieval | 4 | 0 | 0 | 4 | 4 | Scikit, Tensorflow, Solr, Lucene Search Engines/ Python Programming Languages | EC-Independent |
| 9 | UE22CS342BA3 | Image Processing and Computer Vision ** | 4 | 0 | 0 | 4 | 4 | MatLab, Python Programming Languages | EC-Independent |
| 10 | UE22CS342BA4 | Natural Language Processing ## | 4 | 0 | 0 | 4 | 4 | Tensorflow, Scikit Learn, Python 3.x. CoreNLP, Natural Language Toolkit (NLTK), TextBlob,Gensim, SpaCy,PyTorch-NLP , OpenNLP, Hugging Face, OpenAI API. | EC-Independent |
| 11 | UE22CS342BA5 | BlockChain ! | 4 | 0 | 0 | 4 | 4 | Solidity, Remix, Ganache, Metamask. | EC-Independent |

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|---|---|---|---|---|---|---|---|---|---|
| 12 | UE22CS342BA6 | Digital Forensics and Incident Response | 4 | 0 | 0 | 4 | 4 | Open source tools on Forensics. | EC-Independent |
| 13 | UE22CS342BA7 | Digital Twin and eXtended Reality ! | 4 | 0 | 0 | 4 | 4 | C/ C++/ JAVA/ Python using OpenGL. | EC-Independent |
| 14 | UE22CS342BA8 | Topics in Wireless Networks and 5G | 4 | 0 | 0 | 4 | 4 | Wireshark, Claynet, Cisco Packet Tracker. | EC-Independent |
| 15 | UE22CS342BA9 | Generative AI and its Applications | 4 | 0 | 0 | 4 | 4 | Python,,HuggingFace, LM Studio, Kaggle | EC-Independent |
| 16 | UE22CS342BA10 | Cloud Security | 4 | 0 | 0 | 4 | 4 | AWS Security Services | EC- Independent |
| **Elective – IV** | | | | | | | | | |
| 17 | UE22CS343BB1 | Heterogeneous Parallelism !!! | 4 | 0 | 0 | 4 | 4 | pthread, OpenMP CUDA,openCL. | EC-Independent |
| 18 | UE22CS343BB2 | Topics in Deep Learning ## | 4 | 0 | 0 | 4 | 4 | Pytorch. | EC-Independent |
| 19 | UE22CS343BB3 | Database Technologies*** | 4 | 0 | 0 | 4 | 4 | MySQL, postgres, Oracle,Apache Spark, Apache Kafka, Amazon Kinesis. | EC-Independent |
| 20 | UE22CS343BB4 | Machine Learning on Graphs %%% | 4 | 0 | 0 | 4 | 4 | NetworkX for statistical features of graphs,Tensor flow Keras and Scikit Learn for traditional graph ML, and Pytorch Geometric for Graph Neural Networks. | EC-Independent |
| 21 | UE22CS343BB6 | Information Security | 4 | 0 | 0 | 4 | 4 | SSEED Labs VM, Scapy, Burp Suite, Metasploit,Nmap, etc. | EC-Independent |
| 22 | UE22CS343BB7 | Mobile and Autonomous Robotics | 4 | 0 | 0 | 4 | 4 | C, C++, Python, ROS | EC-Independent |
| 23 | UE22CS343BB8 | Security for Internet of Things. | 4 | 0 | 0 | 4 | 4 | Wireshark, Yersinia, VoIP Hopper, Bettercap,aircrack-ng | EC-Independent |
| 24 | UE22CS343BB9 | Applied ML in IoT with TinyML | 4 | 0 | 0 | 4 | 4 | Arduino Nano 33 BLEsense<br>Arduino IDE GoogleColab | EC-Independent |

**Note: Desirable Knowledge**
**Core:** [!]UE22CS252A, UE22CS243A [@@]UE22CS241B, UE22CS252B.

**Elective III:**[#] - UE22CS151A, UE22CS151B, UE22CS252A, UE22CS252B, UE22CS241B, [??] - UE22CS241B,UE22MA241B, UE22CS352A [**]- UE22CS241B, [##] - UE22CS352A, [!] - UE22CS252A.

**Elective IV:** [!!!]-UE22CS151B, UE22CS251B, [##]-UE22CS352A, *** - UE22CS351A, [%%%] - UE22CS343AB3,UE22CS352A, [%%] - UE22CS252B.

**ELECTIVES TO BE OPTED FOR SPECIALIZATION**

| Sl. No. | SPECIALIZATION | ELECTIVE – III | ELECTIVE – IV |
|---|---|---|---|
| A | System and Core Computing (SCC) | UE22CS342BA1, UE22CS342BA2, UE22CS342BA7 | UE22CS343BB1, UE22CS343BB3. |
| B | Machine Intelligence and Data Science (MIDS) | UE22CS342BA2, UE22CS342BA3, UE22CS342BA4, UE22CS342BA7, UE22CS342BA9 | UE22CS343BB2, UE22CS343BB4, UE22CS343BB7 UE22CS343BB9 |
| C | Cyber Security & Connected Systems (CSCS) | UE22CS342BA5, UE22CS342BA6, UE22CS342BA7, UE22CS342BA8, UE22CS342BA10. | UE22CS343BB6, UE22CS343BB7, UE22CS343BB8. |

*Course Information*

**UE22CS351B: Cloud Computing (4-0-2-5-5)**

**No of Credits: 5** **# of Hours: 126**

| Class # | Chapter Title /Reference Literature | Topics to be Covered | % of Portion covered | |
|---|---|---|---|---|
| | | | % of Syllabus | Cumulative % |
| **Unit – 1: Cloud Programming Models** | | | | |
| 1 | T1:Ch1 | Introduction to Cloud Computing Terminologies Parallel, Distributed Parallel computing | **25%** | **25%** |
| 2 | | | | |
| 3 | | Grid & Cloud Computing | | |
| 4 | | | | |
| 5 | | Introduction to Cloud Service Models and examples | | |
| 6 | | | | |
| 7 | | Technology challenges, Cloud Business Drivers, | | |
| 8 | | Deployment models (public, private, hybrid) | | |
| 9 | | Distributed System Models<br>Cloud Architecture | | |
| 10 | | | | |
| 11 | | IaaS Programming Model and AWS demo | | |
| 12 | T1:Ch5 | REST, Web Services | | |
| 13 | | | | |
| 14 | Ref | Paas Programming Model and PaaS demo | | |
| 15 | | Communication using Message queues - pub sub model | | |
| 16 | | | | |
| 17 | | SaaS Programming model – Microservices and monolithic model | | |
| 18 | | Challenges of migrating monolithic applications | | |
| 19 | | | | |
| 20 | | AWS Introduction – Lab preparation | | |
| **21** | | **Review - UNIT - I** | | |
| **22** | | | | |
| **23** | LAB 1 | Introduction to Serverless Computing with AWS Lambda | | |
| **24** | | | | |
| **25** | | | | |
| **26** | Expt 1 | AWS Cloud - Expt 1 | | |
| **27** | | | | |
| **28** | | | | |
| 27 | Expt 2 | AWS Cloud - Expt 2 | | |
| 28 | | | | |
| 29 | | | | |

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|---|---|---|---|---|
| **Unit – 2: Virtualization** | | | | |
| 29 | T1:Ch3 | Types of hypervisors | **25%** | **50%** |
| 30 | | Paravirtualization and Transparent virtualization | | |
| 31 | | Software – trap and emulate, binary translation | | |
| 32 | | Hardware - AMD/Intel | | |
| 33 | | Memory virtualization | | |
| 34 | Ref | Goldberg Popek principles for Virtualization | | |
| 35 | T1:Ch3 | VM Migration | | |
| 36 | Ref | Lightweight virtualization-Containers | | |
| 37 | | | | |
| 38 | Ref | namespaces, cgroups | | |
| 39 | | Deployment of cloud native applications through Docker | | |
| 40 | | | | |
| 41 | | Unionfs , DevOps | | |
| 42 | | Orchestration and Kubernetes | | |
| 43 | | | | |
| 44 | | Review - UNIT - 2 | | |
| 45 | | | | |
| 46 | Lab 2 | Containerization with Docker | | |
| 47 | | | | |
| 48 | | | | |
| 49 | Lab 3 | Deploying Applications with kubernetes | | |
| 50 | | | | |
| 51 | | | | |
| 52 | Expt 3 | AWS 101 – Expt 3 | | |
| 53 | | | | |
| 54 | | | | |
| 55 | Expt 4 | AWS Cloud – Expt 4 | | |
| 56 | | | | |
| 57 | | | | |
| 58 | T/CS | Tutorial – 1/ Case Study 1 | | |
| 59 | | | | |
| 60 | | | | |
| **Unit – 3: Distributed Storage** | | | | |
| 61 | T2:Ch3 | Storage layers – introduction | **25%** | **75%** |
| 62 | T2:Ch3 | block storage | | |
| 63 | T2:Ch4 | Object storage | | |
| 64 | | Partitioning – key-value data | | |
| 65 | T2:Ch4 | Consistent hashing | | |

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|---|---|---|---|---|
| 65 | | Partitioning - rebalancing partition | | |
| 66 | | Request Routing | | |
| 67 | T2:Ch4 | Replication, lag | | |
| 68 | T2:Ch4 | Multileader replication | | |
| 69 | MiniProject | MiniProject: Outline and plan | | |
| 70 | | | | |
| 71 | | | | |
| 72 | T2:Ch4 | Leaderless Replication | | |
| 73 | Ref | Consistency models | | |
| 74 | | | | |
| 75 | | CAP theorem | | |
| 76 | | Transactions, Two-phase commit | | |
| 77 | | | | |
| 78 | | Review - UNIT - 3 | | |
| 79 | | | | |
| 80 | Expt 5 | AWS Cloud – Expt 5 | | |
| 81 | | | | |
| 82 | | | | |
| 83 | Expt 6 | AWS Cloud – Expt 6 | | |
| 84 | Expt 6 Contd | | | |
| 85 | | | | |
| 86 | Lab 4 | Deploying Applications with Jenkins, GitHub actions | | |
| 87 | | | | |
| 88 | | | | |
| **Unit – 4 Cloud Controller, Performance, Scalability and Security** | | | | |
| 89 | T/CS | Tutorial – 2/ Case Study 2 | **25%** | **100%** |
| 90 | | | | |
| 91 | | | | |
| 92 | T1:Ch8 | Master-slave v/s p2p models | | |
| 93 | | Unreliable Communication | | |
| 94 | | Fault tolerance | | |
| 95 | Ref | Cluster coordination - consensus | | |
| 96 | Lab 5 | Consensus Algorithms: Raft | | |
| 97 | | | | |
| 98 | | | | |
| 99 | Expt 7 | AWS Cloud – Expt 7 | | |

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| 100 | | | | |
| 101 | | | | |
| 102 | | AWS Cloud - completion of badge claim | | |
| 103 | | | | |
| 104 | | | | |
| 105 | Ref | Cluster coordination – leader election, - Bully Algorithm | | |
| 106 | | Reverse proxies | | |
| 107 | | Scaling computation - hybrid cloud and cloud bursting | | |
| 108 | | Multitenancy, Multitenant databases | | |
| 109 | T1:Ch2 | Failure detection - checkpointing and application recovery | | |
| 110 | T1:Ch8 | Cloud security requirements - physical/virtual security, Authentication in the cloud: Keystone | | |
| 111 | Lab 6 | Introduction to Apache Zookeeper (alternative to Zookeeper as RAFT) | | |
| 112 | | | | |
| 113 | | | | |
| 114 | T1:Ch8 | Cloud Threats – DoS, Security architecture, legal and regulatory issues | | |
| 115 | T1:Ch8 | Economic Denial of Sustainability, Risk management, security design patterns | | |
| 116 | | Review - UNIT – 4 | | |
| 117 | | | | |
| 118 | | | | |
| 119 | Mini-Project [Review Session-1] | Mini Project: Evaluation (in Class activity: demo+viva) | | |
| 120 | | | | |
| 121 | Mini-Project [Review Session-2] | Mini Project: Evaluation (in Class activity: demo+viva) | | |
| 122 | | | | |
| 123 | Mini-Project [Review Session-3] | Mini Project: Evaluation (in Class activity: demo+viva) | | |
| 124 | | | | |
| 125 | Mini-Project [Review Session-4] | Mini Project: Evaluation (in Class activity: demo+viva) | | |
| 126 | | | | |

| Book Type | Code | Title & Author | Publication Information | | |
|---|---|---|---|---|---|
| | | | Edition | Publisher | Year |
| **Text Books** | T1 | "Distributed and Cloud Computing" From Parallel Processing to theInternet of Things, Kai Hwang,Geoffrey C. Fox,Jack J. Dongarra | | Morgan Kaufmann, Elsevier | 2012 |
| | T2 | Designing Data-Intensive Applications | | O'Reilly Media, Inc. | 2017 |
| **Reference Books** | R1 | "Moving to the Cloud" ,Dinkar Sitaram Geetha Manjunath | | syngress is an imprint of Elsevier | 2011 |
| | R2 | "Docker in Action", Jeff Nickoloff | | Manning Publications | 2016. |
| | R3 | "Cloud Native DevOps with Kubernetes", John Arundel and Justin Domingus | | O'Reilly Media, Inc. | 2019. |

*Course Information*

**UE22CS352B: Object Oriented Analysis and Design (4:0:2:5:5)**

**No of Credits: 5** **# of Hours: 126**

| Class # | Chapter Title/Reference Literature | Topics to be Covered | % of Portions Covered | |
|---|---|---|---|---|
| | | | Reference Chapter | Cumulative |
| 1. | **Unit 1: Object Oriented Design and UML Diagrams - Requirements, Modeling and Analysis (T1, T2, R2)** | Introduction to the course and UML | 25 | 25 |
| 2. | | Use Cases Diagrams. | | |
| 3. | | Use Cases Diagrams. | | |
| 4. | | Class Modeling: UML Class Diagrams | | |
| 5. | | Class Modeling: UML Class Diagrams | | |
| 6. | | Class Modeling: OO relationships | | |
| 7. | | **Lab 1: Online UML Modeling Tool Demo** | | |
| 8. | | **Mini Project Team Formation** | | |
| 9. | | **Mini Project Title Submission** | | |
| 10. | | Class Modeling: Example Case Study | | |
| 11. | | CRC Diagram with case study | | |
| 12. | | Component model | | |
| 13. | | Deployment model | | |
| 14. | | Activity Modeling: UML Activity Diagrams and Modeling, Guidelines. | | |
| 15. | | Activity Modeling: UML Activity Diagrams and Modeling, Guidelines. | | |
| 16. | | **Lab 2: Case Study on Use Case Modeling** | | |
| 17. | | **Lab 2: Case Study on Use Case Modeling** | | |
| 18. | | **Lab Evaluation: Case Study on Use Case Modeling** | | |
| 19. | | Activity Modeling Examples | | |
| 20. | | Activity Modeling Examples | | |
| 21. | | Behavior Modeling: Sequence Diagram | | |
| 22. | | Sequence Diagram Examples | | |
| 23. | | UML State Machine Diagrams and Models | | |
| 24. | | UML State Machine Diagrams and Models | | |
| 25. | | **Lab 3: Case Study on Class Modeling** | | |
| 26. | | **Lab 3: Case Study on Class Modeling** | | |
| 27. | | **Lab Evaluation: Case Study on Class Modeling** | | |
| 28. | | Advanced State Models | 25 | 50 |
| 29. | | Advanced State Models | | |
| 30. | | State Modeling: Examples | | |
| 31. | | Case Studies for UML modeling | | |
| 32. | | Case Studies for UML modeling | | |
| 33. | | Case Studies for UML modeling | | |

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| 34. | | **Lab 4: Case Study on Activity Modeling** | | |
| 35. | | **Lab 4:Case Study on Activity Modeling** | | |
| 36. | | **Lab Evaluation: Case Study on Activity Modeling** | | |
| 37. | **Unit 2: Object Oriented Programming and Architecture Design (T2, R2)** | Overview of Object Orientated Programming using Java/C++ –Classes | | |
| 38. | | Inheritance | | |
| 39. | | Overloading | | |
| 40. | | Overriding | | |
| 41. | | Abstract classes | | |
| 42. | | Interfaces | | |
| 43. | | **Lab 5: Case Study on State Modeling** | | |
| 44. | | **Lab 5: Mini Project – Use Case Modeling** | | |
| 45. | | **Lab Evaluation: Case Study on State Modeling** | | |
| 46. | | **Assignment 1** | | |
| 47. | | | | |
| 48. | | OO Development process | | |
| 49. | | System Design and Frameworks | | |
| 50. | | Architectural patterns | | |
| 51. | | MVC architectural pattern | | |
| 52. | | **Lab 6: OO Programming - Java/C++** | | |
| 53. | | **Lab 6: OO Programming - Java/C++** | | |
| 54. | | **Lab Evaluation: OO Programming - Java/C++** | | |
| 55. | | MVC architectural pattern | 25 | 75 |
| 56. | | Layered Pattern | | |
| 57. | | Client-Server Pattern | | |
| 58. | | Event-Driven Pattern | | |
| 59. | | Microkernel Pattern | | |
| 60. | | Micro-services Pattern | | |
| 61. | | **Lab 7: MVC Pattern Implementation** | | |
| 62. | | **Lab 7: MVC Pattern Implementation** | | |
| 63. | | **Lab Evaluation: MVC Pattern Implementation** | | |
| 64. | **Unit 3: Design principles and Patterns (T2, R2)** | GRASP and its application to Object Design, Creator, Information Expert, Low Coupling, | | |
| 65. | | Controller, High Cohesion, Polymorphism, | | |
| 66. | | Pure Fabrication, Indirection and Protected Variations | | |
| 67. | | Design exercise that involves creating a simple system using GRASP | | |
| 68. | | Introduction to SOLID | | |
| 69. | | SOLID: Single Responsibility | | |
| 70. | | **Project Work – Class Modeling** | | |
| 71. | | **Project Work – Class Modeling** | | |
| 72. | | **Project Work – Class Modeling** | | |

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| 73. | | SOLID: Open-Closed | | |
| 74. | | SOLID: Liskov Substitution | | |
| 75. | | SOLID: Interface Segregation | | |
| 76. | | SOLID: Dependency Inversion | | |
| 77. | | Scenario-based exercise to apply each SOLID principle | | |
| 78. | | Introduction to Design Patterns | | |
| 79. | | **Project Work – Activity and State Modeling** | | |
| 80. | | **Project Work – Activity and State Modeling** | | |
| 81. | | **Project Work – Activity and State Modeling** | | |
| 82. | | Selection and usage of a design pattern | | |
| 83. | | Creational Design Pattern: Singleton | | |
| 84. | | Creational Design Pattern: Factory | 25 | 100 |
| 85. | | Creational Design Pattern: Builder | | |
| 86. | | Creational Design Pattern: Prototype | | |
| 87. | | Creational Design Patterns Exploration: Hands-on challenges | | |
| 88. | | **Lab 10 : Case Study on Creational Design Patterns** | | |
| 89. | | **Lab 10 : Case Study on Creational Design Patterns** | | |
| 90. | | **Lab Evaluation: Case Study on Creational Design Patterns** | | |
| 91. | **Unit 4: Design Patterns & Anti-Patterns (T2,R2)** | Structural Patterns : Adapter | | |
| 92. | | Structural Patterns: Façade | | |
| 93. | | Structural Patterns: Proxy | | |
| 94. | | Structural Patterns: Flyweight | | |
| 95. | | Structural Design Patterns Exploration: Hands-on challenges | | |
| 96. | | Structural Design Patterns Exploration: Hands-on challenges | | |
| 97. | | **Lab 11: Case Study on Structural Patterns** | | |
| 98. | | **Lab 11: Case Study on Structural Patterns** | | |
| 99. | | **Lab Evaluation: Case Study on Structural Patterns** | | |
| 100. | | Behavioural Patterns: Chain of Responsibilities | | |
| 101. | | Behavioural Patterns: Command | | |
| 102. | | Behavioural Patterns: Interpreter | | |
| 103. | | Behavioural Patterns: Iterator | | |
| 104. | | Behavioral Design Patterns Exploration: Hands-on challenges | | |
| 105. | | Behavioral Design Patterns Exploration: Hands-on challenges | | |

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| 106. | | **Lab 12: Project Work – Implementation** | | |
| 107. | | **Project Work – Implementation** | | |
| 108. | | **Project Work – Implementation** | | |
| 109. | | **Assignment 2** | | |
| 110. | | | | |
| 111. | | Anti-patterns – Introduction and classification | | |
| 112. | | Project Management Anti-patterns | | |
| 113. | | Architecture Anti-patterns | | |
| 114. | | Development Anti-patterns | | |
| 115. | | **Lab 13: Project Work – Implementation** | | |
| 116. | | **Project Work – Implementation** | | |
| 117. | | **Project Work – Implementation** | | |
| 118. | | Mini Project Demonstration and Evaluation | | |
| 119. | | | | |
| 120. | | | | |
| 121. | | | | |
| 122. | | | | |
| 123. | | | | |
| 124. | | | | |
| 125. | | | | |
| 126. | | | | |

**Tool(s)/Programming Language Used:** Any UML Modeling tool, Java/C++ Programming Language

**Text Book(s):**

[1] "**Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development**", Craig Larman, 3rd Edition, Pearson 2015.
[2] **"Software Architecture Patterns"**, Mark Richards, 2nd Edition, OReilly 2022

**Reference Book(s) :**

[1] "**Object-Oriented Modelling and Design with UML**", Michael R Blaha and James R Rumbaugh, 2nd Edition, Pearson 2007.
[2] "**Design Patterns: Elements of Reusable Object-Oriented Software**", Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, 1st Edition, Pearson 2015.
[3]: **"Fundamentals of Software Architecture: An Engineering Approach",** Mark Richards & Neal Ford, First Edition,2020.

*Course Information*

**UE22CS341B – COMPILER DESIGN (4-0-0-0-4)**

**No of Credits: 4** **# of Hours: 84**

| Session# | Unit | Topic | Chapter Title /Reference Literature | % Coverage | |
|---|---|---|---|---|---|
| | | | | Unit | Total |
| 1 | I | Introduction and Language Processing system | T1: Chapter 1: Introduction, 1.1 - 1.2<br>Chapter 2: 2.6, 2.7 Lexical Analysis, 3.1–3.5, 3.8<br>T1: Chapter 2 2.4<br>T1: Chapter 4 Syntax Analysis, 4.1.1, 4.1.3, 4.1.4, 4.3.3, 4.3.4, 4.4 | 25 | 25 |
| 2-5 | | Phases of a compiler. | | | |
| 6 | | **Lexical Analysis:** The Role of the Lexical Analyzer | | | |
| 7-8 | | **Lab 1.1:** Introduction to lexer; Create a lexer for C language using the lex tool. | | | |
| 9 | | Input buffering | | | |
| 10 | | Specification and Recognition of Tokens | | | |
| 11 | | Design of a Lexical Analyzer Generator. | | | |
| 12-13 | | **Lab 1.2:** Introduction to YACC/Bison(Parser Generator) | | | |
| 14 | | **Syntax Analysis:**<br>The role of the parser, Syntax Error Handling, Error-Recovery Strategies.<br>Introduction to different parsers (Top Down and Bottom-up Parsers). | | | |
| 15-16 | | **Lab 1.3 :** Write YACC program to validate the syntax of a C program which consists of the following constructs:<br>• ***Simple variable declaration***<br>• ***if, if-else***, and ***do-while*** control statements<br>***Arithmetic*** *and* ***relational expressions***. | | | |
| 17 | | Top-Down Parsing : Grammar enhancement techniques:<br>• Eliminating left-recursion<br>• Left Factoring (Elimination of common prefixes) | | | |
| 18 | | Recursive Descent Parser (RDP) implementation | | | |
| 19-20 | | Model of LL(1) parser;<br>Construction of FIRST and FOLLOW sets | | | |
| 21-22 | | Comparison of RDP and Table driven parser implementations Understanding LL(*)<br>Error recovery in LL(1) Parser | | | |

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|---|---|---|---|---|---|
| 23-25 | II | **Assignment 1:** Extend the file from Lab 2 to handle:<br>• ***for*** (eg: for(i=0, j=0; (i<p) && (j<q); i++, j++) ) and ***while*** and ***switch*** statements.<br>• ***Variable declaration and initialization***.<br>(eg: int a=5, b, c, d=10;)<br>• ***Array declarations*** (eg: int a[10]; int a[5][5]; int a[5][6][7][8]; int a[4][4], b[5]; ) | T1: Chapter 4 Syntax Analysis, 4.5 - 4.7.4 & 4.9<br><br>T1: Chapter 5 Syntax Directed Translation 5.1, 5.2.1–5.2.4, | 25 | 50 |
| 26 | | Bottom-up parsing:<br>Handle and Handle pruning, Shift-Reduce Parsing, Conflicts During Shift-Reduce Parsing | | | |
| 27 | | Model of LR Parser; LR parsing: Items, LR(0) Automaton, Augmented grammar, Closure of Item Sets, and Function GOTO. | | | |
| 28 | | LR (0) parsing | | | |
| 29 | | LR-parsing algorithm | | | |
| 30 | | Simple-LR Parsing(SLR Parsing); | | | |
| 31 | | Understanding Viable prefixes | | | |
| 32-33 | | Canonical LR/CLR Parsing; LALR Parsing | | | |
| 34 | | More exercises and Comparison of all Bottom-up parsers. | | | |
| 35 | | | | | |
| 36-37 | | **Lab 2:**<br>Program to implement a Symbol Table. The symbol table must contain necessary information i.e. line number, token-name, type, value, storage required, scope information. | | | |
| 38 | | Semantic Analyzer :<br>• Synthesized & Inherited Attributes.<br>• Syntax-Directed Definition (SDD):<br>• L-attributed SDD and S-attributed SDD<br>• Evaluating an S-Attributed SDD of a simple desk calculator | | | |
| 39 | | Evaluating an SDD over a given input: (1-example)<br>• Construct Parse Tree for given input.<br>• Construct Dependency graph.<br>• Topologically sort the nodes of the Dependency graph.<br>• Produce as output Annotated Parse Tree.<br>Dependency graph for the<br>• SDD of simple declaration statement: float x, y, z<br>• SDD to find out whether the given type is a Basic Type or an array type and calculate the width required | | | |

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|---|---|---|---|---|---|
| 40-41 | | **Lab 3:** YACC program for Expression Evaluation:<br>Given for example an input that contains statements such as, a=10, b=20, c=a+b, update the symbol table with the value of c=30. Check for variable not declared error, mismatch types in expression and display relevant error messages. | | | |
| 42 | | Units 1 and 2 Revision | | | |
| | | **ISA-1** | | | |
| 43-44 | III | **SDD to generate Syntax tree**<br>**Lab 4:** YACC program to construct an Abstract Syntax Tree (AST) for arithmetic expressions. Define the structure of the node and print the output in postorder traversal. | T1: Chapter 5 Syntax Directed Translation 5.3.1, 5.3.2, 5.4.1 – 5.4.3 , 5.5.4<br><br>T1: Chapters 6 Intermediate –Code Generation, 6.1-6.1.1, 6.2, 6.6: 6.6.1, 6.6.2<br><br>T1: Chapter 8 Code Generation, 8.4 | 25 | 75 |
| 45 | | Evaluating an L-Attributed SDD of a simple desk calculator.<br>L-Attributed SDD to update type and size of an variable in symbol table (L-Attributed SDD for simple declaration statement) | | | |
| 46 | | Parser-Stack implementation of postfix SDT's | | | |
| 47-48 | | SDD to SDT conversion:<br>S-attributed SDD to S-attributed SDT(Postfix SDT) Conversion.<br>L-attributed SDD to L-attributed SDT Conversion rules.<br>L-attributed SDD's and SDT's to generate Intermediate code for<br>● while statement<br>● do-while statement<br>● if-else statement<br>● for statement<br>● Conditional Boolean expressions | | | |
| 49 | | **Lab 5:** YACC program to construct an Intermediate Code Generation (ICG) for arithmetic expressions. Define a function to generate temporaries and print the output in the quadruple format. | | | |
| 50-51 | | Bottom-Up Parsing of L-Attributed SDD for Intermediate code generation (4-sessions)<br>● while statement<br>● if statement | | | |
| 51 | | | | | |
| 52-54 | | **Assignment 2:** To extend the Lab 5 (AST construction) and Lab 6 (ICG) file for ***if-else*** *and* ***do-while*** statement.<br>Use the following productions<br>● ***S → do {S} while (C); S \| if (C) {S} else {S} S***<br>● ***C → T_ID rel T_ID***<br>● ***rel → < \| > \| <= \| >= \| == \| !=*** | | | |

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| 55 | | Intermediate-Code Generation: Introduction; Variants of Syntax Trees – Directed Acyclic Graphs(DAG's) for Expressions. | | | |
| 56-57 | | Three-Address Code – Addresses and Instructions. | | | |
| 58-59 | | Quadruples, Triples and indirect triples | | | |
| 60-61 | | Static Single-Assignment(SSA) | | | |
| 62-63 | | Basic Blocks and Flow Graphs/Control Flow Graphs(CFGs) | | | |
| 64 | | Next-Use Information/Algorithm | | | |
| 65-66 | IV | Machine Independent Optimization: Different Optimization techniques | T1: Chapter 8 Code Generation, 8.5<br><br>Chapter 9 Machine Independent Optimization : 9.1, 9.2.5<br><br>Chapter 7 Run Time Environments, 7.1–7.3<br><br>Chapter 8 Code Generation, 8.1– 8.3, 8.6 | 25 | 100 |
| 67-68 | | Optimization on CFG (Global Optimization). | | | |
| 69-70 | | Live-variable Analysis. | | | |
| 71 | | Code Generation: Issues in the design of a Code Generator. | | | |
| 72 | | Target Hypothetical ISA | | | |
| 73 | | Run-Time Environments: Introduction Storage Organization (Runtime storage) Activation Tree & Activation Record | | | |
| 74-75 | | Calling Sequence and Return Sequence Variable-Length Data on the Stack Introduction to ML language and Access to Nonlocal Data on the Stack Access links and Displays | | | |
| 76-77 | | Code Generator for stack allocation | | | |
| 78-79 | | A Simple Code generation algorithm | | | |
| 80-83 | | Lab 6 : Introduction to LLVM and Clang. Simple exercises | | | |
| 84 | | Units 3 and 4 Revision | | | |
| | | ISA-2 | | | |

**Reference Text books:**

| Book Type | Code | Title & Author | Publication Information | | |
|---|---|---|---|---|---|
| | | | Edition | Publisher | Year |
| Text Book | T1 | **Compilers–Principles, Techniques and Tools** Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffery D. Ullman | 2nd | Pearson Education | 2009 |
| Reference Book | R1 | **"Modern Compiler Design"**, Dick Grune, Kees van Reeuwijk, Henri E. Bal, Ceriel J.H. Jacobs, Koen Langendoen, | 2nd | Pearson Education | 2012 |

*Course Information*

**UE22CS342BA1: Supply Chain Management for Engineers (4-0-0-4-4)**

**No of Credits: 4** **# of Hours: 84**

| Class # | Chapter Title/ Reference Literature | Topics to be Covered | % of Portions Covered | |
|---|---|---|---|---|
| | | | | Cumulative |
| 1 | **Unit: I** Introduction to SCM | Overview of Supply Chain Management [SCM] | 25 | 25 |
| 2 | | Overview of Supply Chain Management [SCM] | | |
| 3 | | Building a strategic framework to analyze Supply Chains | | |
| 4 | | Understanding supply chain scope | | |
| 5 | | Strategic Fit of Supply Chain | | |
| 6 | | Drivers of Supply Chain Performance | | |
| 7 | | Performance Metrics in Supply Chain | | |
| 8 | | Managing Material Flows in Supply Chains | | |
| 9 | | Managing Information Flows in Supply Chains | | |
| 10 | | Introduction and Design of Supply Chain Networks | | |
| 11 | | Planning Strategies in SCM | | |
| 12 | | Sourcing Strategies in SCM | | |
| 13 | | Inventory Strategies in SCM | | |
| 14 | | Distribution Strategies in SCM | | |
| 15 | | Logistics Strategies Related to SCM | | |
| 16 | | Opportunities in SCM | | |
| 17 | | Competitive Advantage through SCM | | |
| 18 | | Real-time Supply Chains | | |
| 19 | | Value Stream Mapping | | |
| 20 | | Assignment Evaluation | | |
| 21 | | Assignment Evaluation | | |
| 22 | **Unit: II** Procurement and Supply Chain Planning (Demand & | Introduction to Procurement Processes | 25 | 50 |
| 23 | | Supplier Selection Criteria | | |
| 24 | | Supplier Evaluation and Performance Assessment | | |
| 25 | | Procurement Strategies and Risk Management | | |
| 26 | | Introduction to Demand Forecasting | | |

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|---|---|---|---|---|
| 27 | Supply) | Quantitative Demand Forecasting Models | | |
| 28 | | Qualitative Demand Forecasting Models | | |
| 29 | | Predictive Analytics for Supply Chain Planning | | |
| 30 | | Demand Forecasting Accuracy and Challenges | | |
| 31 | | Introduction to Aggregate Planning in Supply Chains | | |
| 32 | | Techniques for Aggregate Planning in Supply Chains | | |
| 33 | | Managing Demand Variability in Supply Chains | | |
| 34 | | Inventory Management and Demand Planning | | |
| 35 | | Supply Chain Coordination and Collaboration | | |
| 36 | | Introduction to E-Procurement | | |
| 37 | | Implementation of E-Procurement | | |
| 38 | | Emerging Trends in Procurement | | |
| 39 | | Future of Procurement and SCM | | |
| 40 | | Case Studies in Procurement | | |
| 41 | | Assignment Evaluation | | |
| 42 | | Assignment Evaluation | | |
| 43 | **Unit : III**<br><br>Planning and Managing Inventory and Logistics Management in SCM Modules | Introduction to Inventory Management in an Enterprise | 25 | 75 |
| 44 | | Inventory Planning Strategies | | |
| 45 | | Techniques for Inventory Control | | |
| 46 | | Inventory Classification and Categorization | | |
| 47 | | Warehouse Management Fundamentals | | |
| 48 | | Warehouse Layout and Design | | |
| 49 | | Inventory and Warehouse Management Systems (WMS) | | |
| 50 | | Logistics Management Overview | | |
| 51 | | Logistics Planning and Optimization | | |
| 52 | | Logistics Stakeholders and Their Roles | | |
| 53 | | Modern Logistics Concepts and Trends | | |
| 54 | | Outsourcing Logistics Operations | | |
| 55 | | Logistics Key Performance Indicators (KPIs) | | |

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|---|---|---|---|---|
| 56 | | Introduction to Reverse Logistics | | |
| 57 | | Lean Logistics Concepts | | |
| 58 | | Enhancing Transportation with IoT and AI | | |
| 59 | | Real-Time Tracking and Monitoring in Logistics | | |
| 60 | | Last-Mile Delivery Optimization | | |
| 61 | | Case Studies in Inventory and Logistics Management | | |
| 62 | | Assignment Evaluation | | |
| 63 | | Assignment Evaluation | | |
| 64 | **Unit: IV**<br>Drivers, Analytics and Current Trends in Supply Chain Management | Understanding Cross-Functional Drivers in Supply Chain | 25 | 100 |
| 65 | | Managing Cross-Functional Drivers in Supply Chain | | |
| 66 | | Sourcing Decisions in Supply Chain | | |
| 67 | | Pricing Decisions in Supply Chain | | |
| 68 | | Risk Management in Supply Chain | | |
| 69 | | Compliance in SCM | | |
| 70 | | Introduction to Artificial Intelligence (AI) in SCM | | |
| 71 | | Blockchain Technology in SCM | | |
| 72 | | Internet of Things (IoT) in SCM | | |
| 73 | | Green Supply Chain Management (Green SCM) | | |
| 74 | | Lean Supply Chain Management (Lean SCM) | | |
| 75 | | Global Supply Chain Management (Global SCM) | | |
| 76 | | SCM Analytics: Data-Driven Decision Making | | |
| 77 | | Artificial Intelligence (AI) Techniques for SCM | | |
| 78 | | AI Tools and Technologies for SCM | | |
| 79 | | Current Challenges in Supply Chain Management | | |
| 80 | | Research Areas and Future Trends in SCM | | |
| 81 | | Project Presentations | | |
| 82 | | Project Presentations | | |
| 83 | | Project Presentations | | |
| 84 | | Project Presentations | | |

**Literature**

| Book Type | Code | Title & Author | Publication Information | |
|---|---|---|---|---|
| | | | Publisher | Year |
| **Text Book** | **T1** | **Supply Chain Management: Strategy, Planning and Operation, Sunil Chopra, et al.** | **Pearson, 7th Revised Edition** | **2024** |
| Ref Book | R1 | Essentials of Supply Chain Management, Michael H Hugos | John Wiley & Sons, 3rd Edition | 2018 |
| Ref Book | R2 | Principles of Supply Chain Management: A Balanced Approach, Joel D Wisner | Cengage, 5th Ed | 2019 |
| Ref Book | R3 | Strategic Supply Chain Management: The Five Core Disciplines for Top Performances, Cohen Shoshanah & Joseph Roussel | Mc-Graw Hill, 2nd Ed | 2013 |
| Ref Book | R4 | Logistics and Supply Chain Management, Martin Christopher | Pearson | 2022 |
| Ref Book | R5 | Supply Chain Logistics Management, Donald Bowersox, et al | Mc-Graw Hill Publishing, 5th Edition | 2024 |
| Ref Book | R6 | Supply Chain Management: A Logistic Approach, John J Coyle | Cengage, 10th Ed | 2019 |
| Ref Book | R7 | A Roadmap to Green Supply Chains: Using Supply Chain Archaeology and Big Data Analytics, K L Lyons | Industrial Press | 2015 |
| Ref Book | R8 | Lean Supply Chain and Logistics Management, Paul Myerson | Mc-Graw Hill | 2012 |
| Ref Book | R9 | Supply Chain Analytics, T. A. S. Vijayaraghavan | Wiley | 2021 |
| Ref Book | R10 | Logistics & Supply Chain Management - Course | Online Resource (nptel.ac.in) | N/A |
| Ref Book | R11 | Blockchain, IoT, and AI Technologies for Supply Chain Management | CRC Press | 2023 |

*Course Information*

**UE22CS342BA3 - Image Processing and Computer Vision (4-0-0-4-4)**

**No of Credits: 4** **# of Hours: 84**

| Class # | Chapter Title / Reference Literature | Topics to be Covered | % of Portion covered | |
|---|---|---|---|---|
| | | | % of Syllabus | Cumulative % |
| 1 | **Unit#1 Introduction + spatial domain enhancement T : Chapter 1,2, 3.1-3.8** | **Introduction to digital image processing -** Origins, example fields and various components | **24** | **24** |
| 2 | | Fundamental steps of image processing + Elements of Visual Perception | | |
| 3 | | Image sampling and acquisition | | |
| 4 | | Sampling and Quantization | | |
| 5 | | Relationship between pixels, basic mathematical tools (linear, nonlinear operations) | | |
| 6 | | Image Enhancement in the Spatial Domain: Some Basic Gray Level Transformations | | |
| 7-8 | | Histogram Processing + using histogram statistics for image enhancement | | |
| 9 | | Enhancement using logical operations AND, OR etc., as masks on images (not included in the 4th edition) + some examples | | |
| 10-11 | | **Image enhancement in the spatial domain:** mechanics of linear spatial filtering – convolution and correlation | | |
| 12 | | Smoothing (low pass filters) + Order statistics filters with some examples | | |
| 13 | | Sharpening (high pass filters) + unsharp filters | | |
| 14 | | Combining spatial enhancement methods | | |
| 15-16 | **Unit#2 Image enhancement in the frequency domain + transforms + application to compression T: Chapters 4.1, 4.6 (Translation, Fourier Spectrum and Phase Angle, Discrete** | Filtering in the frequency domain: Discrete Fourier Transform + extension to 2D signals + a qualitative understanding of aliasing | **26** | **50** |
| 17 | | Summary of filtering in the frequency domain and correspondence between spatial and frequency domain filtering | | |
| 18a | | Low pass filters (Gaussian, Butterworth) + Image Sharpening | | |
| 18b | | Ideal filters – what they are + limitations | | |
| 19 | | Unsharp masking and high boost filtering + Homomorphic Filtering | | |
| 20a | | Image transforms introduction | | |
| 20b | | Slant Transform/ Haar Transform, KL Transform | | |
| 21 | | Understanding transform coefficients for some of the popular image transforms (DFT, DCT, DWT) | | |

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|---|---|---|---|---|
| 22 | **convolution theorem), 4.7-4.10, 7.1-7.2 (understanding orthogonal transforms – forward and inverse transforms), 7.5, 7.6 (DFT, DCT, DST), 7.8-7.9, 7.10 (2D DWT only – understanding of Fig. 7.29 – filter bank channels and interpretation of subimages) basics of image compression T : Chapters 8.1-8.2, 8.7-8.9** | 2 channel filter bank for compression and feature extraction | | |
| 23 | | **Basics of image compression** - concept of redundancy + average word length, etc. + Huffman coding | | |
| 24 | | Runlength coding (concept) + symbol encoding | | |
| 25 | | Block transform techniques | | |
| 26 | | Block transform techniques + color and video encoding a brief discussion | | |
| 27 | | Review of Unit 1 | | |
| 28 | | Review of Unit 2 | | |
| 29 | | ISA 1 | | |
| 30 | **Unit#3 Morphological processing and image segmentation T: Chapter 9, 10 9.1-9.5, 9.8 10.1-4 + A brief overview of 10.5-10.7 ("other segmentation techniques") + 6.1-6.9** | **Morphological processing basics: binary image + structural element** | **26** | **76** |
| 31 | | Erosion, dilation, open and closing + Hit or miss | | |
| 32 | | Some algorithms – boundary extraction, hole filling Thinning + thickening, skeleton | | |
| 33 | | | | |
| 34 | | Gray scale morphology | | |
| 35 | | **Segmentation basics**– point, line and edge detection | | |
| 36 | | Thresholding – global, using Otsu's method, multiple thresholds | | |
| 37 | | Segmentation using region-growing and region-merging | | |
| 38 | | Segmentation using morphological operations revisited | | |
| 39 | | Using morphological processing for number plate detection | | |
| 40 | | An overview of other segmentation techniques | | |
| 41 | | **Color image processing basics** | | |
| 42 | | Color models + Pseudo color images | | |
| 43 | | Color transformations + smoothing and sharpening of color images | | |
| 44 | | Segmentation based on color and denoising, etc., of color images | | |

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| 45 | **Unit#4 11.1-11.6 (Excerpts/ overview) + 11.7 (SIFT) 12.3 (minimum distance classifier + prototype matching) + 12.4-12.6 +** | **Feature Extraction and Pattern Classification + Computational Photography** | **24** | **100** |
| 46 | | Boundary descriptors | | |
| 47 | | Region descriptors | | |
| 48 | | Scale image feature transform | | |
| 49 | | Minimum distance classifier and prototype matching | | |
| 50 | | Bayesian classifier for Gaussian Pattern Classes | | |
| 51 | | Neural Networks and Deep Learning | | |
| 52 | | Convolutional Neural Networks + Transfer learning + Popular deep neural network architectures for applications | | |
| 53 | | Recent advances in Image Processing and Computer Vision - 1 | | |
| 54 | | Recent advances in Image Processing and Computer Vision – 2 | | |
| 55 | | Review of Unit 3 | | |
| 56 | | Review of Unit 4 | | |
| 57 | | ISA 2 | | |

**Experiential learning**

| #hrs | Activity |
|---|---|
| 1-3 | Worksheet 1 |
| 4-6 | Worksheet 2 |
| 7-12 | Miniproject 1 |
| 13-15 | Worksheet 3 |
| 16-18 | Worksheet 4 |
| 19-24 | Miniproject 2 |
| 25-27 | Invited talk(s) |

Details of the timeline for worksheets and mini project

**Lecture hours + Experiential learning = 57+27 = 84 slots**

**Literature**

| Book Type | Code | Title & Author | Publication Information | | |
|---|---|---|---|---|---|
| | | | Edition | Publisher | Year |
| Text Book | T1 | Digital Image Processing – Gonzalez and Woods | 4 | Pearson | 2018 |
| | T2 | Computer Vision – Algorithms and Applications | 2 | Springer | 2022 |
| | R0 | Digital Image Processing Using Matlab – Gonzalez Woods and Eddins | 3 | Gatesmark Publishing | 2020 |
| Reference Book | R1 | Digital Image Processing and Analysis – Scott E. Umbaugh | 1 | CRC Press | 2014 |
| | R2 | Digital Image Procesing - S.Jayaraman, S.Esakkirajan, T.Veerakumar | Scila b | McGraw Hill Ed. (India) Pvt. Ltd. | 2013 |
| | R3 | Digital Signal and Image Processing - Tamal Bose | 1 | John Wiley | 2004 |

*Course Information*

**UE22CS342BA4: Natural Language Processing (4-0-0-4-4)**

**No of Credits: 4** **# of Hours: 84**

| Class # | Chapter Title/Reference Literature | Topics to be Covered | % of Portions Covered | |
|---|---|---|---|---|
| | | | Reference Chapter | Cumulative |
| 1 | Unit 1 | Introduction to NLP, Application of NLP, Why NLP is important? Connection of NLP and Machine Intelligence. Introduction to 3 themes of NLP | TB-1 https://www.analyticsvidhya.com/blog/2021/04/role-of-machine-learning-in-natural-language-processing/ 1.2- (1.2.1 – 1.2.3)- RB | 25% |
| 2 | | Learning and Knowledge, Search and Learning | 1.2- (1.2.1 – 1.2.3)- RB | |
| 3 | | Relational, Compositional and Distributional Perspective, some important terminology | 1.2- (1.2.1 – 1.2.3)- RB | |
| 4 | | Different phases/steps in NLP, Text Normalization: Content and Function,Words, Type vs. Token, Word Tokenization and Normalization; Lemmatization and Stemming | https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_natural_language_processing.htm | |
| 5 | | Sentence Segmentation, Types of Ambiguity in Natural Language Processing | 2.2- 2.4- TB-2 | |
| 6 | | Morphological Parsing of words-Porter Stemmer | 2.4- TB-2 | |
| 7 | | NLP Project Idea presentation | | |
| 8 | | NLP Project Idea presentation | | |
| 9 | | NLP Project Idea presentation | | |
| 10 | | Noisy Channel model: Real World Spelling Error, Detection and Spelling Error | 3.1- TB-1, 3.8- TB-1 | |
| 11 | | Minimum Edit Distance Algorithm | 3.10- TB-1 | |
| 12 | | Minimum Edit Distance Algorithm | 3.10- TB-1 | |
| 13 | | Concept of noisy channel model | 3.11- TB-1noisy | |
| 14 | | Language Model: Introduction to n-grams, n-gram language model | 5.9- TB-1 | |
| 15 | | Language Model: Introduction to n-grams, n-gram language model | 5.9- TB-1 | |
| 16 | | Experiential Learning (Hands-on NLTK) | | |
| 17 | | Experiential Learning (Hands-on NLTK) | | |
| 18 | | Experiential Learning (Hands-on NLTK) | | |
| 19 | | Smoothing, discounting and back-off | 3.1-3.3-TB-2 | |

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|---|---|---|---|---|
| 20 | | Smoothing, discounting and back-off | 3.1-3.3-TB-2 | |
| 21 | | Kneser-Ney Smoothing, Interpolation, Perplexity as an evaluation measure | 3.5-TB-2 | |
| 22 | Unit 2 | Word Senses and relations between word senses, Wordnet: A database of Lexical Relations | 3.6, 3.8- TB-2<br>18.1-18.5-TB-2<br>20.2, 20.4- TB-1 | 50% |
| 23 | | Word Sense Disambiguation | 20.5-TB-1, 18.7-TB-2 | |
| 24 | | Word Sense Disambiguation | 20.5-TB-1, 18.7-TB-2 | |
| 25 | | Semantic relatedness based on thesaurus like Wordnet: Resnik similarity, Lin similarity | 20.6-TB-1 | |
| 26 | | Semantic relatedness based on thesaurus like Wordnet: Resnik similarity, Lin similarity | 20.6-TB-1 | |
| 27 | | Jiang-Conrath distance, Extended Gloss overlap and Extended Lesk method | 20.1-20.2- TB-2 | |
| 28 | | Lexicons for sentiment and affect extraction: available sentiment and emotion lexicons | 6.3, 6.5 & 6.6- TB-2<br>6.4, 6.12- TB-2 | |
| 29 | | Vector Semantic and Embedding: Words and Vectors | 14.5.1, 14.5.2- RB | |
| 30 | | TF-IDF, Pointwise mutual information | 14.5.1, 14.5.2- RB | |
| 31 | | Measuring similarity | 6.8- TB-2 | |
| 32 | | Using syntax to define a word's context, evaluating vector models | 6.8- TB-2 | |
| 33 | | Dense vectors via SVD Distributional hypothesis | 6.9- TB-2 | |
| 34 | | Neural embeddings: skip gram and CBOW | 6.10- TB-2 | |
| 35 | | Pre-trained word representation: Word2Vec, improving WOrd2vec, , limitation of distributional methods | 6.10- TB-2 | |
| 36 | | fastText, Glove -SELF Learning | 6.10- TB-2 | |
| 37 | | Hands-on NLTK/Revision | | |
| 38 | | Hands-on NLTK/Revision | | |
| 39 | | **TUTORIAL CLASS – Unit 1 and Unit 2** | | |
| 40 | | NLP Project Literature Survey and progress presentation | | |
| 41 | | NLP Project Literature Survey and progress presentation | | |
| 42 | | NLP Project Literature Survey and progress presentation | | |
| ISA 1 Week | | | | |
| 43 | | Sequence Labelling: Sequence labelling as classification | 7.1 - RB | |
| 44 | | Sequence labelling as structure prediction | 7.2 - RB | |
| 45 | | Viterbi algorithm and Hidden Markov Model | 7.3, 7.4 - RB | |

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| 46 | **Unit 3** | Viterbi algorithm and Hidden Markov Model | 7.3, 7.4 - RB | **75%** |
| 47 | | POS tagging example | 5.3-TB-1, 8.2-TB-2 | |
| 48 | | Discriminative Sequence labelling with features-Conditional Random Field | 7.5.3-RB, 8.5-TB-2 | |
| | | POS Tagging using discriminative models(MEMM, Maximum Entropy Markov Model) | 6.8-TB-1 | |
| | | POS Tagging using discriminative models(MEMM, Maximum Entropy Markov Model) | 6.8-TB-1 | |
| 49 | | Other sequence labelling applications: Named Entity Recognition (NER)and Named Entity Tagging | 8.3-TB-2, 8.3-RB | |
| 50 | | Other sequence labelling applications: Named Entity Recognition (NER)and Named Entity Tagging | 8.3-TB-2, 8.3-RB | |
| 51 | | Sequence labelling using RNNs and LSTMsSELF Learning | 8.1, 8.3, 8.5-TB-1 | |
| 52 | | **Hands-on some libraries in NLP** | | |
| 53 | | **Hands-on some libraries in NLP** | | |
| 54 | | **Hands-on some libraries in NLP** | | |
| 55 | | Constituency Parsing: Ambiguity presented by parse trees, Introduction to CKY parsing | 13.1-13.2-TB-2 | |
| 56 | | CKY PArsing Example, Span based Neural Constituency Parsing | 13.2-13.3-TB-2 | |
| 57 | | CCG Parser, Partial Parsing- Chunking | 13.5, 13.6-TB-2 | |
| 58 | | Statistical Parsing: PCFG, Probabilistic CKY parsing of PCFG | 14.1, 14.2-TB-1 | |
| 59 | | Problems with PCFG | | |
| 60 | | Problems with PCFG | | |
| 61 | | Probabilistic Lexicalized CFG | 14.4-TB-1 | |
| 62 | | Introduction to dependency parsing:Dependency relations, Dependency Formalisms | 14.6- TB-1 | |
| 63 | | Dependency Tree banks, Evaluating parsers | 14.1, 14.2-TB-2 | |
| 64 | | Span-based Neural Constituency Parsing-SELF Learning | 18.7- TB-1 | |
| 65 | **Unit 4** | Co-reference Resolution: Forms of referring expression | 14.3, 14.6-TB-2 | |
| 65 | | Algorithms for coreference resolution | 15.1-RB | |
| 66 | | Mention pair and mention ranking model, mention detection | 15.2-RB<br>15.2.1, 15.2.2-RB,<br>21.4- TB-2 | |

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| 67 | | Classifiers using hand-built features | 21.5-TB-2 | **100%** |
| 68 | | Self-Attention Networks: Transformers, Transformers as Language Models | | |
| 69 | | Transformers as Language Models, Sampling | | |
| 70 | | Pretraining Large Language models | 10.1- TB-1 | |
| 71 | | Fine-Tuning and Masked Language Models: Bidirectional Transformer Encoders | | |
| 72 | | Fine-Tuning and Masked Language Models: Bidirectional Transformer Encoders | | |
| 73 | | Training Bidirectional Encoders, RoBERTa | 11.1- TB-1 | |
| 74 | | In Context Learning, Instruction Fine Tuning | 12.1, 12.3-TB-1 | |
| 75 | | Prompt Engineering | 12.4-TB-1 | |
| 76 | | | | |
| 77 | | | | |
| 78 | | | | |
| 79 | | **TUTORIAL CLASS – Unit 3 and Unit 4** | | |
| 80 | | **Final NLP Project Presentation** | | |
| 81 | | **Final NLP Project Presentation** | | |
| 82 | | **Final NLP Project Presentation** | | |
| 83 | | **Final NLP Project Presentation** | | |
| 84 | | **Final NLP Project Presentation** | | |
| 86 | **Invited Talks** | **Invited Talk-1** | | |
| 87 | | **Invited Talk-1** | | |
| 87 | | **Invited Talk-2** | | |
| 88 | | **Invited Talk-2** | | |

**Tools / Languages:**Tensorflow, Scikit Learn, Python 3.x. CoreNLP, Natural Language Toolkit (NLTK), TextBlob,Gensim, SpaCy,PyTorch-NLP , OpenNLP, Hugging Face, OpenAI API.

**Text Book:**

1. "Speech and Natural Language Processing", Daniel Jurafsky and James H. Martin, 3rd edition online, Feb 3 2024. The more up to date 3rd edition draft is available at http://web.stanford.edu/~jurafsky/slp3/. (text book revision is continuous process according to author)

**Reference Book:**

- "Introduction to Natural Language Processing", Jacob Eisenstein, MIT Press, Adaptive computation and Machine Learning series, 18th October, 2019.
- The open source softcopy is available at githubhttps://github.com/jacobeisenstein/gt-nlp class/blob/master/notes/eisenstein-nlp-notes.pdf.

*Course Information*

**UE22CS342BA5 : Block chain (4-0-0-4-4)**

**# of Credits: 4** **# of Slots: 86**

| Class # | Chapter Title /Reference Literature | Topics to be Covered | % of Portion covered | |
|---|---|---|---|---|
| | | | % of Syllabus | Cumulative % |
| 1 | **Unit – 1**<br><br>**Lec 01 - Lec 07** | Course Overveiw, Introduction to blockchain | 25% | 25% |
| 2 | | | | |
| 3 | | | | |
| 4 | | Key Blockchain Concepts<br>Nodes<br>Cryptocurrency, Tokens | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | Cryptography- Need, history, features<br>Private and public keys, Types of cryptography<br>Digital signatures, Hash functions | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | Sha 256 , Merkle Trees | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | Lab 1 Cryptography and Merkle Tree | | |
| 14 | | | | |
| 15 | | | | |
| 16 | | Commitments in Blockchain<br>**Assignment 1: Families of DS used in blockchain** | | |
| 17 | | | | |
| 18 | | | | |
| 19 | | Bit Coin : A First working example<br>**Activity 1 on understanding Bitcoin. Lab 2 : Creating a bitcoin wallet** | | |
| 20 | | | | |
| 21 | | | | |
| 22 | **Unit – 2**<br><br>**Lec 08 - Lec 14** | Consensus and need for Consensus in Blockhain Network | 25% | 50% |
| 23 | | | | |
| 24 | | | | |
| 25 | | Proof of work, Proof of stake, DPoS, Nothing at stake, | | |
| 26 | | | | |
| 27 | | | | |
| 28 | | Proof of Authority<br>Proof of Elapsed Time<br>Proof of SPACE | | |
| 29 | | | | |
| 30 | | | | |
| 31 | | Proof of Space<br>Proof of Burn<br>**Assignment 2: Consensus Mechanisms** | | |
| 32 | | | | |
| 33 | | | | |
| 34 | | RAFT<br>**Activity 2 - PAXOS.** | | |
| 35 | | | | |

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|---|---|---|---|---|
| 36 | | | | |
| 37 | | **LAB 03 : Consensus Mechanisms** | | |
| 38 | | | | |
| 39 | | | | |
| 40 | | **Revision** | | |
| 41 | | | | |
| 42 | | | | |
| **ISA Week** | | | | |
| 43 | **Unit – 3**<br><br>**Lec 14 - Lec 21** | Smart contracts, Creating and deploying smart contracts | 25% | 75% |
| 44 | | Second generation tokens | | |
| 45 | | Decentralized applications: How they are constructed? | | |
| 46 | | DAPPS construction | | |
| 47 | | Decentralized Autonomous Organizations (DAOs) | | |
| 48 | | Solidity- Variable, Functions | | |
| 49 | | Solidity-modifiers, view, pure | | |
| 50 | | Solidity- fallback, overloading, in-built mathematical and cryptography functions | | |
| 51 | | **Assignment 3 - Solidity** | | |
| 52 | | **Lab 04 - Solidity** | | |
| 53 | | | | |
| 54 | | | | |
| 55 | | Solidity- Withdrawal pattern, Restricted Access | | |
| 56 | | Blockchain-as-a-service (BaaS) | | |
| 57 | | Architecture | | |
| 58 | | Core components | | |
| 59 | | Hyperledger fabric model | | |
| 60 | | **Activity 03 - Solidity** | | |
| 61 | | **Assignment 04 - Hands on session for Solidity** | | |
| 62 | | | | |
| 63 | | | | |
| 64 | | **Lab 05 - Solidity** | | |
| 65 | | | | |
| 66 | | | | |
| 67 | **Unit – 4**<br><br>**Lec 22 - Lec 28** | Blockchain vulnerabilities | 25% | 100% |
| 68 | | Smart contract vulnerabilities | | |
| 69 | | Blockchain on CIA security triad | | |
| 70 | | Blockchain based DNS security platform | | |
| 71 | | | | |
| 72 | | | | |
| 73 | | Deploying blockchain based DDOS protection | | |
| 74 | | Use cases: Public Sector, Finance, Supply Chain. | | |

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|---|---|---|---|---|
| 75 | | Research Aspects in Blockchain. | | |
| 76 | | **Assignment 05: Analyze security challenges and mitigation strategies in blockchain systems.** | | |
| 77 | | | | |
| 78 | | | | |
| 79 | | **Project Evaluation** | | |
| 80 | | | | |
| 81 | | | | |
| 82 | | **Project Evaluation** | | |
| 83 | | | | |
| 84 | | | | |
| 85 | | **Project Evaluation** | | |
| 86 | | | | |
| 87 | | | | |
| 88 | | **ISA 2 Week** | | |

**Text Books and Reference books:**

| Book Type | Code | Title & Author | Publication Information | | |
|---|---|---|---|---|---|
| | | | Edition | Publisher | Year |
| Text Book | T1 | Introduction to Blockchain Technology by Tiana Laurence | 1st | Van Haren Publishing | 2019 |
| Text Book | T1 | Studies in Autonomic, Data-driven and Industrial Computing | 1st | Springer | 2023 |
| Reference Book | R1 | Hands-On Cybersecurity with Blockchain: Implement DDoS protection, PKI-based identity, 2FA, and DNS security using Blockchain by Rajneesh Gupta | 1st | Packt | 2018 |
| Reference Book | R2 | Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction by Narayanan, Bonneau, Felten, Miller and Goldfeder | | Princeton University Press | 2016 |

*Course Information*

**UE21CS342BA6: Digital Forensics and Incident Response (4-0-0-0-4)**

**# of Credits: 4** **# of Slots: 84**

| Class # | Chapter Title /Reference Literature | Topics to be Covered | % of Portion covered | |
|---|---|---|---|---|
| | | | % of Syllabus | Cumulative % |
| **Unit 1: Introduction to Digital Forensics and Incident Response With Essential Technical Concepts** | | | | |
| **1.** | **10 Hours T1: Ch 1,2,4 T2 :ch 1,2 T4 and T5(For refernce) and Internet sources** | Introduction to forensics science and digital forensics :What is Forensic science , understanding digital forensics | **25** | **25** |
| **2.** | | Locard's exchange principle, Scientific method , Organization of note , International standards and practices, Role of examiner in judicial system | | |
| **3.** | | Digital forensic goals, Digital forensics categories and Challenges | | |
| **4.** | | Digital forensics investigation types, Forensics readiness | | |
| **5.** | | **Lab 1:Study of Computer Forensics and different tools used for forensic investigation and Mini Project Discussion** | | |
| **6.** | | Digital forensics Vs other computing domain, Live system and Dead system | | |
| **7.** | | **Incident Response**: Attack Lifecycle, What is Incident Response?, Incident Response Team | | |
| **8.** | | Incident Response Plan (IRP)Incident Response Lifecycle, Incident Response Methodology | | |
| **9.** | | Goals of Incident Response, Incident Response Tools | | |
| **10.** | | Digital evidences types **with Essential Technical Concepts**: Data representation | | |
| **11.** | | File structures, Memory types, types of computer storage, | | |
| **12.** | | understanding the hard disks-HDD, understanding SSD,How magnetic hard drive store data | | |
| **13.** | | Data recovery considerations, File systems- introduction Allocated and unallocated space | | |
| **14.** | | Data Persistence, Page file(Swap space) | | |
| **15.** | | **Initial Response and First Responder Tasks**- Search and Seizure, First responder tool kit and tasks, Documenting digital crime scene, Packing and transporting digital evidences | | |
| **16.** | | Conducting interview, Acquiring digital evidence, | | |

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|---|---|---|---|---|
| | | Analyzing Digital Evidence | | |
| **17.** | | **Lab 2: Acquiring-Analyzing Digital Evidence with Open Source Tools** | | |
| **18.** | | **Lab 2: Acquiring-Analyzing Digital Evidence with Open Source Tools** | | |
| **19.** | | Class Activity(case Study) | | |
| **20.** | | Doubt Clarification/Revision | | |
| **Unit 2:** | **Filesystems - Windows Systems, Windows Registry** | | | |
| **21.** | **12 Hours T1: Ch 2 T2:ch 2,4,5,6 T4 and T5(for refernce) and Internet Sources** | **Filesystems - Windows file systems:** Introduction | **25** | **50** |
| | | understanding and examining FAT, NTFS, | | |
| | | understanding and examining FAT, NTFS | | |
| | | File allocation table(FAT) | | |
| | | New Technology File System(NTFS), | | |
| | | Understanding file systems using open source tools | | |
| **22.** | | examining FAT, NTFS, (HFS+) | | |
| **23.** | | examining FAT, NTFS, (HFS+) | | |
| **24.** | | | | |
| **25.** | | **Lab 3: Analyzing Digital Evidence with Open Source Tools**<br>**Lab 3: Analyzing Digital Evidence with Open Source Tools** | | |
| **26.** | | Windows Registry: windows system artifacts | | |
| **27.** | | Windows Registry: windows system artifacts | | |
| **28.** | | Windows system artifacts :Deleted Data ,Hibernation File (Hiberfile.Sys) | | |
| **29.** | | Registry Print Spooling Recycle Bin Metadata Thumbnail Cache | | |
| **30.** | | Most Recently Used (MRU) Restore Points and Shadow Copy | | |
| **31.** | | Windows forensic analysis- Timeline Analysis, | | |
| **32.** | | file recovery, Windows registry analysis | | |
| **33.** | | Deleted registry key recovery | | |
| **34.** | | **Lab 4: Data recovery and understanding EXIF Tool** | | |
| **35.** | | **Lab 4: Data recovery and understanding EXIF Tool** | | |
| **36.** | | **Lab 5: Understanding Windows Registry with REGEDIT and Open Source Tools** | | |
| **37.** | | **Lab 5: Understanding Windows Registry with REGEDIT and Open Source Tools** | | |
| **38.** | | | | |

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|---|---|---|---|---|
| **39.** | | **Class Activity** | | |
| **40.** | | Doubt Clarification/Revision | | |
| **Unit 3: Introduction to Linux and Mac OS X Systems ,Network Forensics and Web browser Forensics** | | | | |
| **41.** | **12 Hours T1: Ch 5 T2:Ch 7 T3: Ch 6 T4 and T5(for refernce) References and Internet Sources** | **Linux Systems and Artifacts**- Linux file systems (Ext2/Ext3) | **25** | **75** |
| **42.** | | File system layer, filename layer, metadata layer, data unit layer, deleted data | | |
| **43.** | | Linux logical volume manager, Linux boot process and services, Linux System Organization and Artifacts, Unix/Linux | | |
| **44.** | | Forensic Investigation: Unix/Linux forensics, investigation steps and technologies, Principles of file carving | | |
| **45.** | | Mac OS X Systems and Artifacts- OS X File System Artifacts- HFS+ Structures, OS X System Artifacts | | |
| **46.** | | Mac OS X Systems and Artifacts- OS X File System Artifacts- HFS+ Structures, OS X System Artifacts | | |
| **47.** | | **Network Forensics**: Networking Fundamentals and Types of Networks | | |
| **48.** | | Network Forensics Overview, Securing A Network,Developing Procedures for Network Forensics Network Security Tools | | |
| **49.** | | Network Attacks,ForensicFootprints,Network Evidence and Investigations | | |
| **50.** | | Seizure of Networking Devices | | |
| **51.** | | **Applying Forensic Science To Networks** | | |
| **52.** | | | | |
| **53.** | | **Lab 6: Understanding Network Forensics and Analysis of PCAP Files** | | |
| **54.** | | **Lab 6: Understanding Network Forensics and Analysis of PCAP Files** | | |
| **55.** | | **Web browser forensics**- Introductio Internet overview, IE | | |
| **56.** | | Microsoft web browser, Firefox, Google Chrome | | |
| **57.** | | Web browser investigation tools | | |
| **58.** | | Web browser investigation tools | | |
| **59.** | | **Lab 7: Understanding Browser Forensics with Open Source Tools** | | |

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|---|---|---|---|---|
| **60.** | | Doubt Clarification/Revision | | |
| **Unit 4:** | **E-Mail forensics, Mobile Device Forensics, Anti-forensics and Report Writing** | | | |
| **61.** | **T1: Ch 8,10<br>T2:Ch 8<br>T4 and T5(for refernce)<br>10 Hours<br>T1: Ch 6<br>T2: Ch 9, 11(guide)<br>T4 and T5(for refernce)** | **Email Forensics**- Steps in email communications, | **25** | **100** |
| **62.** | | E-Mail header examination, email forensics, recovering emails | | |
| **63.** | | List of E-mail protocols, | | |
| **64.** | | Email Forensics- Steps in email communications, List of E-mail protocols | | |
| **65.** | | E-Mail header examination | | |
| **66.** | | **Lab 8: Understanding Email Forensics with Open Source Tools** | | |
| **67.** | | **Lab 8: Understanding Email Forensics with Open Source Tools** | | |
| **68.** | | Mobile device forensics- Cellular Networks and How They Work | | |
| **69.** | | Overview of Cell Phone Operating Systems, | | |
| **70.** | | Potential Evidence Found on Cell Phones | | |
| **71.** | | Collecting and Handling Cell Phones as evidence, | | |
| **72.** | | How to Collect Email Evidence in Victim | | |
| **73.** | | Cell Phone Forensic Tools | | |
| **74.** | | GPS sytemfunstion and potential evidence | | |
| **75.** | | mobile device forensic investigation, storage location, Acquisition methods | | |
| **76.** | | Mobile Forensics:Demo | | |
| **77.** | | Introduction to Antiforensics, Classification of antiforensics techniques | | |
| **78.** | | Antiforensics Practices-Data Wiping and Shredding, Trail Obfuscation, Encryption, Data Hiding, | | |
| **79.** | | Stenography techniques and tools, Introduction to malware analysis and malware forensics | | |
| **80.** | | Report Writing: Prep work for report Writing, Structure of the report<br>Characteristics of a good report, | | |
| **81.** | | | | |
| **82.** | | Document design and good writing practices | | |
| **83.** | | Legal Acceptance, digital forensics report writing for High-Tech Investigations | | |
| **84.** | | Case study on Anti-Forensics and Report writing | | |

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| **85.** | | Doubt Clarification/Revision | | |
| **86.** | | **Office Hours: About CTF/Hackathon** | | |
| **87.** | | **Office Hours: About CTF/Hackathon** | | |

**Text Book(s):**


T1. Sammons, J. (2012). *The basics of digital forensics: the primer for getting started in digital forensics*. Elsevier.

T2. Hassan, N. A. (2019). *Digital Forensics Basics: A Practical Guide Using Windows OS*. Apress.

T3. Altheide, C., & Carvey, H. (2011). *Digital forensics with open source tools*. Elsevier.

T4. "Introductory Computer Forensics-A Hands-on practical Approach", by Xiaodong Lin, Springer, 2018.

T5. "Practical Cyber Forensics- An Incident-Based Approach to Forensic Investigations", by Niranjan Reddy, A Press, 2019.


**Reference Book(s):**


1: "Digital Forensics Workbook_-Hands-on Activities in Digital Forensics", by Michael K Robinson ,CreateSpace Independent Publishing Platform, 2015

*Course Information*

**UE21CS342BA7: Digital Twin and eXtended Reality (4-0-0-0-4)**

**# of Credits: 4** **# of Slots: 84**

| Class # | Chapter Title /Reference Literature | Topics to be Covered | % of Portion covered | |
|---|---|---|---|---|
| | | | % of Syllabus | Cumulative % |
| **Unit – 1 Introduction to AR and VR** | | | | |
| 1 | T1 | Introduction | 25% | **25%** |
| 2 | T1 | Concept of DT | | |
| 3 | T1 | Overview of AR and VR technologies | | |
| 4 | T1 | Introduction to the OpenGL graphics pipeline | | |
| 5 | T1 | Overview of 2D Transformations | | |
| 6 | T1 | Rotation, Translation and Scaling | | |
| 7 | Hands-On | Setting up OpenGL Development Environment | | |
| 8 | T1 | First OpenGL Program | | |
| 9 | T1 | Control Functions and Animation | | |
| 10 | Hands-On | Unity3D: Building a micro game | | |
| 11 | T1 | Various Spaces: Vector Space, Affine Space and Euclidian Space | | |
| 12 | T1 | Affine Transformation | | |
| 13 | T1 | Transformation in Homogeneous Coordinates | | |
| 14 | T1 | 3D transformation | | |
| 15 | T1 | Homogeneous Transformations | | |
| 16 | Hands-On | Using Blender to understand the coordinate geometry | | |
| 17 | T1 | Concatenation of Transformation | | |
| 18 | T1 | Transformation Matrices | | |
| 19 | T1 | Interface to Three dimensional Applications | | |
| 20 | T1 | Quaternions Basics | | |
| 21 | T1 | Quaternions multiplication and Rotation | | |
| 22 | Hands-On | Quaternion Visualization | | |
| 23 | Assignment – Audit the course | | | |
| 24 | Revision | | | |

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|---|---|---|---|---|
| **Unit – 2 Digital Twin Essentials.** | | | | |
| 25 | T2 | The Big Picture of Digital Twins, History of the Digital Twin, Origin of the Digital Twin concept | 25% | 50% |
| 26 | T2 | Digital Twin and Product Life cycle Relationship | | |
| 27 | T2 | Types of Digital Twin: Discrete Vs Composite, Product versus facility | | |
| 28 | T2 | Types of Digital Twin: Simulation versus operational, Analytics versus physics-based | | |
| 29 | T2 | Characteristics of a Digital Twin | | |
| 30 | R1 | Digital Twin Architecture | | |
| 31 | T2 | Industrial Digital Twin applications | | |
| 32 | Web Sources | Examples of mock, functional, and executable twins | | |
| 33 | Web Source | Example of Physics Driven Modelling: DT of Propeller of Drone | | |
| 34 | Web Source | DT of a Ceiling Fan | | |
| 35 | Web Source | DT of Bio Mechanical Digital Twin | | |
| 37 | Web Source | Data Driven modelling: DT of RUL of Battery | | |
| 38 | Web Source | DT of Traffic Mobility in Bangalore | | |
| 39 | Web Source | DT of GUT | | |
| 40 | Web Source | Hybrid Modelling: DT of Heart | | |
| 41 | Web Source | DT of Solar Array | | |
| 42 | Web Source | Dt of CAR | | |
| 43 | Web Source | Case Study | | |
| 44 | Assignment: Mini Project Phase 1 | | | |
| 45 | | | | |
| 46 | Revision 2 | | | |
| **ISA-1** | | | | |
| **Unit–3 System Modelling and Simulation** | | | | |
| 47 | T3 | Introduction to Simulation | 25% | **75%** |
| 48 | T3 | System and System Environment | | |
| 49 | T3 | Discrete Event System Simulation | | |
| 50 | T3 | Concepts in Discrete-Event Simulation | | |
| 52 | T3 | The Event Scheduling/Time Advance Algo | | |
| 53 | T3 | Example: The Checkout-Counter Simulation | | |

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|---|---|---|---|---|
| 54 | T3 | Example: The Dump-Truck Problem | | |
| 55 | T3 | Inout Modeling: Data Collection | | |
| 56 | T3 | Identifying distribution within data | | |
| 57 | T3 | Verification of Simulation models | | |
| 58 | T3 | Calibration and Validation of Models, Face Validity | | |
| 59 | T3 | Validation of Model Assumptions, Validating Input-Output Transformations | | |
| 60 | T3 | Input-Output Validation: Using Historical Input Data, The Candy Factory example | | |
| 61 | T3 | Input-Output Validation: Using a Turing Test | | |
| 62 | T3 | Types of Simulations with Respect to Output Analysis | | |
| 63 | T3 | Stochastic Nature of Output Data | | |
| 64 | T3 | Absolute Measures of Performance and Their Estimation | | |
| 65 | T3 | Case Study: Manufacturing and Material-Handling System | | |
| 66 | T3 | | | |
| 67 | T3 | | | |
| 68 | | Mini Project | | |
| 69 | | | | |
| 70 | | Revision | | |
| **Unit–4 Security and application studies** | | | | |
| 71 | R2 | Digital twins and cybersecurity | **25%** | **100%** |
| 72 | R2 | Security Framework, Digital twins threat modelling | | |
| 73 | R2 | Common attacks on digital twins | | |
| 74 | R2 | Common attacks on digital twins | | |
| 75 | R2 | Digital twin authentication and identification challenge | | |
| 76 | R2 | IDS, IPS | | |
| 77 | R2 | Authentication Methods, Communication Channel Protection. | | |
| 78 | R2 | Building cyber resilience in digital twins | | |
| 79 | R2 | Privacy Framework, Lack of Privacy, and trust | | |
| 80 | R2 | Privacy by Design | | |
| 81 | R2 | Enhancing trust with block chain integration | | |
| 82 | | Review of Mini Project | | |
| 83 | | Review of Mini Project | | |
| 84 | | ISA-2 | | |

| Book Type | Code | Title & Author | Publication Information | | |
|---|---|---|---|---|---|
| | | | Edition | Publisher | Year |
| **Text Books** | T1 | "Interactive Computer Graphics - A top-down approach with shader-based OpenGL", Edward Angel and Dave Shreiner, Pearson Education, Sixth edition, 2012. | 1 | Pearson Education | 2012 |
| **Text Books** | T2 | Building Industrial Digital Twins by Shyam Varan Nath & Pieter van Schalkwyk, by Packt Publishing Ltd | 1 | Packt Publishing Ltd. | 2021 |
| **Reference Book** | R1 | Diab, W. W., A. Ferraro, B. Klenz, S. W. Lin, E. Liongosari, W. E. Tannous, and B. Zarkout. "Industrial IoT Artificial Intelligence Framework." (2022): 1-59. | 1 | Digital Twin Consortium (White Paper) | 2022 |
| **Reference Book** | R2 | El Saddik, Abdulmotaleb, ed. Digital Twin for Healthcare: Design, Challenges, and Solutions. Elsevier, 2022. | 1 | Elsevier | 2022 |

*Course Information*

**UE22CS342BA9: Generative AI and its Applications (4-0-0-4-4)**

**# of Credits: 4** **# of Slots: 84**

| Class # | Chapter Title/Reference Literature | Topic | Unit Wise Syllabus Coverage | Cumulative Percentage |
|---|---|---|---|---|
| UNIT - 1 | | | | |
| 1 | | Course Introduction -Overview, Course Information and Evaluation Policy Discussion | 25% | 25% |
| 2 | | Introduction to GenAI and its Applications | | |
| 3 | | Introduction to Large Language Models (LLMs), Evolution and Applications | | |
| 4 | T2 - Chapter 2 2.2 to 2.5 Chapter 4 4.1,4.6, Chapter 1 3.1 Chapter 17 17.2, 17.3, 17.6 | NLP Basics: Terminologies, Tokenization and N-Gram Models | | |
| 5 | | NLP Basics: POS, NER and Text Classification | | |
| 6 | Refer Lab Manual | **Lab Exercise 1**: Performing basic NLP tasks (Tokenization, POS Tagging and Named Entity Recognition) | | |
| 7 | T2 - Chapter 6 6.3, 6.5, 6.8, 6.9 | Introduction to Word Embeddings, Types of Word Embeddings: Word2Vec - CBoW & SkipGram, Word Piece, GloVe, BPE. | | |
| 8-9 | Refer Lab Manual | **Lab Exercise 2**: Types of Word Embeddings(one hot encoding,Bag of Word (Bow),Neural Approaches) | | |
| 10-12 | T2 - Chapter 9 9.1, 9.2, 9.5, 10.1-10.3 | Introduction to LLM Architecture (High Level Overview), Transformer Anatomy and Architecture | | |

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|---|---|---|---|---|
| 13 | T2 - Chapter 10 10.3 | Introduction to Pre-trained Models, Introduction to Hugging Face | | |
| 14-15 | Refer Lab Manual | **Lab Exercise 3**:Implementing Text Classification using pre-trained Transformer models from Hugging Face | | |
| 16 | T2 - Chapter 11 11.1-11.4 Refer Paper 9 | Exploring BERT and GPT Architectures | | |
| 17 | | Exploring variants of BERT:ELMo, ROBERTa, BART | | |
| 18 | Refer Manual | **Lab Exercise 4**: Implementation of Sentiment analysis using BERT and optimization using RoBERTa | | |
| 19-21 | | ***Project-Phase 1 Implementation and Evaluation***<br>***(Basic NLP Tasks (Tokenization, POS, Embedding Techniques of your problem statement)*** | | |
| UNIT - 2 | | | | |
| 22 | T1 - Chapter 3 | Introduction to Prompt Engineering – Overview and Applications | 25% | 50% |
| 23 | | Prompt Engineering Techniques - Zero Shot, One Shot, Few Shot Prompting | | |
| 24 | | Chain of Thought, Tree of Thought, Graph of Thought Prompting | | |
| 25 | Refer Manual | **Lab Exercise 5:** Implementation of different prompting engineering techniques(CoT, ToT,GoT) | | |
| 26 | | | | |
| 27 | | | | |
| 28 | Refer LangChain Documentation | Introduction and Basics of LangChain | | |
| 29 | | Deep dive into LangChain, LangChain Expression Language, Creating Dynamic Chains using LangChain | | |
| 30 | | | | |
| 31 | R4 - Chapter 1-6 | Naive Retrieval Augmented Generation(Naïve RAG): Chunking, Embedding, Vector Stores | | |
| 32 | | Data Processing Techniques- processing different data types and formats | | |
| 33 | | Advanced RAG | | |
| 34 | R3 - Chapter 4 | Mixture of Experts (MoE) | | |
| 35-36 | Refer Manual | **Lab Exercise 6:** Building a Chatbot using RAG techniques | | |

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|---|---|---|---|---|
| 37 | T2 - Chapter 10 10.6 | Bias and Toxicity Evaluation | | |
| 38-42 | | ***Project-Phase 2 & 3 Implementation and Evaluation***<br>***Utilize Prompt Engineering Techniques (CoT, ToT, GoT) and implement a RAG system for your project*** | | |
| ISA 1 | | | | |
| UNIT - 3 | | | | |
| 43 | Refer CrewAI documentation | Introduction to Agentic Workflows | 25% | 75% |
| 44 | | Deep Dive into CrewAI | | |
| 45 | | Implementing Task-Driven Agent Collaboration | | |
| 46 | | **Lab Exercise 7:** Building Agentic workflows using CrewAI | | |
| 47 | | | | |
| 48 | | | | |
| 49 | Refer Paper - R5 | Generative Adversarial Networks (Introduction, Variants, Applications) | | |
| 50 | | | | |
| 51 | Refer Paper - R6 | Introduction to Diffusion Networks | | |
| 52 | | Advanced Diffusion Networks, Combining GANs and Diffusion Models. | | |
| 53 | | | | |
| 54 | R3 - Chapter 4 | Introduction to Multimodal Models, Exploring CLIP and BLIP Applications | | |
| 55-63 | | ***Project-Phase 4 Implementation and Evaluation***<br>***Implement Agentic Workflows for your project using CrewAI. Use Multi-Modal Models if needed.*** | | |
| UNIT - 4 | | | | |
| 64 | T2 - Chapter 10 10.3 | Introduction to LLM Fine Tuning | 25% | 100% |
| 65 | R7 - Refer Paper | Data Resolution/Precision, Quantization | | |
| 66 | | Generative AI Lifecycle | | |
| 67 | T2 - Chapter 10 10.3 | LLM Pre-training | | |
| 68 | | Fine Tuning Principles | | |
| 69 | T2 - Chapter 10 10.4, 10.5 | Fine Tuning using LoRA and QLoRA | | |
| 70 | R8 - Refer Paper | Prompt Tuning and Soft Prompts | | |

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|---|---|---|---|---|
| 71-72 | Refer DeepEval and TruLens Documentation | Deep-Dive on different LLM Evaluation Techniques using DeepEval andTruLens | | |
| 73-75 | Refer Lab Manual | **Lab Exercise 8:** Different types of Finetuning- Parameter fine-tuning, Prompt fine-tuning | | |
| 76 | T2 - Chapter 10 10.6, 10.1,10.2 | Harm of LLM, Data behind LLM | | |
| 77-78 | T2 - Chapter 10 10.5 | LLM Scaling and Privacy, Different types of evaluation techniques | | |
| 79-81 | | ***Project-Phase 5 Implementation and Evaluation*** | | |
| 82-84 | | ***Project-Phase 6 Implementation and Evaluation*** | | |
| ISA 2 | | | | |
| ESA | | | | |

**Tools & Languages:**

Python, LMStudio, Gemini API, CrewAI, LangChain, LangGraph, HuggingFace, Kaggle.

**Textbooks:**

**Text Book:**

1. Quick Start Guide to Large Language Models: Strategies and Best Practices for Using ChatGPT and Other LLMs by Sinan Ozdemir, Addison-Wesley Professional, Edition 1 2023
2. Daniel Jurafsky and James H. Martin. 2024. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models, 3rd edition. Online manuscript released August 20, 2024. https://web.stanford.edu/~jurafsky/slp3.

**Reference Books:**

1. Pretrain Vision and Large Language Models in Python: End-to-end techniques for building and deploying foundation models on AWS,by Emily Webber, packtpublishing,Edition 1, 2023
2. Transformers for Natural Language Processing: Build innovative deep neural network architectures for NLP with Python, PyTorch, TensorFlow, BERT, RoBERTa, and more by Denis Rothman (Author) ,publishing,Edition 1, 2023
3. Understanding Large Language Models: Learning Their Underlying Concepts and Technologies by Thimira Amaratunga, APress, Edition 1 , 2023
4. Retrieval-Augmented Generation (RAG): Empowering Large Language Models (LLMs) by Dr. Ray Islam (Author) ,Edition 1,2023
5. (Paper) Generative Adversarial Nets (2014) by Ian J. Goodfellow
6. (Survey Paper) An Overview of Diffusion Models: Applications, Guided Generation, Statistical Rates and Optimization.
7. (Paper) A Study of BFLOAT16 for Deep Learning Training.
8. (Paper) Using Soft-Prompt Tuning to Evaluate Bias in Large Language Models
9. (Paper) Improving Language Understanding by Generative Pre-Training

*Course Information*

**UE22CS343BB1–HETEROGENEOUS PARALLELISM (4-0-0-4-4)**

**# of Credits: 4** **# of Slots: 84**

| Class No. | Chapter Title/ Reference Literature | Topics to be covered | % of Portions covered | |
|---|---|---|---|---|
| | | | %Syllabus | Cumulative |
| 1 | **UNIT-1: FineGrained Parallelism** | Introduction | 25% | 25% |
| 2 | | Review on Parallelism | | |
| 3 | | Review on Parallel Performance | | |
| 4 | | Review of Parallel Performance | | |
| 5 | | Instruction Level Parallelism-1 | | |
| 6 | | Instruction Level Parallelism-2 | | |
| 7 | | Instruction Level Parallelism-3 | | |
| 8 | | EnhancementTechniques-2 | | |
| 9 | | EnhancementTechniques-2 | | |
| 10 | | EnhancementTechniques-3 | | |
| 11 | | Prediction | | |
| 12 | | Speculation | | |
| 13 | | Vectorization | | |
| 14 | | Predication | | |
| 15 | | Cache Optimization | | |
| 16 | | Cache Optimization | | |
| 17 | | Laws of Parallelism | | |
| 18 | | Data Parallelism | | |
| 19 | | Task Parallelism | | |
| 20 | | Pipeline Parallelism | | |
| 21 | | PThreads | | |
| 22 | **UNIT-2: Coarse Grained Parallelism& Parallel Algorithms** | Multithreading | 25% | 50% |
| 23 | | Multi-Core architectures - Homogeneous | | |
| 24 | | Multi-Core architectures - Heterogeneous | | |
| 25 | | Introduction to Parallel Algorithms | | |
| 26 | | Parallel Algorithms-Examples | | |
| 27 | | Parallel Algorithms-Examples | | |
| 28 | | Parallel Algorithms–Examples | | |

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|---|---|---|---|---|
| 29 | | Parallel Algorithms–Examples | | |
| 30 | | Parallel Algorithms-Examples | | |
| 31 | | Task Decompositions and Mapping | | |
| 32 | | Task Decompositions and Mapping | | |
| 33 | | Task Decompositions and Mapping | | |
| 34 | | Task Decompositions and Mapping | | |
| 35 | | Task Decompositions and Mapping | | |
| 36 | | GPU sand GPGPUs | | |
| 37 | | GPU Architectures-Introduction | | |
| 38 | | GPU Architectures-Case Study | | |
| 39 | | GPU Architectures–Case Study | | |
| 40 | | GPU Architectures–Application | | |
| 41 | | GPU Architectures–Application | | |
| 42 | | Many-Core Heterogeneous Architectures | | |
| 43 | **UNIT-3:**<br><br>**Parallelism Frameworks** | Introduction to Parallel Programming Framework | 25% | 75% |
| 44 | | Introduction to OpenMP | | |
| 45 | | OpenMP–Libraries | | |
| 46 | | OpenMP–Use Cases | | |
| 47 | | OpenMP–Use Cases | | |
| 48 | | OpenMP–Examples | | |
| 49 | | OpenMP–Examples | | |
| 50 | | OpenMP–Examples | | |
| 51 | | OpenMP–Examples | | |
| 52 | | Race Conditions | | |
| 53 | | Race Conditions | | |
| 54 | | Race Conditions | | |
| 55 | | Deadlocks & Debugging | | |
| 56 | | Deadlocks & Debugging | | |
| 57 | | Deadlocks & Debugging | | |

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|---|---|---|---|---|
| 58 | | Memory Models for Parallel Programming | | |
| 59 | | Memory Models for Parallel Programming | | |
| 60 | | Memory Models for Parallel Programming | | |
| 61 | | Memory Consistency Models | | |
| 62 | | Memory Consistency Models | | |
| 63 | | Memory Consistency Models | | |
| 64 | **UNIT-4:**<br><br>**GPU Programming & Hardware Accelerators** | CUDA Programming Framework | 25% | 100% |
| 65 | | CUDA Programming Framework | | |
| 66 | | CUDA Programming Examples | | |
| 67 | | CUDA Programming Examples | | |
| 68 | | CUDA Memory Interfaces | | |
| 69 | | CUDA Memory Interfaces | | |
| 70 | | CUDA Memory Interfaces | | |
| 71 | | CUDA Programming Examples | | |
| 72 | | CUDA Programming Examples | | |
| 73 | | OpenMP with GPU Programming | | |
| 74 | | OpenMP with GPU Programming | | |
| 75 | | Hardware acceleration platforms | | |
| 76 | | Hardware acceleration platforms | | |
| 77 | | Hardware acceleration platforms | | |
| 78 | | Architecture and organization of Modern FPGAs | | |
| 79 | | Architecture and organization of Modern FPGAs | | |
| 80 | | Architecture and organization of Modern FPGAs | | |
| 81 | | Case Studies | | |
| 82 | | Case Studies | | |
| 83 | | Concurrency in Main stream Languages | | |
| 84 | | Concurrency in Main stream Languages | | |

| Book Type | Author&Title | Edition | Publisher | Year |
|---|---|---|---|---|
| T1 | Parallel Programming: for Multicore and Cluster Systems | 3rd | Springer | 2023 |
| R1 | Computer Architecture: A Quantitative Approach By John Hennessy, David Patterson` | 6th | Morgan Kaufmann | 2017 |
| R2 | Programming Massively Parallel Processors by David Kirk and Wen-mei Hwu | 3rd | Morgan Kaufmann | 2016 |
| R3 | Computer Systems: A Programmer's Perspective by Randal E. Bryant, David R. O'Hallaron | 2nd | Pearson | 2016 |
| R4 | Parallel Programming for FPGAs. By Ryan Kastner, Janarbek Matai, and Stephen Neuendorffer | 1st | Creative Commons | 2018 |

**Tools/Languages:** PThread, OpenMP, CUDA, OpenCL, OpenMPI

**Assessment plan:**

| Event | Portion | %of Marks |
|---|---|---|
| ISA1 | Units1and2 | 15% |
| ISA2 | Units3and4 | 15% |
| | | |
| ESA–Theory | Units1,2,3,4 | 50% |
| | | |
| 3 Assignments | Units1,2,3,4 | 10% |
| Project | - | 10% |

## UE22CS343BB2: Topics in Deep Learning (4-0-0-4-4)

**# of Credits: 4** **# of Slots: 84**

| Class # | Chapter Title/ Reference Literature | Topics to be Covered | Percentage Of Portion Covered | |
|---|---|---|---|---|
| | | | Absolute | Cumulative |
| Unit 1: Introduction to Deep Learning Introduction, Activation functions, Loss functions, Batch Normalization, Regularization and Optimization. Convolutional Neural Network(CNN) | | | | |
| 1 | | Introduction to Deep Learning and Course Logistics | 25% | 25% |
| 2 | T2:10-12,44-50 | Activation functions | | |
| 3 | T2:13 | Loss functions | | |
| 4 | T2:150 | Batch Normalization | | |
| 5 | T2:61,180-181 | Regularization | | |
| 6 | T2:132-138 https://medium.com/nerd-for-tech/optimizers-in-machine-learning-f1a9c549f8b4 | Optimization | | |
| 7 | T2:305-326 | CNN- Introduction,Filters,Feature Maps | | |
| 8 | T2:305-326 | Max-Pool Layers, Other Pooling Types | | |
| 9 | T2:305-326 | Back Propagation | | |
| 10 | T2:326-335, https://medium.com/axinc-ai/yolov5-the-latest-model-for-object-detection-b13320ec516b | Alexnet, ZFNet | | |
| 11 | T2:326-335, https://medium.com/axinc-ai/yolov5-the-latest-model-for-object-detection-b13320ec516b | VGGNet, GoogleNet | | |
| 12 | T2:326-335, https://medium.com/axinc-ai/yolov5-the-latest-model-for-object-detection-b13320ec516b | ResNet, RCNN | | |
| 13 | T2:326-335, https://medium.com/axinc-ai/yolov5-the-latest-model-for-object-detection-b13320ec516b | FRCNN, Faster RCNN | | |
| 14 | T2:326-335, https://medium.com/axinc- | YOLO V5 | | |

| | | | | |
|---|---|---|---|---|
| | ai/yolov5-the-latest-model-for-object-detection-b13320ec516b | | | |
| 15 | https://machinelearningmastery.com/transfer-learning-for-deep-learning/, https://towardsdatascience.com/a-comprehensive-hands-on-guide-to-transfer-learning-with-real-world-applications-in-deep-learning-212bf3b2f27a, https://towardsdatascience.com/transfer-learning-with-convolutional-neural-networks-in-pytorch-dd09190245ce | Transfer Learning:Introduction,Motivation,Variations | | |
| 16 | https://machinelearningmastery.com/transfer-learning-for-deep-learning/, https://towardsdatascience.com/a-comprehensive-hands-on-guide-to-transfer-learning-with-real-world-applications-in-deep-learning-212bf3b2f27a, https://towardsdatascience.com/transfer-learning-with-convolutional-neural-networks-in-pytorch-dd09190245ce | TL Architecture of CNNs | | |
| 17 | | Class Assignment on CNN & TL/YOLO | | |
| 18 | | Class Assignment on CNN & TL/YOLO | | |
| 19 | | Class Assignment on CNN & TL/YOLO | | |
| 20 | | **Revision** | | |
| 21 | **Lab/Experiential learning** | **Revision** | | |
| Unit 2: Recurrent Neural Networks (RNN) and Transformers | | | | |
| 22 | T2-265-289 | RNN Introduction | 25% | 50% |
| 23 | T2-265-289 | Recurrent Neurons,- Memory Cells | | |
| 24 | T2-265-289 | Variable-Length Input, Output Sequences | | |
| 25 | T2-265-289 | Variable-Length Input, Output Sequences | | |
| 26 | T2-265-289 | RNN Architecture | | |

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|---|---|---|---|---|
| 27 | T2-265-289 | Sequence Learning Problem | | |
| 28 | T2-265-289 | BPTT-Back Propagation Through Time | | |
| 29 | T2-265-289 | Truncated BPTT | | |
| 30 | T2-265-289 | Vanishing and Exploding Gradient | | |
| 31 | T2-265-289 | Bidirectional RNN | | |
| 32 | T2-265-289 | LSTM Cell ,GRU Cell | | |
| 33 | T2:435-450 & 454 | Text Classification with RNN | | |
| 34 | T2:435-450 & 454 | Encoder/Decoder Architecture | | |
| 35 | T2:435-450 & 454 | Seq2Seq Model with Attention | | |
| 36 | T2:435-450 & 454 | Transformer Model | | |
| 37 | T2:435-450 & 454 | BERT Architecture | | |
| 38 | T2:435-450 & 454 | Transformer Attention and its Implementation | | |
| 39 | | In class Assignment using RNNs, Transformers and TL / predefined model | | |
| 40 | | In class Assignment using RNNs, Transformers and TL / predefined model | | |
| 41 | | In class Assignment using RNNs, Transformers and TL / predefined model | | |
| 42 | | Revision | | |
| Unit 3: Generative Models & Meta Learning | | | | |
| 43 | T2:197-208 | Introduction to Autoencoders | | |
| 44 | T2:197-208 | Regularization in Autoencoders | | |
| 45 | T2:197-208 | Denoising Autoencoders | | |
| 46 | T2:197-208 | Sparse Autoencoders | | |
| 47 | T2:197-208 | Contrastive Autoencoders | | |
| 48 | T2:197-208 | Variational Autoencoders (VAEs) | | |
| 49 | T2:197-208 | Architecture and Training Methods | | |
| 50 | T2:467-471, https://machinelearningmastery.com/tour-of-generative-adversarial-network-models/#:~:text=The%20deep%20convolutional%20generative%20adversarial,training%20of%20a%20generator%20model. | Image Generation | 25% | 75% |
| 51 | T2:467-471, https://machinelearningmastery.com/tour-of-generative-adversarial-network-models/#:~:text=The%20deep%20convolutional%20generative%20adversarial,trai | DCGAN | | |

| | | | | |
|---|---|---|---|---|
| | ning%20of%20a%20generator%20model. | | | |
| 52 | T2:467-471, https://machinelearningmastery.com/tour-of-generative-adversarial-network-models/#:~:text=The%20deep%20convolutional%20generative%20adversarial,training%20of%20a%20generator%20model. | Style GAN | | |
| 53 | T2:467-471, https://machinelearningmastery.com/tour-of-generative-adversarial-network-models/#:~:text=The%20deep%20convolutional%20generative%20adversarial,training%20of%20a%20generator%20model. | WGAN | | |
| 54 | T2:467-471, https://machinelearningmastery.com/tour-of-generative-adversarial-network-models/#:~:text=The%20deep%20convolutional%20generative%20adversarial,training%20of%20a%20generator%20model. | Applications | | |
| 55 | T2:361-371 | Introduction to GNNs | | |
| 56 | T2:361-371 | Graph Convolution Networks,Applications | | |
| 57 | https://towardsdatascience.com/how-to-run-model-agnostic-meta-learning-maml-algorithm-c73040069810, https://www.instadeep.com/research/blog/model-agnostic-meta-learning-made-simple/ | Introduction to Meta Learning | | |
| 58 | https://towardsdatascience.com/how-to-run-model-agnostic-meta-learning- | MAML | | |

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|---|---|---|---|---|
| | maml-algorithm-c73040069810, https://www.instadeep.com/research/blog/model-agnostic-meta-learning-made-simple/ | | | |
| 59 | https://towardsdatascience.com/how-to-run-model-agnostic-meta-learning-maml-algorithm-c73040069810, https://www.instadeep.com/research/blog/model-agnostic-meta-learning-made-simple/ | FOMAML | | |
| 60 | https://towardsdatascience.com/how-to-run-model-agnostic-meta-learning-maml-algorithm-c73040069810, https://www.instadeep.com/research/blog/model-agnostic-meta-learning-made-simple/ | Adaptive Neural Inductive Learning | | |
| 61 | https://towardsdatascience.com/a-friendly-introduction-to-siamese-networks-85ab17522942, https://medium.com/@rinkinag24/a-comprehensive-guide-to-siamese-neural-networks-3358658c0513 | Siamese Networks | | |
| 62 | **Experiential learning** | **Assignment 3: Jackfruit problem** | | |
| 63 | **Experiential learning** | **Assignment 3: Jackfruit problem** | | |
| Unit 4: Reinforcement Learning, Diffusion Models, Federated Learning and Overview of Latest Deep Learning Models | | | | |
| 64 | T2:393-394, | Introduction | 25% | 100% |
| 65 | T2:398-402 | Basic Framework of RL | | |
| 66 | T2:393-394, | Learning to Optimize Rewards | | |
| 67 | T2:398-402 | Credit Assignment Problem | | |
| 68 | T2:393-394, | Temporal Difference Learning | | |
| 69 | T2:398-402 | Q Learning | | |
| 70 | T2:393-394, | Deep Q Learning | | |
| 71 | T2:398-402 | Training and Testing | | |
| 72 | https://scholar.harvard.edu/files/binxuw/files/stable_d | Introduction,Stable Diffusion Architectures | | |

| | | | | |
|---|---|---|---|---|
| | iffusion_a_tutorial.pdf | | | |
| 73 | https://machinelearningmastery.com/the-vision-transformer-model/ | Introduction :Vision Transformers | | |
| 74 | https://dugas.ch/artificial_curiosity/GPT_architecture.html | GPT Architecture | | |
| 75 | https://www.v7labs.com/blog/federated-learning-guide, https://towardsdatascience.com/introduction-to-federated-learning-and-challenges-ea7e02f260ca | Horizontal Federated Learning | | |
| 76 | https://www.v7labs.com/blog/federated-learning-guide, https://towardsdatascience.com/introduction-to-federated-learning-and-challenges-ea7e02f260ca | Vertical Federated Learning | | |
| 77 | https://www.v7labs.com/blog/federated-learning-guide, https://towardsdatascience.com/introduction-to-federated-learning-and-challenges-ea7e02f260ca | Federated Transfer Learning (FTL) | | |
| 78 | Experiential learning | **Assignment 3: Jackfruit problem** | | |
| 79 | Experiential learning | **Assignment 3: Jackfruit problem** | | |
| 80 | Experiential learning | **Assignment 3: Jackfruit problem** | | |
| 81 | Experiential learning | **Assignment 3: Jackfruit problem** | | |
| 82 | Experiential learning | **Assignment 3: Jackfruit problem** | | |
| 83 | Experiential learning | **Assignment 3: Jackfruit problem** | | |
| 84 | Experiential learning | **Assignment 3: Jackfruit problem** | | |

| Type | Title | Author(s) | Publisher/Source | Year |
|---|---|---|---|---|
| Text books | "Advanced Deep Learning with Python" | Ivan Vasilev | Packt Publishing | 2019 |
| | "Neural Network and Deep learning" | Charu C Agarwal | Springer International Publishing | 2018 |
| Reference Books | "Hands-on Machine Learning with Scikit-Learn and TensorFlow" | Aurelian Geron | O‟Reilly | 2017 |
| | "Deep Learning with Keras" | Antonio Gulli and Sujit Pal | Packt Publishing | 2017 |
| | "Pattern Recognition and Machine Learning" | Christopher Bishop | Springer | 201 |

## UE22CS343BB3- DATABASE TECHNOLOGIES (4-0-1-4-4)

**No of Credits: 4** **# of Hours: 84**

| Class # | Chapter Title/ Reference Literature | Topics to be covered | % of Portions Covered | |
|---|---|---|---|---|
| | | | Reference Chapter | Cumulative |
| 1. | Unit 1: Relational Data Model and Storage Formats and Indexing | Review of Relational Design Theory – Relational Algebra. | T1- 1,2,3,5,8,13 ,14,15 | 25 |
| 2. | | Secondary Storage Management - Secondary Storage Management, Memory Hierarchy, Architecture, Disk Failures, RAID | | |
| 3. | | Flash Storage & DB Buffer - Database Buffer, Buffer Manager, Buffer Management Architecture | | |
| 4. | | Buffer Management Strategies | | |
| 5. | | Column DB - Column Database, Row Store and Column Store - Overview, Why Column Stores, Column Stores - Data Model, Column database Vs Row database, Pros and Cons of Columnar Databases | | |
| 6. | | Arranging Data on Disk - Arranging Data on Disk, Block and Record Addresses, Storage Allocation in SQL Server | | |
| 7. | | Arranging Data on Disk - Swizzling, Variable-Length Data and Records, Record Modifications | | |
| 8. | | Indexes - Overview, Multiple Indexes | | |
| 9. | | Indirection in Secondary Indexes | | |
| 10. | | Document Retrieval and Inverted Indexes | | |
| 11. | | B Trees - Overview, Lookup in B Trees, | | |
| 12. | | Insertion into B Trees, Deletion from B Trees, Efficiency of B Trees | | |
| 13. | | Hashing - Extensible and Linear Hash Tables | | |
| 14. | | Hashing - Multiple Key Indexes | | |
| 15. | | , Performance of Multiple Key Indexes | | |
| 16. | | Index in SQL - Index Definition in SQL, The CREATE INDEX Command, Single-Column Indexes, Unique Indexes, Composite Indexes, Choice of Index, The DROP INDEX Command, When should indexes be avoided | | |
| 17. | | Multidimensional Data, R Trees, Bitmap Indexes | | |
| 18. | | H/L/P/A #1 | | |
| 19. | Unit 2: Query | Query Execution - Query Execution, Query Compilation and The Computation Model for Physical Operators | T1- 1,15,16 | 50 |

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|---|---|---|---|---|
| 20. | **Processing and Optimization** | One Pass Algorithms - One-Pass Algorithms for Tuple-at-a-Time Operations, One-Pass Algorithms for Unary, Full-Relation Operations: Duplicate Elimination, Grouping | | |
| 21. | | One Pass Algorithms - One-Pass Algorithms for Binary Operations: Set Operations, Natural Join | | |
| 22. | | Two Pass Algorithms (Based on Sorting) - Duplicate Elimination Using Sorting, Grouping and Aggregation Using Sorting | | |
| 23. | | Two Pass Algorithms (Based on Hashing) - Duplicate Elimination Using Hashing, Grouping and Aggregation Using Hashing | | |
| 24. | | Buffer Management<br>- Buffer Management Strategies (Least Recently Used, First In First Out, Clock Algorithm)<br>- Relationship Between Physical Operator Selection and Buffer Management | | |
| 25. | | - Index Scan, - Clustering and Non-clustering Indexes | | |
| 26. | | Query Compiler - Syntax Analysis and Parse Trees<br>- Query Parsing and Preprocessing<br>- Syntax Analysis and Parse Trees<br>- Grammar for a Simple Subset of SQL<br>- Preprocessor<br>- Preprocessing Queries Involving View | | |
| 27. | | Algebraic Laws for Improving Query Plans<br>- Laws for Selection<br>- Laws for Projection<br>- Laws for Joins and Product<br>- Laws for Duplicate Elimination<br>- Laws for Grouping and Aggregation | | |
| 28. | | From Parse Trees to Logical Query Plan - Conversion to Relational Algebra, Removing Subqueries From Conditions | | |
| 29. | | From Parse Trees to Logical Query Plan - Improving the Logical Query Plan | | |
| 30. | | Improving the Logical Query Plan - most commonly used optimization techniques, Grouping Associative/Commutative Operators | | |
| 31. | | Cost Based Plan Selection | | |
| 32. | | Cost Based Plan Selection - Heuristic Enumeration, Branch & Bound, | | |
| 33. | | Hill Climbing, Dynamic Programming, Selinger-style Optimization | | |
| 34. | | Choosing An Order For Joins - Dynamic Programming to Select a Join Order and Grouping, | | |

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|---|---|---|---|---|
| 35. | | Dynamic Programming With More Detailed Cost Functions, A Greedy Algorithm for Selecting a Join Order | | |
| 36. | | H/L/P/A #2 | | |
| 37. | | Assignments Evaluation – #1 | | |
| 38. | | ISA #1 | | |
| 39. | **Unit 3:**<br><br>**Parallel and Distributed Databases** | Models of Parallelism - Parallel Database Architectures, Models of Parallelism, Intra-query and Inter-query Parallelism | T1- 20 | 75 |
| 40. | | MapReduce | | |
| 41. | | Parallel & Distributed Algorithms | | |
| 42. | | Distributed Databases - Parallel Vs Distributed Database, Distributed Database Concepts, Data Distribution Among Distributed Databases, Homogeneous and Heterogeneous Distributed Databases, Advantages of Distributed Databases, Additional Functions of DDB | | |
| 43. | | Distributed Databases - Data Fragmentation, Horizontal, Vertical and Hybrid Types, Data Replication | | |
| 44. | | | | |
| 45. | | Distributed Transactions | | |
| 46. | | Distributed Commit, Two-Phase Commit Protocol, Concurrency Control | | |
| 47. | | Distributed Query Processing - Distributed Query Processing Stages | | |
| 48. | | The Distributed Join Problem | | |
| 49. | | Distributed Query Processing - Semi Join, Joins of Many Relations | | |
| 50. | | Distributed Locking - Centralized Lock Systems, | | |
| 51. | | Primary-Copy Locking, Global Locks From Local Locks | | |
| 52. | | Distributed Catalog Management | | |
| 53. | | Management Schemes For Distributed Catalogs | | |
| 54. | | Peer to Peer Distributed Search | | |
| 55. | | Peer to Peer Distributed Search | | |
| 56. | | Project Teams formation, Instructions, Proposal, | | |
| 57. | | Project Approval, Initiation | | |
| 58. | | H/L/P/A #3 | | |
| 59. | **Unit 4:**<br><br>**Data-Stream Management** | Data streaming Intro | T1- 10,22<br>T2- 1,2,3,4,5,6, 10, 19,29 | 100 |
| 60. | | Stream Processing Model | | |
| 61. | | Streaming Architectures | | |
| 62. | | Spark as a SP Engine | | |
| 63. | | Spark's Distributed Processing Engine | | |
| 64. | | Spark's Resilience Model | | |
| 65. | | Apache Kafka | | |

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| 66. | | Apache Kafka Architecture | | |
| 67. | | Apache Kafka Architecture - Content & Topic based routing & Fault tolerance | | |
| 68. | | Amazon Kinesis | | |
| 69. | | Streaming Use Case | | |
| 70. | | Introduction to Vector database | | |
| 71. | | Serverless vector databases and Use cases | | |
| 72. | | Current Trends in Design and Implementation of Database Systems and Decision Support Systems | | |
| 73. | | Data Warehousing | | |
| 74. | | Data Mining | | |
| 75. | | Data Lakes | | |
| 76. | | Data Mesh and Data Fabric | | |
| 77. | | Multi-model Databases | | |
| 78. | | H/L/P/A #4 | | |
| 79. | | Assignments Evaluation – #2 | | |
| 80. | | Project Implementation | | |
| 81. | | Project Implementation | | |
| 82. | | Project Evaluation | | |
| 83. | | Project Evaluation | | |
| 84. | | ISA #2 | | |

**Text Book(s):**

T1: “Database Systems: The Complete Book”, H Garcia-Molina, JD Ullman and J Widom, 2nd Ed., Pearson, 2018.

T2: “Stream Processing with Apache Spark”, Gerard Maas & Francois Garillot, O’Reilly, June 2019.

**Reference Book(s):**

R1: “Fundamentals of Database Systems”, Elmasri and Navathe, Pearson Education, 7th Ed., 2016.

R2: “Streaming Systems” by Tyler Akidau, SlavaChernyak, Reuven Lax, O'Reilly, July 2018.

**Tools & Languages:** MySQL, postgres, Oracle, Apache Spark, Apache Kafka, Amazon Kinesis.

## UE22CS343BB4: Machine Learning on Graphs

**No of Credits: 4** **# of Hours: 84**

| Class# | Chapter Title / Reference Literature | Topics to be Covered | % of the portion covered | |
|---|---|---|---|---|
| | | | % of Syllabus | Cumulative % |
| Wk1-Lec1<br>Wk1-Lec2<br>Wk1-Lec3 | **Unit #1 Introduction**<br><br>**T1: Ch.- 1,2 (1.1,1. 2,2.1, 2.2, 2.3)**<br><br>**T2: Ch. 2 (2.6, 2.7)**<br><br>**Slides from PESU Academy** | Motivation for the course. Evaluation policy of the course. Introduction to Algorithms. Introduction to Assignments, Discussion | **25** | **25** |
| Wk1-Lec4<br>Wk1-Lec5<br>Wk1-Lec6 | | Types of Complex Graphs: Multi-relational Graphs eg Heterogeneous graphs, Multiplex graphs etc. Computational Tasks on Graphs | | |
| Wk2-Lec7<br>Wk2-Lec8<br>Wk2-Lec9 | | Graph Features for traditional machine learning– Node level features, Node Classification, Relation prediction, Clustering and community detection, graph<br>Classification, regression, and clustering | | |
| Wk2-Lec10<br>Wk2-Lec11<br>Wk2-Lec12 | | Graph kernel features- Graphlet & Motif Graph Kernels-Graphlet and Motifs contd. Weisfeiler-Lehman kernel | | |
| Wk3-Lec13<br>Wk3-Lec14<br>Wk3-Lec15 | | Measures for neighborhood overlap<br>Graph clustering and spectral methods – Graph Laplacians. Graph Cuts and clustering, Spectral clustering | | |
| Wk3-Lec16<br>Wk3-Lec17<br>Wk3-Lec18 | | Semi-supervised Learning on Graph - Label Propagation Algorithm. Label Spreading Algorithm | | |
| Wk4-Lec19<br>Wk4-Lec20<br>Wk4-Lec21 | | Hands-On Session 1 (Part of Internal Assessment) | | |
| Wk4-Lec22<br>Wk4-Lec23<br>Wk4-Lec24 | **Unit #2: T1: Ch. 2 and 3 and**<br><br>**PESU Academy Slides** | Paper Implementation - Assignment Announcement, Group formation, and Paper distribution<br>Encoder-Decoder perspective-encoder, decoder, and optimization of the encoder-decoder model. | **25** | **50** |
| Wk5-Lec25<br>Wk5-Lec26<br>Wk5-Lec27 | | Factorization-based approaches - Random Walk embedding | | |
| Wk5-Lec28<br>Wk5-Lec29<br>Wk5-Lec30 | | Random walk approaches: Node2Vec | | |
| Wk6-Lec31<br>Wk6-Lec32<br>Wk6-Lec33 | | Factorization-based approaches - Random Walk embedding –Deep Walk, Comparisons | 25 | 50 |

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|---|---|---|---|---|
| Wk6-Lec34<br>Wk6-Lec35<br>Wk6-Lec36 | | Shallow Embeddings-Limitations of shallow embedding. | | |
| Wk7-Lec37<br>Wk7-Lec38<br>Wk7-Lec39 | | Shallow embedding in multi-relational Knowledge Graph-embedding as reconstruction task, loss function, and decoders. | | |
| Wk7-Lec40<br>Wk7-Lec41<br>Wk7-Lec42 | | Hands-On Session 2 - (Part of Internal Assessment)<br>Paper Implementation - Discussion | | |
| Wk8-Lec43<br>Wk8-Lec44<br>Wk8-Lec45 | **Unit #3<br>T1: Ch. 5 (5.1,5.2, 5.3) Ch. 7 (7.1) and PESU Academy Slides** | Vanilla GNN - Neural message passing framework. Generalized neighborhood aggregation, Generalized update methods, Graph Convolution Networks (GCN), GraphSAGE. | 25 | 75 |
| Wk8-Lec46<br>Wk8-Lec47<br>Wk8-Lec48 | | Multi-relational GCN and Graph Attention Networks (GAT), | | |
| Wk9-Lec49<br>Wk9-Lec50<br>Wk9-Lec51 | | Hands-On Session 3 (2 Sessions)<br>Paper Implementation - Resolution of Issues | | |
| Wk9-Lec52<br>Wk9-Lec53<br>Wk9-Lec54 | | Graph Transformer. Graph pooling. Applications and loss functions. | | |
| Wk10-Lec55<br>Wk10-Lec56<br>Wk10-Lec57 | | Efficiency issues in GNN Modelling–GNN layer optimization, Stacking GNN layers, | | |
| Wk10-Lec58<br>Wk10-Lec59<br>Wk10-Lec60 | | Expressiveness, designing Maximally expressive GNNs, Expressive Power by aggregate functions. Applications and loss functions | | |
| Wk11-Lec61<br>Wk11-Lec62<br>Wk11-Lec63 | | Paper Implementation - Review 1<br>Presentation | | |

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| Wk11-Lec64<br>Wk11-Lec65<br>Wk11-Lec66 | **Unit 4: T1: Ch. 9 (9.1-9.3), T2: Ch. 4 (4.3) Ch. 8 (8.2, 8.6, 8.7) Ch. 9 (9.4, 9.5) Ch. 10 and Ch.11 (overview in the context of text and image)** | Deep Generative models on graph – Variational autoencoder on the graph. | 25 | 100 |
| Wk12-Lec67<br>Wk12-Lec68<br>Wk12-Lec69 | | Generative adversarial network on the graph, Auto-regressive methods. | | |
| Wk12-Lec70<br>Wk12-Lec71<br>Wk12-Lec72 | | GNN on complex graphs – Heterogeneous GNN, Dynamic GNN, Hypergraph GNN | | |
| Wk13-Lec73<br>Wk13-Lec74<br>Wk13-Lec75 | | Interdisciplinary Applications of GNN: Unstructured data – Text and Image. Application of GNN to Biology and Chemistry | | |
| Wk13-Lec76<br>Wk13-Lec77<br>Wk13-Lec78 | **Ch. 12 (12.2,12.4) And PESU Academy slides** | Structured Data - Social Network, Recommender System, Cyber Security. | | |
| Wk14-Lec79<br>Wk14-Lec80<br>Wk14-Lec81 | | An introduction to trustworthy graph AI. Meta-Learning perspectives of graph ML. | | |
| Wk14-Lec82<br>Wk14-Lec83<br>Wk14-Lec84 | | Paper Implementation Demo - Review 2 | | |

**Text Books and References:**

| Book Type | Code | Title & Author | Publication Information | | |
|---|---|---|---|---|---|
| | | | Edition | Publisher | Year |
| Text Book | T1 | "Graph Representation Learning", William L Hamilton, Morgan and Claypool Publishers, 2020. | 2 | Morgan and Claypool Publishers | 2020 |
| Text Book | T2 | "Deep Learning on graphs", Yao Ma and Jiliang Tang, Cambridge University Press, 2021 | 3 | Cambridge University Press, | 2021 |
| Reference Book | R1 | Introduction to Graph Neural Networks, Zhiyuan Liu and Jie Zhou, Synthesis Lectures on Artificial Intelligence and Machine Learning, | 2 | Morgan and Claypool Publisher | 2020 |
| Reference Book | R2 | Social Media Mining, Reza Zafarani | 1 | Cambridge University Press | 2015 |
| Reference Book | R3 | Network Science, Albert Barabasi | | | 2016 |

## UE22CS343BB6- Information Security - (4:0:0:0:4)

**No of Credits: 4** **# of Hours: 84**

| Class # | Chapter Title/Reference Literature | Topics to be Covered | % of Portions Covered | |
|---|---|---|---|---|
| | | | % of Syllabus | Cumulative % |
| 1 | Unit #1<br>T1: Chapter 2,3,16<br>R1: Chapter 1,2,3 | Unit #1 | **25** | **25** |
| 2 | | | | |
| 3 | | | | |
| 4 | | 25% | | |
| 5 | | Security Principles, Secure coding, | | |
| 6 | | Security Principles, Secure coding, Secure Lifecycle | | |
| 7 | | Secure Lifecycle | | |
| 8 | | Misuse case | | |
| 9 | | Misuse case | | |
| 10 | | Set UID, Env variables | | |
| 11 | | Set UID, Env variables | | |
| 12 | | Set UID, Env variables | | |
| 13 | | Lab 1 : Set UID, Env variables | | |
| 14 | | | | |
| 15 | | | | |
| 16 | | Buffer overflow - 1 | | |
| 17 | | Buffer overflow - 1 | | |
| 18 | | Buffer overflow - 1 | | |
| 19 | | Lab 2 : Shell Code Attack | | |
| 20 | | | | |
| 21 | | | | |
| 22 | Unit #2<br>T1: Chapter 4,5<br>R1: Chapter 4,5,6 | Buffer overflow - 2 | **25** | **50** |
| 23 | | Buffer overflow - 2 | | |
| 24 | | Return to Libc | | |
| 25 | | Case Study I discussion - Target | | |
| 26 | | | | |
| 27 | | | | |
| 28 | | Lab 3 : Buffer overflow | | |
| 29 | | | | |
| 30 | | | | |
| 31 | | Format String Attack | | |
| 32 | | Exploiting the vulnerability | | |

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| 33 | | Code injection attack | | |
| 34 | | Lab 4 : Return to libc | | |
| 35 | | | | |
| 36 | | | | |
| 37 | | Countermeasures | | |
| 38 | | Malware and its Types | | |
| 39 | | Malware analysis: Conifer, Morris, Stuxnet worm | | |
| 40 | | Lab 5 : Formate String Attack | | |
| 41 | | | | |
| 42 | | | | |
| 43 | | Ransomware | | |
| 44 | | Shellcode | | |
| 45 | | Revision (ISA | | |
| 46 | Unit #3<br><br>T1: Chapter 6<br>R2: Chapter 1,2,3 | Privacy - threat Modelling + STRIDE | **25** | **75** |
| 47 | | Privacy - threat Modelling + STRIDE | | |
| 48 | | Privacy - threat Modelling + STRIDE | | |
| 49 | | Lab 6 : Malware | | |
| 50 | | | | |
| 51 | | | | |
| 52 | | Web security Basics | | |
| 53 | | Web security Basics | | |
| 54 | | Web security Basics | | |
| 55 | | Privacy Threats | | |
| 56 | | Privacy Threats | | |
| 57 | | Privacy Threats | | |
| 58 | | Case Study II discussion - Apple | | |
| 59 | | | | |
| 60 | | | | |
| 61 | | SQL Injection | | |
| 62 | | SQL Injection | | |
| 63 | | SQL Injection | | |
| 64 | | Lab 7 : SQL Injection | | |
| 65 | | | | |
| 66 | | | | |

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| 67 | Unit #4<br>T1: Chapter 11,12,14<br>R1: Chapter 9,10,11<br>R2: Chapter 6,7,8 | CSRF | **25** | **100** |
| 68 | | CSRF | | |
| 69 | | XSS | | |
| 70 | | Static Analysis and Pen testing | | |
| 71 | | Lab 8 : CSRF | | |
| 72 | | | | |
| 73 | | Lab 9 : XSS | | |
| 74 | | | | |
| 75 | | | | |
| 76 | | Patching and VA | | |
| 77 | | Patching and VA | | |
| 78 | | | | |
| 79 | | Lab 10 : Shellshock | | |
| 80 | | | | |
| 81 | | Burp suite | | |
| 82 | | Pentesting | | |
| 83 | | | | |
| 84 | | Revision (ISA-2) | | |
| 85 | | Hackathon(RR + EC Campus) | | |
| 86 | | | | |
| 87 | | | | |
| 88 | | | | |

**Literature**

| Book Type | Code | Title & Author | Publication Information | | |
|---|---|---|---|---|---|
| | | | Edition | Publisher | Year |
| Text Book | T1 | "Computer & Internet Security: A Hands-on Approach", | 2nd/3rd | Wenliang Du | 2022/2019 |
| Reference Book | R1 | "Computer Security: Principles and Practice" | 2nd | William Stallings and Lawrie Brown | 2014 |
| Reference Book | R2 | "Secure Programming with Static Analysis", | 3rd | Brian Chess and Jacob West | 2007 |
| Reference Book | R2 | "Secure Programming with Static Analysis", | 3rd | Brian Chess and Jacob West | 2007 |

**UE22CS343BB7: Mobile and Autonomous Robotics (4-0-1-4-4)**

**No of Credits: 4** **# of Hours: 84**

| Class No. | Chapter title/ Reference literature | Topics to be covered | % of Portions covered | |
|---|---|---|---|---|
| | | | Absolute % | Cumulative % |
| **UNIT – I: Introduction to Autonomous Robots** | | | | |
| 1 | T1 | -Autonomous Robots (ARs)<br>-Definition of ARs, opportunities, challenges, and applications | 25% | 25% |
| 2 | T1 | -Historical overview and future of ARs | | |
| 3 | T1 | -Basic Concepts and Terminology | | |
| 4 | T1 | -Sensors and Actuators, Types and Applications | | |
| 5 | T1 | -Motors and Controllers | | |
| 6 | T1 | -Power Sources and Management | | |
| 7 | R2 | -Introduction to ROS/ROS2<br>-Architecture & Communication Protocols | | |
| 8 | Hands-on-1 | -ROS/ROS2 installation and setup | | |
| 9 | Hands-on-1 | -ROS/ROS2 installation and setup | | |
| 10 | T1 | -Understanding Robot Motion<br>-Forward and Inverse Kinematics | | |
| 11 | T1 | -Dynamics: Robot Movement and Forces | | |
| 12 | T1 | -Range Finders and Encoders | | |
| 13 | T1 | -Vision Sensors | | |
| 14 | R2 | -Advanced ROS Concepts: Nodes, Topics, Services | | |
| 15 | Hands-on-2 | -Topic subscription and publishing | | |
| 16 | Hands-on-2 | -Developing ROS Packages | | |
| 17 | T1 | -Perception Sensors: Object Recognition, Mapping<br>-Decision-Making: Planning, Navigation | | |
| 18 | T1 | -Discussing Emerging Trends in Robotics | | |
| 19 | T1 | Autonomous Robots and Manipulations | | |
| 20 | Assignment-1 | Mini-Project (Team formation) | | |
| 21 | Assignment-1 | Problem statement | | |
| **UNIT – II: Locomotion and Perception** | | | | |
| 22 | T1 | - Importance of Locomotion in Robotics<br>-Types of Locomotion Mechanisms: | 25% | 50% |

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|---|---|---|---|---|
| | | Ground and Aerial Robots | | |
| 23 | T1 | -Legged Mobile Robots<br>-Wheeled Mobile Robots | | |
| 24 | T1 | -Aerial Mobile Robots | | |
| 25 | T1 | -Explanation of Degrees of Freedom (DOF)<br>-2-DOF and 3-DOF robots | | |
| 26 | T1 | -5-DOF and 6-DOF robots | | |
| 27 | T1 | -Forward and Inverse Kinematics | | |
| 28 | R2 | -ROS Packages for Hardware Control | | |
| 29 | Hands-on-3 | -3D Visualization Tool | | |
| 30 | Hands-on-3 | -RViz | | |
| 31 | T1 | -Kinematic Models and Constraints | | |
| 32 | T1 | -Mobile Robot Maneuverability | | |
| 33 | T1 | -Mobile Robot Workspace | | |
| 34 | T1 | -Motion Control (Kinematic Control) | | |
| 35 | Hands-on-4 | -Dynamics of a wheeled robot | | |
| 36 | Hands-on-4 | -TurtleSim | | |
| 37 | T1 | -Sensors for Mobile Robots | | |
| 38 | T1 | -Gyroscope, accelerometers, IMU, GPS | | |
| 39 | T1 | -Range sensors, camera vision and LiDAR. | | |
| 40 | Assignment-2 | Mini-Project (Phase-1) | | |
| 41 | Assignment-2 | Mini-Project (Phase-1) | | |
| 42 | Revision | Unit1 &Unit2 | | |
| 43-48 | **ISA-1** | | | |
| **UNIT – III: Robot Vision and Localization** | | | | |
| 49 | T1 | -Robot vision basics - UGVs / UAVs/AUVs | 25% | 75% |
| 50 | T1 | -Feature Extraction<br>-Fundamentals of Image Processing | | |
| 51 | T1 | -Image Feature Extraction: Interest Point Detectors | | |
| 52 | R2 | -ROS Integration with Sensors and Actuators | | |
| 53 | Hands-on-5 | -Use sensor and actuator packages on ROS | | |
| 54 | Hands-on-5 | -Use sensor and actuator packages on ROS | | |
| 55 | T1 | -Feature Extraction Based on Range Data (Laser, Ultrasonic) | | |
| 56 | T1 | -Object detection and tracking, | | |
| 57 | T1 | -Stereo vision and 3D perception<br>-The basics of scene segmentation and parsing | | |
| 58 | R2 | -Robot. Sensor. Motor. | | |
| 59 | R2 | -Robot. Sensor. Motor. | | |
| 60 | Hands-on-6 | -Object detection and tracking | | |
| 61 | Hands-on-6 | -Object detection and tracking | | |

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| 62 | T1 | -Introduction and Challenges of Localization | | |
| 63 | T1 | -Localization-Based Navigation Versus Programmed Solutions | | |
| 64 | T1 | -Single-hypothesis and Multiple-hypothesis belief | | |
| 65 | T1, T2 | -The robot localization problem | | |
| 66 | T1, T2 | -Classification of localization problems | | |
| 67 | T1, T2 | -Markov localization and Kalman filter localization | | |
| 68 | T1, T2 | -SLAM: The simultaneous localization and mapping problem | | |
| 69 | T1, T2 | -Extended Kalman Filter (EKF) SLAM<br>-Particle filter SLAM<br>-Open challenges in SLAM | | |
| 70 | Assignment-3 | -Mini-Project (Phase 2) | | |
| **UNIT IV: Navigation** | | | | |
| 71 | T1 | -Introduction Path Planning | 25% | 100% |
| 72 | T1 | -Graph search and Potential field path planning | | |
| 73 | T1 | -Obstacle avoidance: Bug algorithm, Vector field histogram, bubble band technique | | |
| 74 | T1 | -Obstacle avoidance: Curvature velocity techniques, Dynamic window approaches. | | |
| 75 | T1 | - Dynamic programming, UGV and UAV planning | | |
| 76 | Hands-on-7 | -Dynamic programming with a basic planner | | |
| 77 | Hands-on-7 | -Active planner for a maze solver robot | | |
| 78 | T1 | -Navigation Architectures | | |
| 79 | T1 | -The basics of AUV planning | | |
| 80 | Web Source | -Basics of Reinforcement Learning using AI/ML<br>-Applications and Social Implications. | | |
| 81 | Revision-3 | Unit-3 | | |
| 82 | Revision-4 | Unit-4 | | |
| 83 | Assignment-4 | Mini-Project (Final) | | |
| 84 | Assignment-4 | Mini-Project (Final) | | |

**Textbook(s):**

1) Introduction to Autonomous Mobile Robots (Intelligent Robotics and Autonomous Agents series) second edition by Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza

2) Probabilistic Robotics By Sebastian Thrun, Wolfram Burgard and Dieter Fox. ISBN-13: 978-0262201629, ISBN-10: 0262201623. Intelligent Robotics and Autonomous Agents series; 1st Edition

**References:**

1) Introduction to Autonomous Robots: Nikolaus Correll, Magellan Scientific, 2016.

2) ROS Robot Programming, ROBOTIS Co., Ltd. From the basic concept to practical programming and robot application. YoonSeok Pyo, HanCheol Cho, RyuWoon Jung, and TaeHoon Lim.

3) Introduction to Robotics: Mechanics and Control 4th Edition, John Craig, ISBN-13: 978-0133489798, Pearson; 4th edition.

**UE22CS342BA2: Algorithms for Information Retrieval (4-0-1-4-4)**

**No of Credits: 4** **# of Hours: 84**

| Class# | Topics to be Covered | % of Portion covered | |
|---|---|---|---|
| | | % of Syllabus | Cumulative e % |
| **Unit1:Fundamentals of Information Retrieval** | | | |
| 1 | **Introduction to Information Retrieval**<br>• **Objective:** Understand what Information Retrieval(IR)is and its importance.<br>• **Content:** Overview of IR, history, and examples.<br>• **Activity:** Discussion on real-world applications. | 25% | 25% |
| 2 | **Background of IR Systems**<br>• **Objective:** Explore the evolution of IR systems.<br>• **Content:** Historical background, need for IR systems.<br>• **Activity:** Case study discussion. | | |
| 3 | **Architecture of IR Systems**<br>• **Objective:** Learn the basic architecture of IR systems.<br>• **Content:** Components and flow of IR systems.<br>• **Activity:** Diagram analysis. | | |
| 4 | **Strategies of IR Systems**<br>• **Objective:** Explore various trategies for building IR systems.<br>• **Content:** Commons trategies and their applications.<br>• **Activity:** Group brainstorming on strategies. | | |
| **5** | **IR Models: Boolean and Extended Boolean Models**<br>• **Objective:** Learn Boolean and extended Boolean models.<br>• **Content:** Definitions, exam ples ,and comparison.<br>• **Activity:** Problem-solving. | | |
| **6** | **Dictionary and Vocabulary**<br>• **Objective:** Understand dictionary and vocabulary in IR.<br>• **Content:** Roleinindexing and retrieval.<br>• **Activity:** Hands-onbuildingofasmall dictionary. | | |
| **7** | **Positional Postings and Phrase Queries**<br>• **Objective:** Learn about positional postings and phrase queries.<br>• **Content:** Techniques and applications.<br>• **Activity:** Query analysis. | | |
| **8** | **Tolerant Retrieval**<br>• **Objective:** Understand tolerant retrieval and its role in IR.<br>• **Content:** Definitions and examples.<br>• **Activity:** Analyzeasampleto lerant retrieval system. | | |
| **9** | **Indexing in IR Systems**<br>• **Objective:** Explore indexing methods.<br>• **Content:** Techniques for building efficient indices.<br>• **Activity:** Build as mall indexusing Python | | |

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| 10 | **Index Compression Techniques**<br>• **Objective:** Learn about index compression methods.<br>• **Content:** Different techniques and their importance.<br>**Activity:** Analyze a compressed index. | | |
| 11 | **Evaluation of IR Algorithms**<br>• **Objective:** Understand how to evaluate IR algorithms.<br>• **Content:** Precision, recall,andF- measure.<br>• **Activity:** Evaluate asample algorithm. | | |
| 12 | **Vector Space Model Basics**<br>• **Objective:** Explore the vectorspace model.<br>• **Content:** Mathematical representation of documents.<br>• **Activity:** Work on documentscoring. | | |
| 13 | **tf-idf Scoring and Variants**<br>• **Objective:** Learntf-idf and its variations.<br>• **Content:** Term weighting and frequency easures.<br>• **Activity:** Implement tf-idfin Python. | | |
| 14-15 | **Application of Vector Space Models**<br>• **Objective:** Apply vectorspacemodels to IR tasks.<br>• **Content:** Query matching and ranking.<br>• **Activity:** Practical coding session. | | |
| 16 - 17 | **Positional Indexing**<br>**Objective:** Dive deeper into positional indexing.<br>• **Content:** Phrase queries and positional scoring.<br>**Activity:** Build a positional index. | | |
| 18-19 | **Case Study: Indexing and Scoring**<br>• **Objective:** Analyze case studieson indexing and scoring.<br>• **Content:** Real-world examples.<br>**Activity:** Group project presentations. | | |
| 20 | **Unit Review and Quiz**<br>• **Objective:** Reinforce understanding of Unit 1.<br>• **Content:** Review key concepts.<br>**Activity:** Conduct a quiz. | | |
| **Unit2:RankingandWebSearchBasics** | | | |
| 21 | **Introduction to Rankingin IR**<br>• **Objective:** Understand the concept of ranking and its role in IR systems.<br>• **Content:** Importance of ranking, overview of ranking metrics.<br>• **Activity:** Discuss real-world examples of ranked results. | | |
| 22 | **Efficient Scoring and Ranking**<br>• **Objective:** Explore techniques for efficient scoring and ranking.<br>• **Content:** Algorithms and methodologies for scoring.<br>• **Activity:** Analyze a sample ranking algorithm. | | |

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| **23** | **Parametric and Zone Indexes**<br>• **Objective:** Learn about parametric and zone indexes in IR.<br>• **Content:** Definitions, uses, and advantages.<br>• **Activity:** Builda small parametric index. | 25 | 50 |
| **24** | **Tiered Indexes**<br>• **Objective:** Understand the concept of tiered indexes.<br>• **Content:** Advantages and implementation methods.<br>• **Activity:** Implement a basic tiered index. | | |
| **25** | **Query Term Proximity**<br>• **Objective:** Explore the role of proximity in query matching.<br>• **Content:** Techniques for measuring query term proximity.<br>• **Activity:** Solve problems on query term distances. | | |
| **26** | **Query Parser Design**<br>• **Objective:** Learn about query parsing mechanisms.<br>• **Content:** Steps to design a query parser.<br>• **Activity:** Build a simple query parser. | | |
| **27** | **Aggregating Scores for Ranking**<br>• **Objective:** Understand score aggregation methods.<br>• **Content:** Weighted scoring, average scoring.<br>• **Activity:** Write a program to aggregate scores. | | |
| **28** | **Performance Measurement**<br>• **Objective:** Learn performance metrics for IR systems.<br>• **Content:** Metrics like MAP, DCG, and precision-recall curves.<br>• **Activity:** Evaluate a sample IR system using these metrics. | | |
| **29** | **Web Applications of IR**<br>• **Objective:** Explore web-based IR applications.<br>• **Content:** Examples like e- commerce, search engines.<br>• **Activity:** Analyze a search engine's functionality. | | |
| **30** | **Web Search Algorithms**<br>• **Objective:** Understand web search algorithms.<br>• **Content:** Overview of algorithms like TF-IDF and BM25.<br>• **Activity:** Discuss algorithmic improvements. | | |
| **31-32** | **Relevance Feedback**<br>• **Objective:** Learn the concept of relevance feedback in IR.<br>• **Content:** User feedback loop, techniques for query improvement.<br>• **Activity:** Simulate relevance feedback for a sample system. | | |

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| **33** | **Query Expansion**<br>• **Objective:** Understand the process of query expansion.<br>• **Content:** Techniques like synonym addition and term weighting.<br>• **Activity:** Implement query expansion in Python. | | |
| **34-35** | **Other IR Models**<br>• **Objective:** Explore alternative IR models.<br>• **Content:** Probabilistic models, language models.<br>• **Activity:** Analyze strengths and weaknesses of each model. | | |
| **36-37** | **Advanced Web Search Techniques**<br>• **Objective:** Learn advanced web search strategies.<br>• **Content:** Structured queries, metadata usage.<br>**Activity:** Perform advanced searcher sonasampledataset. | | |
| **38** | **Practical: Implementing a Simple Search Engine**<br>• **Objective:** Build a simple search engine.<br>• **Content:** Combining all learned concepts.<br>• **Activity:** Hands-oncoding. | | |
| **39** | **Case Study: Google's Search Algorithm**<br>• **Objective:** Understand Google's ranking system.<br>• **Content:** Overview of Page Rank and improvements.<br>• **Activity:** Discussion and analysis. | | |
| **40** | **Unit Review and Quiz**<br>• **Objective:** Reinforce understanding of Unit 2.<br>• **Content:** Review key concepts and metrics.<br>• **Activity:** Conductaquiz. | | |
| **Unit3:LinkAnalysis,MultimodalInformationRetrieval** | | | |
| **41** | **Introduction to Link Analysis**<br>• **Objective:** Understand link analysis and its role.<br>• **Content:** Basic principles and applications.<br>• **Activity:** Discuss examples like hyperlinks on the web. | 25 | 75 |
| **42** | **Economic Model of Web Search**<br>• **Objective:** Explore the economics behind web search.<br>• **Content:** Revenue generation, user behavior analysis.<br>• **Activity:** Analyze ad-based revenue models. | | |
| **43-44** | **The Page Rank Algorithm**<br>• **Objective:** Learn PageRank and its working.<br>• **Content:** Mathematical formulation and applications.<br>**Activity:** Implement PageRank in Python. | | |
| **45** | **Scalability Issuesin Search**<br>• **Objective:** Understand scalability challenges.<br>• **Content:** Techniques to improve scalability.<br>• **Activity:** Case study discussion. | | |
| **46** | **Search User Experience**<br>• **Objective:** Explore user-centric design in search | | |

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| | systems.<br>• **Content:** UI/UX principles for search engines.<br>• **Activity:** Analyze search interfaces. | | |
| **47-48** | **Web Crawling and Indices**<br>• **Objective:** Learn web crawling basics.<br>• **Content:** Crawling techniques, building indices.<br>**Activity:** Build a simple web crawler. | | |
| **49-50** | **Link Analysis Techniques**<br>• **Objective:** Study various link analysis methods.<br>• **Content:** HITS, SimRank, and other techniques.<br>**Activity:** Compare algorithms with examples. | | |
| **51-52** | **Multimodal IR: Basics and Applications**<br>• **Objective:** Explore multimodal IR.<br>• **Content:** Text, images, and metadata integration.<br>**Activity:** Analyze a multimodal IR system. | | |
| **53** | **Query by Example**<br>• **Objective:** Understand Query by Example.<br>• **Content:** Techniques and use cases.<br>• **Activity:** Implement a simple query by example system. | | |
| **54** | **Content Comparison Using Distance Measures**<br>• **Objective:** Learn image distance measures.<br>• **Content:** Euclidean, cosine similarity.<br>• **Activity:** Compare two datasets using Python. | | |
| **55-57** | **Building a Complete Search System**<br>• **Objective:** Build a comprehensive search system.<br>• **Content:** Integrating concepts from Units 1-3.<br>**Activity:** Group project. | | |
| **58-59** | **Case Study: Lucene and Solr**<br>• **Objective:** Explore real-world search engines.<br>• **Content:** Features and architecture of Lucene and Solr.<br>**Activity:** Hands-on with Solr. | | |
| **60** | **Unit Review and Quiz**<br>• **Objective:**RecapUnit3concepts.<br>• **Content:** Discuss key take aways.<br>**Activity:** Conductaquiz. | | |
| **Unit4:Unit-4:QuestionAnswering,neuralmodelsforIR** | | | |
| **61** | **Introduction to QA Systems**<br>• **Objective:** Learn about QA systems.<br>• **Content:** Types, examples, and importance.<br>**Activity:** Discuss applications like Siri or Alexa. | 75 | 100 |
| **62-63** | **Factoid QA Models**<br>• **Objective:** Study factoid-based QA models.<br>• **Content:** Techniques for answering fact-based questions.<br>**Activity:** Solve sample QA tasks | | |
| **64** | **Entity Linking Models** | | |

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| | • **Objective:** Learn entity linking techniques.<br>• **Content:** Mapping entities to knowledge graphs.<br>• **Activity:** Implement entity linking in Python. | | |
| **65-66** | **Knowledge-based QA**<br>• **Objective:** Explore knowledge-based QA systems.<br>• **Content:** Using knowledge graphs and databases.<br>• **Activity:** Build a small knowledge- based QA system. | | |
| **67** | **Pretrained Models for QA**<br>• **Objective:** Study the role of pretrained models.<br>• **Content:** BERT, GPT, and others in QA.<br>• **Activity:** Fine-tune a pretrained model. | | |
| **68-70** | **Neural Models forIR**<br>• **Objective:** Understand neural approaches.<br>• **Content:** Embeddings, deep learning for IR.<br>• **Activity:** Buildaneural IR model. | | |
| **71-72** | **QAasan IR Task**<br>• **Objective :**Relate QAto IR.<br>• **Content:** Query matching, retrieval- based QA.<br>**Activity:** Develop a retrieval-based QA system. | | |
| **73-74** | **CaseStudy: Advanced QA Systems**<br>• **Objective:** Analyze advanced QA systems.<br>• **Content:** Real-world systems like Watson.<br>• **Activity:** Group discussions. | | |
| **75-77** | **Research Trends in QA**<br>• **Objective:** Explore recent QA research.<br>• **Content:** Review recent papers.<br>**Activity:** Presentation on research findings. | | |
| **78** | **Practical: Builda Simple QA System**<br>• **Objective:** Integra telearned concepts.<br>• **Content:** End-to-end QA system development.<br>• **Activity:** Coding project. | | |
| **79** | **Discussion: Ethical Issues in QA**<br>• **Objective:** Address ethical concerns.<br>• **Content:** Bias, privacy issues.<br>• **Activity:** Debate session. | | |
| **80** | **Unit Review and Quiz**<br>• **Objective:**ReinforceUnit4concepts.<br>• **Content:** Recap and practice.<br>• **Activity:**Quiz and discussion. | | |
| **81** | Revision | | |
| **82-84** | **Hackathon** | | |
| | ISA2 | | |

**Textbook(s):**

1. “Introduction to Information Retrieval”, Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, ISBN: 9781107666399, Cambridge University Press, 2009.

2. “Search Computing”, Challenges and Directions: chapter 8: Multimedia andMultimodal Information Retrieval.

3. “Speech and Language Processing”, Third Edition, Daniel Jurafsky, James H. Martin, Chapter 14: Question Answering and Information Retrieval, 2023.

**Reference Book(s):**

- “Algorithms of the Intelligent Web”, Haralambos Marmanis, Dmitry Babenko, Manning Publishers, 2011.