

## FIRST SEMESTER

**ICT 5118**

### **MATHEMATICAL FOUNDATIONS OF COMPUTATIONAL INTELLIGENCE**

**[3 1 0 4]**

#### **Abstract**

Reasoning Calculus: Propositional logic, Predicate logic; Linear Algebra and Optimization; Optimization for Machine Learning; Analytic Geometry; Linear Transformations and Linear Systems; Eigenvectors and Diagonalizable Matrices; Optimization Basics; Advanced Optimization Solutions; Constrained Optimization and Duality; Matrix Factorization; Probability and Distributions

**SDL Component:** topics from constrained optimization and duality, optimization for machine learning.

#### **References**

1. Michael Huth and Mark Ryan, *Logic in Computer Science*, 2<sup>nd</sup> Edition, Cambridge University Press, 2007.
2. Charu C Agarwal, *Linear Algebra and Optimization for Machine Learning*, Springer, 2020
3. Marc Peter Deisenroth, A.Also Faisal, and Cheng Soon Ong, *Mathematics for Machine Learning*, Cambridge University Press, 2020
4. Kaare Brandt Petersen, and Michael Syskind Pedersen, *The Matrix Cookbook*, Technical University of Denmark, 2012

**ICT 5127**

### **KNOWLEDGE AND DATA ENGINEERING**

**[3 1 0 4]**

#### **Abstract**

Introduction to Relational Database Design, Data Warehousing, OLAP operations, Warehouse schema, Data Warehousing Architecture, Data Warehouse Backend Process. Data Pre-processing, Data cube, Sampling, Discretization and concept hierarchy generation, Segmentation by natural partitioning. Introduction to Data mining, Association rules mining, market-based analysis, Apriori Algorithm, Partition Algorithm, Pincer – Search Algorithm, Dynamic item set counting algorithm, FP-tree growth Algorithm Tree, Multilevel association rules, approaches to mining multilevel association rules, correlation analysis, Issues and challenges in Data mining. Introduction to Clustering Techniques, Clustering paradigms, Partitioning Algorithms, k – Medoid & k- means Algorithms, Introduction to Classification and Prediction, Tree Construction principle, Decision Tree Construction Algorithm, Data Partitioning Techniques, Interquery, Intraquery, Intraoperation and Interoperation Parallelisms, Distributed data storage, Distributed Transactions, Commit Protocols, Data Lake.

**SDL Component:** Topics from data partitioning, intraoperation and inter operation parallelisms and distributed data storage and data lake

## References

1. Jiawei Han and Micheline Kamber, *Data Mining Concepts and Techniques (3e)*, Morgan Kauffmann Publishers, 2012
2. Arun K Pujari, *Data Mining Techniques (2e)*, Universities Press India, 2016
3. Silberschatz, Korth and Sudarshan, *Database System Concepts*, 7<sup>th</sup> Edition, McGraw Hill, 2021

**ICT 5119**

**ARTIFICIAL INTELLIGENCE TECHNOLOGIES [3 1 0 4]**

### Abstract

Introduction; applications of AI in industry, NLP as an AI technology, TensorFlow Model Analysis; Feature engineering, transformation and selection with TensorFlow, machine learning production system, Deep Feedforward Networks: Gradient-based learning, Architecture Design, BPA; Regularization for Deep Learning: Parameter norm penalties, Recurrent and Recursive Networks: RNNs, BiRNNs, Encoder-decoder sequence-to-sequence architecture, LSTM

**SDL component: Challenges** in Neural Network Optimization, Parameter Initialization Strategies, Approximate Second-Order Methods, Optimization Strategies and Meta-Algorithms, Variants of Convolution Function, Structured Outputs, Data Types, Random or Unsupervised Features, Echo State Networks, LSTM

### References

1. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media, Inc, ed. jan 2022
2. Russell S., and Norvig P., *Artificial Intelligence A Modern Approach (3e)*, Pearson 2010.
3. Ian Goodfellow and Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press 2016
4. Allen Downey, Jeff Elkner and Chris Meyers , *Learning with Python, How to Think Like a Computer Scientist,(1e)*, DreamTech Press, 2015.
5. Bishop C.M., *Pattern Recognition and Machine Learning (2e)*, Springer, 2013.
6. Francois Chollet, *Deep Learning with Python*, Manning, 2017

**Abstract**

Introduction to Cloud Computing, Understanding Cloud Architecture and Services, Application Paradigms, Virtualization, Core Cloud Services, Cloud Security, Edge Computing Definition and Use Cases, Applications and Issues, Cloud Application Development using open source tools.

**SDL component:** Edge computing use cases, Cloud application development using open source tools.

**References**

1. Sehgal, Naresh Kumar, and Pramod Chandra P. Bhatt, *Cloud Computing: Concepts and Practices*, Springer, 2018.
2. Dan C Marinescu, *Cloud Computing Theory and Practice*, Morgan Kaufmann, 2013.
3. Naveen Sabharwal and Ravi Shankar, *Apache CloudStack Cloud Computing*, Packt Publishing Ltd., 2013.
4. Mark C Chu-Carroll, *Code in the Cloud*, Pragmatic Bookshelf, 2011.
5. Barrie Sosinsky, *Cloud Computing Bible*, Wiley Publishing Inc., 2011.
6. Rajkumar Buyya , Satish Narayana Srirama, *Fog and Edge Computing: Principles and Paradigms*, Wiley Publishing Inc., 2019.

**ICT 5129 SOFTWARE MODELLING AND PROGRAM VERIFICATION [3 1 0 4]****Abstract**

Introduction to model checking: System verification, Transition systems, Executions, Modeling hardware and software systems; Linear time properties: Linear time properties, Linear time behavior, Traces, Trace equivalence and linear time properties, Liveness properties, Fairness; Model checking in SAL: Introduction, Language of SAL, SAL examples; Linear time logic: linear time logic syntax, Automata based LTL model checking; Program verification: Introduction, Proof calculus; Verification tools.

**SDL Component:** Topics from Program verification, proof calculus and verification tools

**References**

1. Michael Huth and Mark Ryan, *Logic in computer science modelling and reasoning about systems*, Cambridge University Press 2004.
2. Christel Baier and Joost-Pieter Katoen, *Principles of Model Checking*, The MIT Press 2008.
3. Leonardo de Moura, Sam Owre and N. Shankar, *The SAL Language Manual*, SRI International 2003.

## **HUM 5051 RESEARCH METHODOLOGY & TECHNICAL COMMUNICATION**

**[1 0 3 -]**

### **Abstract**

The purpose of this course is create an awareness about Research and knowledge that Research can be carried out by adopting systematic approach. The course covers the fundamental concepts, Research skills, Research design, Data Collection, Data analysis and interpretation, report writing, Innovation and IPR.

**SDL Component:** Data analysis and report writing, some topics from IPR

### **References**

1. Bruce Tuckman and Brian Harper Conducting Educational research, 6<sup>th</sup> edition, Rowman and Littlefield publishers, 2012.
2. Bryman, A., & Bell, E. (2011). Business Research Methods, 3rd Edn. United Kingdom: Oxford University Press.
3. Zikmund, W. G., Carr, J.C., Adhikari, A., & Griffin, M. (2013). Business Research Methods; A South-Asian Perspective, 8th Edn. New Delhi: Cengage Learning India Pvt. Ltd.

## **ICT 5145**

## **AI-ML-SDD CAPSTONE PROJECT**

**[0 1 4 3]**

### **Abstract**

This course deals with design and implementation of industrial problem statement. The duration of capstone project will be of 12 weeks. As a part of this, student will submit detailed problem statement explicitly specifying the objectives (3<sup>rd</sup> week). A mid-term evaluation of the capstone project work will be done in 6<sup>th</sup> week. Students will submit the synopsis in 11<sup>th</sup> week. The final evaluation will be conducted in 12<sup>th</sup> week. The evaluation is based on Prototype demo and final report submission.

### **References**

1. Pressman R., *Software Engineering, A Practitioners Approach* (8e), Tata McGraw Hill Publication, 2018.
2. James shore and Shane warden, *The Art of Agile Development: Pragmatic Guide to Agile Software Development*(2e), Orielly publications, 2021

## SECOND SEMESTER

### **ICT 5217      TESTING AND ANALYSIS OF SOFTWARE SYSTEMS      [3 1 0 4]**

#### **Abstract**

Introduction, Fundamentals of Test and Analysis, Basic Techniques used in Testing and Analysis, Black Box Techniques, Functional Testing, Combinatorial Testing, White Box Testing, Structural Testing, Testing Object Oriented Software, Static Analysis and Fault Based Testing, Levels and Types of Testing, Planning and Monitoring the Process, Test Automation

**SDL Component:** Open research issues in static analysis and fault-based testing, Planning and Monitoring the Process: Quality and Process, Test and Analysis Strategies, Test and Analysis Plans, Risk Planning, Monitoring the Process, Improving the Process, The Quality Team. Test Automation: Test Automation Tools, Recent Trends in Software Testing, Role of AI in software testing, Advanced topics (Not from Syllabus): From research papers, Fault Prediction, Flaky Test

#### **References**

1. Ilene Burnstein, “Practical Software Testing”, Springer International Edition, 2003.
2. Mauro Pezze and Michal Young, “Software Testing and Analysis. Process, Principles, and Techniques” John Wiley and Sons, 2008.
3. Glenford J. Myers, Tom Badgett, Corey Sandler, “The Art of Software Testing”, Wiley, Third Edition, 2012
4. Brian Chess, Jacob West, “Secure Programming with Static Analysis”, Addison Wesley, 1st edition, 2007
5. Mark Fewster, Dorothy Graham, “Software Test Automation: Software Test Automation”, 2022”, Addison Wesley, 2000
6. Renu Rajani and Pradeep Oak, Software Testing-Effective Methods, Tools and Techniques, 2nd Edition, Tata McGraw Hill Education, 2017.

### **ICT 5218                                  DEVOPS AND AUTOMATION                                  [3 1 0 4]**

#### **Abstract**

Introduction to DevOps life cycle, DevOps tools, Version Control System, GIT, Continuous Integration, jenkins, Containerizing the applications, Docker life cycle, Docker commands, Kubernetes components, Kubernetes master slave architecture, Namespace, Application deployment in kubernetes cluster, Configuration management, Ansible architecture, Setting up master slave using ansible, Ansible playbook, Roles, Configurations using ansible, Continuous monitoring.

**SDL Component:** Introduction to continuous monitoring, Nagios, Nagios Architecture, Nagios commands, Nagios plugins, Nagios notification

## References

1. Joakim Verona, *Practical DevOps (1e)*, Packt Publishing Limited, 2016
2. Jennifer Davis & Ryn Daniels, *Effective DevOps(1e)* O'Reilly Media, Inc,2016
3. Mitesh Soni, *Jenkins Essentials(2e)*, Packt Publishing Limited, 2017.
4. Jamon Camisso, Hanif Jetha, Katherine Juell, *Kubernetes for Full-Stack Developers,2020*

**ELECTIVE I** **[3 0 0 3]**

**ELECTIVE II** **[3 1 0 4]**

**ELECTIVE III** **[3 1 0 4]**

**OPEN ELECTIVE** **[3 0 0 3]**

## **HUM 5051 RESEARCH METHODOLOGY & TECHNICAL COMMUNICATION**

**[1 0 3 2]**

### **Abstract**

The purpose of this course is create an awareness about Research and knowledge that Research can be carried out by adopting systematic approach. The course covers the fundamental concepts, Research skills, Research design, Data Collection, Data analysis and interpretation, report writing, Innovation and IPR.

**SDL Component:** Data analysis and report writing, some topics from IPR

### **References**

1. Bruce Tuckman and Brian Harper Conducting Educational research, 6<sup>th</sup> edition, Rowman and Littlefield publishers, 2012.
2. Bryman, A., & Bell, E. (2011). Business Research Methods, 3rd Edn. United Kingdom: Oxford University Press.
3. Zikmund, W. G., Carr, J.C., Adhikari, A., & Griffin, M. (2013). Business Research Methods; A South-Asian Perspective, 8th Edn. New Delhi: Cengage Learning India Pvt. Ltd.

**ICT 5247**

**DEVOPS/ASD CAPSTONE PROJECT**

**[0 1 4 3]**

**Abstract**

This course deals with design and implementation of industrial problem statement. The duration of capstone project will be of 12 weeks. As a part of this, student will submit detailed problem statement explicitly specifying the objectives (3<sup>rd</sup> week). A mid-term evaluation of the capstone project work will be done in 6<sup>th</sup> week. Students will submit the synopsis in 11<sup>th</sup> week. The final evaluation will be conducted in 12<sup>th</sup> week. The evaluation is based on Prototype demo and final report submission.

**References**

1. Jennifer Davis & Ryn Daniels, *Effective DevOps(1e)* O'Reilly Media, Inc, 2016
2. *John Ferguson Smart*, Jenkins: The Definitive Guide, O'Reilly Media, Inc, 2011
3. Jamon Camisso, Hanif Jetha, Katherine Juell, *Kubernetes for Full-Stack Developers*, 2020

**PROGRAM ELECTIVES**

**ICT 5408**

**MACHINE LEARNING**

**[3 0 0 3]**

**Abstract**

Introduction, Decision Trees, Limits of Learning, Geometry and Nearest Neighbors, Perceptron, Practical Issues, Beyond Binary Classification, Linear Models, Bias and Fairness, Neural Networks, Kernel Methods, Learning Theory, Ensemble Methods, Efficient Learning, Unsupervised Learning, Expectation Maximization, Structured Prediction, Imitation Learning

**SDL component:** Topics from structured prediction, imitation learning and reinforcement learning.

**References**

1. Hall Daume III, A Course in *Machine Learning*, Self Publishing, 2017.
2. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar., *Foundations of Machine Learning*, MIT Press, 2012.
3. Daphne Koller and Nir Friedman, *Probabilistic Graphical Models: Principles and Techniques*, MIT Press, 2009.
4. Christopher M. Bishop., *Pattern Recognition and Machine Learning (2e)*, Springer, 2013.
5. Solon Barocas, Moritz Hardt and Arvind Narayanan, *Fairness and Machine Learning*, failml.org, 2021

**ICT 5417**

**BLOCKCHAIN TECHNOLOGY & APPLICATIONS [3 0 0 3]**

**Abstract**

Introduction to—decentralized applications, blockchain, protocol, understanding of how blockchain works. Blockchain primitives, consensus model. Ethereum and working with Smart Contracts and its development environment. Introduction to bitcoin, Building Blockchain applications using frameworks.

**SDL component:** Topics from Building blockchain applications using frameworks

**References**

1. Blockchain Basics: A Non,Technical Introduction in 25 Steps, Daniel Drescher, Apress; 1st Edition, 2017.
2. Beginning Blockchain: A Beginner's Guide to Building Blockchain Solutions, Bikramaditya Singhal, Gautam Dhameja , Priyansu Sekhar Panda, Apress; 1st ed. Edition, 2018.
3. Mastering Blockchain, Imran Bashir, Ingram short title, Second Edition, 2018.
4. Hands,On Blockchain with Hyperledger, Petr Novotny Venkatraman Ramakrishna Nitin Gaur Anthony O'Dowd Luc Desrosiers, Ingram short title, 2018.
5. Solidity Programming Essentials, Ritesh Modi, Ingram short title, 2018
6. BlockChain from Concept to Execution, Debajani Mohanty, BPB; 2nd revised and updated edition, 2018.
7. Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations, Henning Diedrich, CreateSpace Independent Publishing Platform; 1st edition, 2016.
8. Bitcoin and Cryptocurrency Technologies,A Comprehensive Introduction Hardcover, Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller , Steven Goldfeder,Princeton University Press, 2016.
9. Hands,On Blockchain for Python Developers: Gain blockchain programming skills to build **decentralized applications using Python**, Arjuna Sky Kok, Packt Publishing, 1st edition, 2019.

**ICT 5420**

**FULL STACK WEB DEVELOPMENT**

**[3 1 0 4]**

**Abstract**

Web development with HTML, CSS, JavaScript, HTML5, Front end web UI frameworks, bootstrap, Bootstrap javascript components, Front end web development with react, react components with JSX, React router, react forms, flow architecture, Redux, Server side development with NodeJS, Express and MongoDB, REST API using express, data storage with MongoDB, Mongoose ODM.

**SDL Component:** Web Development with HTML, CSS, JavaScript: picture slideshows, and menu systems, Front-end Web UI Frameworks : Popovers, modals and the carousel, Front-End Web Development with React: React Forms, Server-side Development with NodeJS, Express and MongoDB: Mongoose ODM

**References**

1. Frank Zammetti, Modern Full-Stack Development: Using TypeScript, React, Node.js, Webpack, and Docker, APress publication, 2020.

2. Chris, *The Full Stack Developer*, APress publication, 2018.
3. Juha Hinkula, *Hands-On Full Stack Development with Spring Boot 2 and React: Build modern and scalable full stack applications using Spring Framework 5 and React with Hooks*, 2nd Edition, Packt publishing, 2019.
4. Nadar Dabit, *Full Stack Serverless: Modern Application Development with React, AWS, and GraphQL Greyscale Indian Edition*, 2020.

**ICT 5409**

**SEMANTIC WEB TECHNOLOGIES**

**[3 1 0 4]**

**Abstract**

The Semantic Web Activity of W3C: Overview of techniques and standards, XML with Document Type Definitions and Schemas; Describing Web Resource: RDF data models, syntax, semantics, schema, RDFS, RDF Data structures, Containers and collections; Querying Semantic Web: SPARQL matching patterns, filters, querying schemas; Ontology and Information Systems: Use of ontologies, types, design principles, methodologies; Ontology Languages: OWL2, OWL2 profiles; Logic for the Semantic Web: Predicate and Description Logics; Ontology Reasoning: Monotonic rules, Rule interchange format, Semantic web rules languages, RuleML; Ontology Design and Management: Types, purposes, creating ontology manually, reusing existing, mapping.

**SDL Component:** Topics from Rule ML, Ontology Design and Management, Reusing existing mapping

**References**

1. Grigoris Antoniou, Paul Groth, Frank van Harmelen, Rinke Hoekstra, *A Semantic Web Primer*, 3<sup>rd</sup> edition, The MIT Press, 2012.
2. Peter Szeredi, Gergely Lukacsy, Tamas Benko, and Zsolt Nagy, *The Semantic Web Explained*, Cambridge University Press, 2014
3. Liyang Yu, *Introduction to the Semantic Web and Semantic Web Services*, CRC Press, 2019
4. Elisa F.Kendall, Deborah L.McGuinness, Ying Ding, and Paul Groth, *Ontology Engineering*, Morgan & Claypool Publishers, 2019

**ICT 5422**

**INTERNET OF THINGS AND APPLICATIONS**

**[3 1 0 4]**

**Abstract**

The IoT course will enable the students to develop and deploy Smart applications involving internet and cloud computing. The Course develops skills to build the IoT systems by focussing on topics IoT Architectural reference model and Design methodology, IoT devices: sensors, actuators and embedded systems, Communication Technologies of IoT systems, IoT protocols, Network and transport layer protocols for IoT, IoT security.

**SDL Component:** Network and transport layer protocols for IoT, IoT security.

## References

1. Internet of Things: A General Overview between Architectures, Protocols and Applications Marco Lombardi , Francesco Pascale and Domenico Santanie
2. Arshdeep Bahga, Vijay Madishetti, “Internet of things: A hands on Approach”, Universities Press,
3. RFC’s of COAP, XMPP, MQTT, AMQP - Internet Resources

## ICT 5421 INTELLIGENT SOFTWARE ENGINEERING [3 0 0 3]

### Abstract

AI for Software Design: AI and Behavioral Programming, AI Techniques for Software Requirement Prioritization; Agent Based Software Programming: Social Commitments for Engineering Interaction in Distributed Systems, Intelligent Agents; AI for Software Development: Seq-2-Seq Learning for Automated Software Artifact Generation, Machine Learning-Based Code Reviews, Deep Design Learning with Deterministic Laplacian Verification; AI for Software Testing: Machine Learning-Based Software Testing, Machine Learning-Based Test Oracle Creation, Intelligent Risk Analysis, Qualitative Reasoning Model for Software Testing; AI for Software Debugging: AI-Based Spreadsheet Debugging, AI Methods for Software Debugging

**SDL Component:** Topics from AI for software Debugging, AI Based spreadsheet Debugging.

### References

1. Meir Kalech, Rui Abreu, and Mark Last (Editors), *Artificial Intelligence Methods for Software Engineering*, World Scientific, 2021
2. Suresh Chandra Satapathy, Ajay Kumar Jena, Jagannath Singh, Saurabh Bilgaiyan, *Automated Software Engineering: A Deep Learning-Based Approach*, Springer, 2020
3. Radek Silhavy, Petr Silhavy, and Zdenka Prokopova (Editors), *Intelligent Systems Applications in Software Engineering*, Springer, 2019
4. Peter Norvig, and Stuart Russel, *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson, 2021

## ICT 5419 DESIGNING FOR EMERGING TECHNOLOGIES SYSTEMS [3 1 0 4]

### Abstract

Introduction, Emerging Technologies, Roles and responsibilities of the Design, Designing Object Oriented System, Basic UML notations, Diagramming tools, S.O.L.I.D. design principles, Dependency inversion principle, Gang of Four (GOF) design patterns, Designing Emerging Technologies System, Designing Connected Products, , UX design for connected products, Product/service definition and strategy, Understanding people and context, Translating research into product definitions, Embedded device design, Interface and interaction design, Cross-device interactions and interusability, Interoperability, Effective design discussion, Understanding industrial design, Practical methodology.

**SDL Component:** Topics from Embedded device design, Industrial design and practical methodology.

## References

1. James Rumbaugh, Michael Bloha, *Object Oriented Modeling and Design With UML* (2e), Pearson Education, 2007.
2. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, *Design Patterns: Elements of Reusable Object-Oriented Software*, 1st Edition, Addison-Wesley Professional, 1994.
3. Claire Rowland, Elizabeth Goodman, Martin Charlier et al., *Designing Connected Products*, 1st Edition, O'Reilly Media, Inc.2015.
4. Jonathan Follett, *Designing for Emerging Technologies*, 1st Edition, O'Reilly Media, Inc.2015.
5. Claire Rowland and Martin Charlier, *Discussing Design: Improving Communication and Collaboration Through Critique*, 1st Edition, O'Reilly Media, Inc.2015.
6. Simon King and Kuen Chang, *Understanding Industrial Design* 1st Edition, O'Reilly Media, Inc.2015.

## OPEN ELECTIVE

**ICT 5303**

**CYBER SECURITY AND CYBER LAWS**

**[3 0 0 3]**

### Abstract

Introduction to Information, Network and System Security, Encryption techniques, Message Integrity and Message Authentication, Digital Signature, Key Management, User Authentication. Web security model: Browser security model including same-origin policy, Client-server trust boundaries, Session management, authentication: Single sign-on, HTTPS and certificates. Application vulnerabilities and defenses: SQL injection, XSS, CSRF. Client-side security: Cookies security policy, HTTP security extensions, Plugins, extensions, and web apps, Web user tracking, Server-side security tools, e.g. Web Application Firewalls (WAFs) and fuzzers. Cybercrime, Cybercrime investigation, Laws and ethics

**SDL Component:** Kerberos, IP Security, VPN, Case studies of Cybercrime, Cost of cybercrime and IPR issues, Cybercrime: Proliferation of mobile and wireless devices

### References

1. Mayank Bhushan, *Fundamentals of cybersecurity*, BPB publications, 2017
2. Raef Meeuwisse, *Cyber Security for Beginners*, 2015
3. Rolf Oppliger, *Security Technologies for the World Wide Web* (2e), Artech House, 2002.
4. Seth Fogie, Jeremiah Grossman, Robert Hansen and Anton Rager, *XSS Attacks: Cross Site Scripting Exploits and Defense*, Syngress, 2007.
5. Justin Clarke et.al., *SQL Injection Attacks and Defense* (2e), Syngress, 2012.
6. Dafydd Stuttard, and Marcus Pinto, *The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws* (2e), Wiley, 2011.