كلية علوم وهندسة الحاسبات

FACULTY OF COMPUTER SCIENCE & ENGINEERING

Department of Computer Science & Engineering

CSE011 Computer Skills

0 Cr. Hrs. = (*1* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *60* – ECTS = *0*

Prerequisite - - -

Types of computers – Computer hardware and software components – Data representation and number systems – Introduction to networking – Introduction to internet –Algorithm development – algorithm representation – flowcharts – stepwise refinement – problem solving methods and tools.

CSE012 Scientific Applications of Computers

2 Cr. Hrs. = (*2* LCT + *0* TUT + *1* LAB + *0* OTH) – SWL = *105* – ECTS = *4*

Prerequisite - - -

Windows-based operating environment, electronic mail, the World Wide Web, computerized library skills. Word processing and electronic spreadsheets. Desktop Publishing and Computer Graphics.

CSE013 Introduction to Information systems & technology

2 Cr. Hrs. = (*2* LCT + *0* TUT + *1* LAB + *0* OTH) – SWL = *105* – ECTS = *4*

Prerequisite - - -

An Introduction to Information Systems. Computer Hardware. Data Resource Management. Telecommunications and Networks. Electronic Business Systems. Enterprise Business Systems& Electronic Commerce Systems. Decision Support Systems.

CSE014 Structured Programming

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite - - -

•. Primitive data types, control structures, loops and decisions. •. Functions and parameter passing, top-down design, arrays. •. Mechanics of compiling, running, testing, and debugging programs.

CSE015 Object Oriented Programming

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite CSE014

Introduction to the Unified Modelling Language. Classes, subclasses, and inheritance. Concepts of encapsulation and information hiding. Polymorphism and Abstract classes. Creation, implementation, and reuse of application programming interfaces API. Operators, Operator overloading, delegates, and events.

CSE081 Digital Branding

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite - - -

Compare and contrast marketer control versus consumer control.

Examine consumer empowerment. Explore consumer participation and engagement. Examine content marketing and determine its value. Explore different strategies for content distribution. Identify some of the challenges associated with content marketing. Explore the concept of owned media and its importance to brands. Investigate the impact of owned media decision making. Examine a range of owned media assets and determine their value. Investigate brand engagement and why is it important. Examine and evaluate a range of engagement platforms. Identify different levels of engagement. Explore strategies for shaping earned media.

CSE111 Data Structures

3 Cr. Hrs. = (***3*** LCT + ***0*** TUT + ***3*** LAB + ***0*** OTH) – SWL = ***180*** – ECTS = ***6***

Prerequisite **CSE015**

Arrays, stacks, queues, lists, doubly linked lists. Trees, dynamic storage allocation, graphs. Different Searching and Sorting and Algorithms.

CSE112 Design &Analysis of Algorithms

3 Cr. Hrs. = (***3*** LCT + ***0*** TUT + ***3*** LAB + ***0*** OTH) – SWL = ***180*** – ECTS = ***6***

Prerequisite **CSE111**

Introduction. Fundamental techniques for designing and analyzing algorithms. Asymptotic analysis. Divide-and-conquer algorithms. Recurrences. Merge sort. Linear-time median. Greedy algorithms. Quick-sort algorithm. Dynamic programming. Graph algorithms. Graph search and Dijkstra's algorithm. Minimum Spanning Trees. Randomized algorithms. Hashing.

CSE113 Electric &Electronic Circuits

3 Cr. Hrs. = (***1*** LCT + ***2*** TUT + ***3*** LAB + ***0*** OTH) – SWL = ***180*** – ECTS = ***6***

Prerequisite **PHY212**

Circuits and Circuit Elements: Concept of a circuit, V-I relationships for R, L and C. Series and parallel combinations of elements. Voltage and current sources. Stored energy, power dissipation. Circuit Laws and Theorems: Kirchoff's Laws, Superposition theorem, Thevenin, Norton theorems, loop analysis. Time Varying Signals: The sinusoid, amplitude, phase, frequency. Response of L, C R to ac. Phase relationships. ac Circuits: Phasor representation. Complex number notation. Analysis of ac circuits. Impedance, admittance, resonance. Power factor and power factor correction. Transient Response: First order R L and R C response. Stored energy. Time constants. Electric Machines: Force on a current carrying wire in a magnetic field, equivalent circuit and torque speed relationship of dc machines, torque speed relationship for induction, synchronous and stepper motors. Basic Diode Behavior: large and small signal diode models. Diode Applications: Clipping, clamping, voltage doublers, voltage multipliers, rectifiers, simple smoothing, ripple, regulators, zener diode. Transistors: BJT, JFET and MOSFET characteristics, similarities and differences. Switching Applications: on-state and off-state behavior, drive considerations for BJT and (power) MOSFET, inductive loads and techniques for controlling back emf, switching AC power, bridge topologies for motor control. Amplifier Applications: amplification, biasing, designing dc conditions. Small signal ideas, generation of simple model (gm based), equivalent circuits, coupling and decoupling, mid-frequency examples. Operational Amplifiers: advantages of - ideal performance. Basic circuit shapes, idea of feedback, follower circuits, virtual earth circuits, effect of finite gains. Use of superposition to handle multiple source amplifiers.

CSE131 Logic Design

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **ELE113**

Number systems and coding. Boolean Algebra. Combinational circuits. Decoders and multiplexers. Synchronous sequential circuits. Counters, Registers and Memory. Advanced Arithmetic Circuits.

CSE132 Computer Architecture &Organization

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **CSE131**

Design of Basic Computer; Design concepts of Processors; Basic Assembly Language; Design of Channels and Controllers; Interconnections; Memory Structures and Design; Memory Management; Cache Memory Systems; firmware Design; Reliability; Testing and Fault Tolerance; CISC Computer; RISC Computers; Computer Interfacing; Computer Architecture Examples.

CSE211 Web Programming

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **CSE015**

Web architecture and HTTP: History and architecture of the World Wide Web. •. Overview of the Hyper Text Transfer Protocol, other related protocols. •. Client-side scripting and Server-side scripting. •. Database Connectivity. •. Sending mail, cookies, and sessions.

CSE212 Theory of Computation &Compilers

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE 014**

Finite automata, Regular languages, converting DFA to NFA, Context-free languages, Pushdown automata, and Turing Machine. Lexical analysis; parsing theory; symbol tables; type systems; scope; semantic analysis; intermediate representations; runtime environments; code generation; and basic program analysis and optimization.

CSE221 Database Systems

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **- - -**

Evolution of database management systems. Relational Data Model and Relational Algebra. Structured Query Language. Entity Relationship Modelling and Design. Tables Normalization. Forms/ Reports/ Menus Implementation.

CSE233 Operating Systems

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **- - -**

Principles of operating systems, sequential processes, concurrent processes, concurrency, functional mutual exclusion, processor cooperation and deadlocks, processor management. Control and scheduling of large information processing systems, Resource allocation, dispatching, processor access methods, job control languages, Memory management, memory addressing, paging and store multiplexing, Multiprocessing and time sharing, batch processing, Scheduling algorithms, file systems, protection and security, design and implementation methodology, performance evaluation and case studies.

CSE241 Security of Information Systems

3 Cr. Hrs. = (**3** LCT + **0** TUT + **2** LAB + **0** OTH) – SWL = **165** – ECTS = **6**

Prerequisite **- - -**

Common attacking techniques. Common security policies. Basic cryptographic tools. Authentication and authorization. Access control. Software security. Operating system security. Legal and ethical issues in information systems security.

CSE242 Cryptography

3 Cr. Hrs. = (**3** LCT + **0** TUT + **3** LAB + **0** OTH) – SWL = **180** – ECTS = **6**

Prerequisite **CSE112**

Computer Security Concepts: OSI security architecture, security attacks, security services, security mechanisms, network security model. Classical Encryption Techniques: symmetric cipher model, cryptanalysis, substitution techniques (Ceaser, Monoalphabetic, Play-fair, Hill cipher), transposition techniques, rotor machines, steganography. BlockCiphers and the Data Encryption Standard (DES): block cipher principles, Data Encryption Standard (DES), strength of DES, differential and linear cryptanalysis. Public-Key Cryptography and RSA: principles of public-key cryptosystems, RSA algorithm. Diffie-Hellman Key Exchange: Discrete logarithm, key exchange and generation algorithm, attacks on Diffie-Hellman protocol. Cryptographic Hash Functions: applications of cryptographic hash functions, requirements and security, hash functions based on Cipher Block Chaining (CBC), Secure Hash Algorithm (SHA). Digital Signatures: essential elements, limitations of symmetric key, Digital Signature Standard (DSS). Distribution of public keys and X.50. Network Security Protocols: Authentication, key exchange and key distribution protocols. Network Security Standards: IP security (IPsec), Secure Sockets Layer (SSL), Transport Layer Security (TLS), Hypertext Transfer Protocol Secure (HTTPS). Security analysis: Use of formal tools, e.g., Automated Validation of Internet Security Protocols and Applications (AVISPA).

CSE243 Secure Programming

3 Cr. Hrs. = (**3** LCT + **0** TUT + **3** LAB + **0** OTH) – SWL = **180** – ECTS = **6**

Prerequisite **CSE241**

Introduction. Secure code development principles. Best practices. Security strategies and controls. Malicious code and defensive techniques. Code review and testing. Security documentation and error messages. Secure coding techniques. Access control. Input validation. Threat identifications and modeling. Vulnerability analysis. Automated code analysis. Risk assessment. Secure code development life-cycle: development, maintenance, and refinement. Knowledge catalog: principles, guidelines, vulnerabilities, attack patterns, and historical risks. Coding errors. Breaking software. Web-applications threats and vulnerabilities.

CSE251 Software Engineering

3 Cr. Hrs. = (**3** LCT + **0** TUT + **3** LAB + **0** OTH) – SWL = **180** – ECTS = **6**

Prerequisite **- - -**

Principles and techniques for the design and construction of reliable, maintainable, and useful software systems; Software life cycle, requirements specifications, and verification and validation issues; Implementation strategies (e.g. top-down, bottom-up, teams), support for reuse, and performance improvement; Concepts of software engineering: requirements definition, modularity; structured design; data specifications; functional specifications; verification, documentation; software maintenance; Software support tools;. Software project organization; quality assurance; management and communication skills.

CSE261 Computer Networks

3 Cr. Hrs. = (**3** LCT + **0** TUT + **2** LAB + **0** OTH) – SWL = **165** – ECTS = **6**

Prerequisite **- - -**

Architecture and protocols of computer networks; Protocol layers; network topology; Data-communication principles, including circuit switching, packet switching and error control techniques; Sliding window protocols, protocol analysis and verification; Routing and flow control; Local and wide area networks; Network interconnection; Client-server interaction; Emerging networking trends and technologies; topics in security and privacy.

CSE271 Introduction to Parallel Computing

3 Cr. Hrs. = (**3** LCT + **0** TUT + **3** LAB + **0** OTH) – SWL = **180** – ECTS = **6**

Prerequisite **CSE112**

Introduction to Parallelism. Parallel Programming. Parallel Architectures. Parallel Algorithms. Parallel Applications. Other Parallel Models.

CSE272 Embedded Systems

3 Cr. Hrs. = (**3** LCT + **0** TUT + **3** LAB + **0** OTH) – SWL = **180** – ECTS = **6**

Prerequisite **CSE132**

Introduction: the importance of microcontrollers, the roles and functions of microcontrollers. Acquaintance with microcontrollers and their simulators and debuggers. Understanding different addressing modes. Programming, debugging, and simulating assembly language programs. Developing a prototype for an embedded system. Interrupts and serial I/O. Memory Expansion. Microcontroller interfaces. Interfacing techniques. Interfacing requirements. A typical microcontroller system is utilized in this course with typical software-based applications. Interfacing with USB, I2C, SPI, CAN, LIN.

CSE273 Parallel &distributed Systems

3 Cr. Hrs. = (**2** LCT + **1** TUT + **1** LAB + **0** OTH) – SWL = **150** – ECTS = **6**

Prerequisite **CSE132**

Motivations for parallel programming. Instruction Level Parallelism (ILP). Parallel Random Access Machines (PRAM). Cluster computing and grid computing. Message passing systems and applications. Message Passing Interface (MPI) and configuration of MPI cluster. MPI programming algorithms and implementation of PRAM through MPI. Peer-to-Peer (P2P) systems, mobile agents. GPUs, Multi-Core, Distributed file systems. Distributed coordination systems. Replication and consistency. Fault tolerance. Grid computing paradigm. Cloud computing: properties and characteristics, service models, deployment models.

CSE281 Image Processing

3 Cr. Hrs. = (**3** LCT + **0** TUT + **3** LAB + **0** OTH) – SWL = **180** – ECTS = **6**

Prerequisite **- - -**

Digital image fundamentals; Image enhancement in the spatial domain: grey level transformation; Histogram processing; Spatial filters; Image enhancement in frequency domain: D Fourier transform; Other transforms; Smoothing filters; Sharpening filters; Image restoration; Noise model; Estimating the degradation function; filters; Geometric transformations; Image segmentation: detection of discontinuities; edge linking and boundary detection; Thresholding; Region based segmentation ; Morphological image processing : operation concepts ; some basic algorithms, Image Compression.

CSE311 Design of Compilers

3 Cr. Hrs. = (*2* LCT + *1* TUT + *1* LAB + *0* OTH) – SWL = *150* – ECTS = *6*

Prerequisite **CSE015**

Fundamental concepts in automata theory and formal languages including grammar, deterministic and nondeterministic finite automata, regular expression, formal language, pushdown automaton, Turing machines, the halting problem, diagonalization and reduction, decidability, Rice's theorem, P, NP, and NP-completeness. Systems software, compilers, interpreters. Byte-codes. Lexical analysis: interface with input, parser and symbol table, token, lexeme and patterns. Syntax analysis: context-free grammars, ambiguity, precedence, top-down parsing, recursive descent parsing, transformation on the grammars, predictive parsing. Bottom up parsing, operator precedence grammars, LR parsers. Regular expressions and semantics. Error detection, type-checking and run-time environments. Code generation, code optimizations, code improvement techniques.

CSE312 Advanced Web Programming

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **CSE211**

Introduction to HTML5 and JavaScript. HTML5 and Forms. HTML5; Intro to Flash, Canvas, Local storage, and Geolocation. HTML5 and JavaScript. HTML5, CSS Animation. Adobe Muse and Dreamweaver.

CSE313 Android Development

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **CSE014**

Introduction to Android. Developing for Android: My First Android Application. Android Activities and UI Design. Advanced UI Programming. Toast, Menu, Dialog, List and Adapters. Multimedia Programming using Android. Database – SQLite. Location Based Services and Google Maps. Android Development using other Tools. Testing and Debugging Android Application. Installation ofapk.

CSE314 IOS Development

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **- - -**

iPhone and iPad Device Anatomy. iOS Architecture and SDK Framework. iOS and SDK Version Compatibility. Apple iOS Developer Program. Xcode.

CSE315 Discrete Mathematics

3 Cr. Hrs. = (*2* LCT + *2* TUT + *0* LAB + *-1* OTH) – SWL = *150* – ECTS = *6*

Prerequisite **- - -**

Propositional Logic. Predicate Logic and Quantification. Methods of Proof. Sets and Functions. Arithmetic Algorithms. Growth of Functions. Computational Complexity of Algorithms. Integer properties and Matrices. Mathematical Induction. Recursion. Sequences and Summations. Program Correctness. Graphs and its Applications. Trees and its Applications. Languages and Grammars. Finite-State Machines. Automata and Language Recognition. Turing Machines.

CSE322 Big Data Analytics 1

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE121**

This course provides a broad and practical introduction to big data: data analysis techniques including databases, data mining, and machine learning; data analysis tools including spreadsheets, relational

databases and SQL, Python, and R; data visualization techniques and tools; pitfalls in data collection and analysis. Tools and techniques are hands-on but at a cursory level, providing a basis for future exploration and application.

CSE323 Advanced database systems

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE221**

Query processing and optimization. Database tuning. Transaction processing. Concurrency control. Database recovery. Object databases: standards, languages, and design. Object-relational databases. Database security. Distributed database systems: architecture, data fragmentation, distributed read/update transparency, access primitives, integrity constrains, distributed database design, queries, optimization, concurrency and reliability control. XML, semi-structured, federated, and Internet databases. Data warehousing. Introduction to data mining.

CSE344 Cyber Security

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE242**

This course provides an overview of Cyberspace, defines the scope of Cybersecurity, and addresses information classification and system compartmentalization. Course includes an appreciation of information confidentiality, integrity, and availability, and covers Cybersecurity architecture, strategy, services, hardware, software, and cloud services. The course also examines national security issues, critical infrastructure, and the potential for cybercrime and cyber terrorism, as well as the need for corporations to align their security with business needs and consider the threat from malicious employees, contractors, and/or vendors.

CSE352 Systems Analysis &Design

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **CSE251**

The Systems Development Environment. Rapid Application Development. Introduction to agile methodologies. Managing the Information Systems project. Automated Tools for Systems Development. Determining & Structuring System Requirements. Structuring System Data & Logic Requirements. Designing Distributed and Internet Systems.

CSE362 Industrial Networks

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE261**

The course is presented through a layered top-down approach starting from the application layer down to the physical layer, focusing on basic networking concepts and typical application layer examples. Focusing on the Internet and the fundamentally important issues of networking, this course provides a foundation for students interested in computer science and electrical engineering, without requiring extensive knowledge of programming or mathematics. A typical outline of the course goes by the following sequence: Application layer (e.g. e-mail, the Web, PHP, wireless Web, MP3, and streaming audio). Transport layer essentials and requirements. Network layer functions and fundamentals of routing, congestion control, QoS, IPv4, and IPv. Data link layer and MAC Sublayer with emphasis on gigabit Ethernet, 80. 11, broadband wireless, and switching. Physical layer (e.g. copper, fiber, wireless, satellites, and Internet over cable). The course dissects and depicts the principles associated with each layer and then focuses on

Fieldbus networks, Control Area Networks (CAN, LIN, FLEXRAY) and SCADA systems.

CSE363 Cloud Computing

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE261**

Trends of computing, introduction to distributed computing. Introduction to Cloud Computing: Cloud computing properties and characteristics, service models, deployment models; Attributes of Cloud computing: Multi-tenancy; a single instance of software or other computing resource serving several clients, massive scalability; ability to support hundreds of thousands of clients at the same time, elasticity. Infrastructure-as-a-Service (IaaS): Introduction to IaaS, resource (i.e., server, storage and network) virtualization, case studies; Platform-as-a-Service (PaaS): Introduction to PaaS. Cloud platform, management of computation and storage, case studies; Software-as-a-Service (SaaS): Introduction to SaaS, Web services, Web. 0, Web OS, case studies.

CSE374 Parallel programming

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **CSE015**

Introduction. Parallel versus distributed algorithms. Message passing and shared memory. Parallel algorithm design: parallel graph algorithms, parallel searching and sorting algorithms. Parallel computational algorithms. Basic distributed problems and protocols. Synchronous computation: communicators, pipeline, transformers, waiting, guessing, synchronous problems. Algorithms in systems with no failures. Election: election in trees, rings, mesh networks, cube networks, and complete networks, universal election protocols. Message routing: shortest path routing, coping with changes, routing in static systems. Distributed set operations: distributed selection, distributed sorting. Stable properties detection. Continuous computations. Computing in presence of faults: faults and failure, modeling faults, the crushing impact failure, localized entity and link failures, ubiquitous faults. Failure detectors. Parallel and distributed matrix algorithms. Optimization in parallel and distributed algorithms. Complexity analysis of distributed and parallel algorithms. Applications.

CSE376 Real Time & Embedded Systems Design

3 Cr. Hrs. = (*3* LCT + *1* TUT + *2* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE272**

Introduction to automotive embedded networking - Automotive CAN network simulation using CANoe (Vector Germany) evaluation version - Principles of CAPL script to simulate external events and network communications - Introduction to CAN bus protocol - TIVA C embedded development using CAN bus - MISRA static code checking guidelines - MISRA and Code Composer Texas Instruments tools - Real Time Operating System on TIVA C - OSEK network management standard - OSEK NM simulation using CANoe - OSEK state machine C development - Introduction to AutoSar Automotive embedded development standard - AutoSar Real Time Environment (RTE) - AutoSar Basic Software (BSW) - AutoSar Software Components (SWC).

CSE382 Computer Graphics

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSC281**

Introduction to computer graphics hardware, algorithms, and software. Graphics Programming, OpenGL. Displaying images. 3D transformations. Light and shading. Ray tracing. Hidden surface

removal. Color technology. Image morphing. Texture mapping. Line drawing. Local illumination models. Curves and Surfaces. Geometric Modelling. Animation.

CSE383 Computer Vision

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE281**

Local Feature Extraction. Projective Geometry. Stereo Vision. Point Matching. 3D Reconstruction. Motion Detection. Object Recognition.

CSE424 Data Warehousing

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE323**

Introduction: Comparison of operational and decisional systems; Metadata. Data warehousing architectures: Corporate Information Factory; DW. 0. Multidimensional modeling and OLAP tools: Structure; Integrity constraints; Operations; Advanced concepts. Database optimization: Basic concepts; Phases and goals. Database physical design for analytical queries: Star-join and join indexes; Bitmaps; Materialized views; Implementations (relational and NOSQL). Extraction, Transformation and Load: Data quality; Integration; ETL management.

CSE425 Big Data Analytics 2

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE322**

Map Reduce; Clustering algorithms for high-dimensional data; predictive analytics; Dimensionality reduction; Application of machine learning algorithms for analyzing structure of large graphs like social network graphs Technologies for extracting important properties of large datasets.

CSE426 Selected Topics in Data Science

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE322**

The course provides topics that are selected from different recent trends in Data Science that are not covered in the description of the courses listed in the curriculum.

CSE427 Selected Topics in Big Data

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE322**

The course provides topics that are selected from different recent trends in Big Data that are not covered in the description of the courses listed in the curriculum.

CSE428 Data Analytics

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **- - -**

An introduction to the field of data analysis, including its positioning in the wider world and the main methods and concepts of both its statistics and machine learning disciplinary facets.

CSE445 Selected Topics in Information Security

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE 241**

Topics are selected from different areas in Information Security that are not covered in the description of the courses listed in the curriculum.

This course will cover recent trends and issues in the field of Information Security and will be chosen at the discretion of the Program Administration Council and the Faculty Council.

CSE446 Information &Computer Networks Security

3 Cr. Hrs. = (**3** LCT + **0** TUT + **3** LAB + **0** OTH) – SWL = **180** – ECTS = **6**

Prerequisite **CSE 261CSE 241**

Attacks and threats, symmetric key cryptography, public key cryptography, authentication protocols, digital signature, viruses, worms, Trojan horses, malicious programs, computer crimes, web-security, firewalls, intrusion detection, TLS, IPSec, SET, digital homeland security, offensive and defensive tools, security issues in wireless technologies and mobile computing, ethics and hacking in laws.

CSE447 Selected Topics in Computer Security

3 Cr. Hrs. = (**3** LCT + **0** TUT + **3** LAB + **0** OTH) – SWL = **180** – ECTS = **6**

Prerequisite **CSE241**

Topics are selected from different areas in Information Security that are not covered in the description of the courses listed in the curriculum. This course will cover recent trends and issues in the field of Information Security and will be chosen at the discretion of the Program Administration Council and the Faculty Council.

CSE448 Cyber Forensics

3 Cr. Hrs. = (**3** LCT + **0** TUT + **3** LAB + **0** OTH) – SWL = **180** – ECTS = **6**

Prerequisite **- - -**

Computer and Cyber Forensic Basics- Introduction to Computers, Computer History, Software, Hardware, Classification, Computer Input-Output Devices, Basic Computer Terminology, Internet, Networking, Computer Storage, Cell Phone / Mobile Forensics, Computer Ethics and Application Programs, Cyber Forensic Basics-Introduction to Cyber Forensics, Storage Fundamentals, File System Concepts, Data Recovery, Operating System Software and Basic Terminology.

CSE453 Building information systems

3 Cr. Hrs. = (**3** LCT + **0** TUT + **3** LAB + **0** OTH) – SWL = **180** – ECTS = **6**

Prerequisite **CSE 251**

Define the information systems basics that support different managerial levels using modern environments. -List deep understanding of database design and optimization in local/remote and centralized /distributed deployment models. -Propose and evaluate the information system components and infrastructure. -Operate modern computing, programming, information technology, and database design skills to build information system. -Implement comprehensive computing knowledge of information systems to solve practical information problems. -Work in groups and manage team, time and organizational skills to build information systems. -Retrieve the modern information efficiently in building information systems. -Use the modern computing facilities in building information systems.

CSE454 Advanced software Engineering'

3 Cr. Hrs. = (**3** LCT + **0** TUT + **3** LAB + **0** OTH) – SWL = **180** – ECTS = **6**

Prerequisite **CSE251**

Differences between structured and object-oriented paradigms. The Unified Modeling Language (UML). Use-case modeling. Class modeling: noun extraction, Class-Responsibility-Collaboration (CRC) cards. Dynamic modeling. State diagrams. Testing during the object-oriented analysis phase. CASE tools for object-oriented analysis and design. Object-oriented design: interaction diagram, detailed class

diagram, clients of objects, detailed design and program description languages.

CSE455 Selected Topics in software engineering

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE251**

Topics which are not included in the curriculum and seems to be needed should be suggested as an elective course by the Program Administration Council and the Faculty Council.

CSE464 Internet of Things

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE261**

Introduction to IoT. Concepts and architecture. Connected devices. Managing IoT resources in the cloud. Fog computing. Programming frameworks. Virtualization on Embedded boards. Collecting and managing data. Reliability, privacy, and security. IoT applications.

CSE465 Selected Topics in cloud computing

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE363**

Topics which are not included in the curriculum and seems to be needed should be suggested as an elective course by the Department Faculty Council.

CSE466 Selected Topics in IoT

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **CSE465**

Topics which are not included in the curriculum and seems to be needed should be suggested as an elective course by the Department Faculty Council.

CSE467 Client/Server Technologies &Applications

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **- - -**

Design of Information Systems and Fundamentals of the development of application software systems. The presentation of tools and methodology development are in line to obtain the skills to identify and solve specific information problems. Selected teaching strategy is to create skills for students to explore literature and to explore the problem originated information and finding the right tools to solve it. Overall, the course aims to develop additional skills to build complex three-layer systems based on client / server technologies. Requirements: students to have training in programming, using programming environments and knowledge of basic algorithms and data structures.

CSE475 Distributed Information systems

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE251**

An introduction to computer systems. Introduction to Internetworking, protocol stacks and data transport. Design and operation of distributed systems and applications. Central concepts in distributed systems, including transparency, scalability, middleware, synchronization, failure handling, consistency, and parallelism. Operating systems, scheduling, processes, memory systems and cloud abstractions. Security considerations, basic cryptography and network security. Basic designs and constraints of Internet-of-Things, including energy, scalability, privacy, and semantical interoperability. Analysis and presentation of a network based distributed system. Examining running networks with observing tools.

CSE477 Selected Topics in embedded systems

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE272**

Topics which are not included in the curriculum and seems to be needed should be suggested as an elective course by the Department Faculty Council.

CSE478 High Performance computing

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE271**

Overview of existing HPC software and hardware. Basic software design patterns for high performance parallel computing. CUDA for parallel computing on the Graphics Processing Unit (GPU). Message Passing Interface (MPI) parallel programming. OpenMP and POSIX threads solution to enable parallelism across multiple CPU cores. Standard algorithms utilizing parallelism. Matrix and vector operations. Collective communications. The use of Graphics Processing Units (GPUs) for general purpose computations (GPGPU). Multi-GPU and Multi-CPU solutions. Optimizing HPC-based programs. Designing GPU-based systems. Applications.

CSE479 Selected Topics in high performance computing

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE478**

Topics which are not included in the curriculum and seems to be needed should be suggested as an elective course by the Department Faculty Council.

CSE484 Interactive Multimedia

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **CSE382**

Introduction to Multimedia Studies. Data Representation. Basic Compression Techniques. Video and Audio Data Compression Techniques. Multimedia Networks and QoS Support. Multimedia Wireless Networks, Heterogeneous Networks, and advanced QoS Support. Multimedia Applications. Topics in Multimedia Technologies.

CSE485 Computer Games theory

3 Cr. Hrs. = (*3* LCT + *1* TUT + *1* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **CSE382**

. Preferences, Utility, and Goals. Strategic Form Non-Cooperative Games. Iterated Games. Extensive Form Non-Cooperative Games. Cooperative Games. Social Choice.

CSE486 Selected Topics in Computer Vision

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **CSE383**

The course provides topics that are selected from different advanced and recent trends in Computer Vision that are not covered in the description of the courses listed in the curriculum.

CSE487 Mixed &Augmented Reality

3 Cr. Hrs. = (*3* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *165* – ECTS = *6*

Prerequisite **CSE382**

3D Vision. Approaches to Augmented Reality. Alternative Interface Paradigms. Spatial Augmented Reality. Lighting and Illumination Issues in Augmented Reality.

CSE488 Visualization &Animation

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE382**

Perception and its applications. Graphical perception. Visual encoding principles. Interaction principles. Single-view methods. Multiple-view methods. Item reduction methods. Attribute reduction methods. Tabular data. Visualization toolkits. Graphs and trees. Flow visualization. Geo-spatial visualization. Volume visualization. Vector visualization. High-dimensional Visualization. Visualizing relational data. Design and evaluation. Visualizing structure. Visualizing time. Scaling. Key-framing. Storyboarding. Animation software. Spacing and timing. Digital animation techniques. 2D and 3D animatic, special effects design, 3D paint techniques and integration. Sequence planning, non-photorealistic rendering. Kinematics, physically based dynamics modeling. Motion capture. Scene composition, lighting, and sound track generation. Visual effects process. Texture-mapping, rendering and camera tracking techniques. Live action films.

CSE493 Graduation Project 1

3 Cr. Hrs. = (*2* LCT + *0* TUT + *0* LAB + *0* OTH) – SWL = *120* – ECTS = *6*

Prerequisite **SENIOR STANDING**

During the first of the two semesters, students will begin their work on the project and are expected to complete at least half the project by the end of the semester. Students will develop and work on their projects under faculty supervision.

CSE494 Graduation Project 2

3 Cr. Hrs. = (*2* LCT + *0* TUT + *0* LAB + *0* OTH) – SWL = *120* – ECTS = *6*

Prerequisite **- - -**

During the second of the two semesters, students will continue their work on the project and are expected to complete the project by the end of the semester. Students will develop and work on their projects under faculty supervision.

Department of Artificial Intelligence Science & Engineering

AIE111 Artificial Intelligence

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE111**

Knowledge representation and organization, Search strategies & inference methods, and. AI problem solving tools and techniques. Agent Architecture, Multi-Agent Systems, Reasoning with uncertain or incomplete knowledge;

AIE121 Machine Learning

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE 111**

Linear Regression and regularization. Instance-based Learning and Decision Tree Induction. Maximum Likelihood (Linear and Logistic regression). Probabilistic (Bayesian) Inference (Linear regression, Logistic regression with the Laplace approximation, Intro to Sampling). Support Vector Machines. Artificial Neural Networks: perceptron, MLPs, back propagation, intro to Deep Learning. Ensemble learning, bagging, boosting, stacking, random forests. Clustering algorithms, k-means, Expectation-Maximization, Hierarchical Clustering, Dimensionality reduction techniques, SVD/PCA, Multi-dimensional scaling.

AIE212 Knowledge-based Systems

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE111**

Propositional and predicate logic, non-classical logic, computational intelligence (recap). Knowledge based systems (KBS): information management, objectives, components, and types of KBS, expert systems. KBS Architecture: source of knowledge, types of knowledge, skills components, structure KBS, knowledge base, reasoning based on rules of inference mechanisms, forward and backward chaining, the reasoning in the presence of uncertainty, KBS based on fuzzy logic, application KBS, Semantic Web. Knowledge representation: representational models, predicate logic, rules, frames and objects, descriptive logic, semantic networks, ontologies, formal concepts, conceptual graphs. KBS development: development methodology, mechanisms of recovery and recycling of knowledge and tools to develop KBS: C Language Integrated Production System (CLIPS), Java Expert System Shell (JESS), Protégé, and Web Ontology Language (OWL).

AIE213 Optimization techniques

3 Cr. Hrs. = (*3* LCT + *3* TUT + *0* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **MCS212**

Linear Algebra and Matrices. Probability Theory Review. Linear

Programming. One-dimensional Search Techniques. Gradient-based Techniques. Quasi-Newton Methods. Constrained Optimization. Non-linear Constrained Optimization.

AIE231 Neural Networks

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE121**

Simple perceptron for classification, BackProp and Multilayer Perceptron for deep learning, Statistical Classification by deep networks, Regularization and Tricks of the Trade in deep learning, Error landscape and optimization methods for deep networks, Convolutional networks, Sequence prediction and recurrent networks, Bellman equation and SARSA, Variants of SARSA, Q-learning, n-step-TD learning, Policy gradient, Deep reinforcement learning: applications, Reinforcement learning and the brain.

AIE241 Natural Language Processing

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **CSE111**

Overview of NLP. Statistical Machine Translation. Word Alignment Models for Statistical MT. Machine Translation: Word Alignment, Parallel Corpora, Decoding, Evaluation. Modern MT Systems (Phrase-based, Syntactic). N-Grams, Final Project Discussion. Syntax and parsing. Competitive Grammar Writing. Dependency Parsing. Coreference Resolution. Computational Semantics.

AIE314 AI-based programming

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE212**

Introduction to Artificial Intelligence, Classification and Regression Using Supervised Learning, Predictive Analytics with Ensemble Learning, Detecting Patterns with Unsupervised Learning, Building Recommender Systems, Logic Programming, Heuristic Search Techniques, Natural Language Processing, Probabilistic Reasoning for Sequential Data, Building A Speech Recognizer, Object Detection and Tracking, Artificial Neural Networks, Reinforcement Learning, Deep Learning with Convolutional Neural Networks, Genetic Algorithms, Building Games With Artificial Intelligence.

AIE315 Computational Logic

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE111**

Topics include the syntax and semantics of Propositional Logic, Relational Logic, and Herbrand Logic, validity, contingency, un-satisfiability, logical equivalence, entailment, consistency, natural deduction (Fitch), mathematical induction, resolution, compactness, soundness, and completeness.

AIE316 Evolutionary Algorithms

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE213**

Introduction: Simple example of Evolution, Comparison and Motivation. The Model of Biological Evolution. a. Genotypes and Phenotypes. b. Basics of the Neo-Darwinian Paradigm. Optimization. Evolutionary Algorithms – General Overview. Genetic Algorithms. a. Basic Algorithm.

b. Schema Processing Interpretation of Genetic Algorithms. c. Schema Theorem. d. Convergence Velocity Perspective. e. Practical Applications: From Airline Crew Scheduling to Car Crash Optimization. Evolution Strategies. a. Basic Algorithms. b. Convergence Velocity Perspective. c. Practical Applications. d. Advanced Techniques (mixed-integer, multi objective). Genetic Programming. a. Basic Algorithm. b. Practical Applications. Advanced Topics. a. Mixed-Integer Representations. b. Self-Adaptation in Genetic Algorithms. c. Optimizing Evolutionary Algorithms.

AIE317 Artificial intelligence in medicine

2 Cr. Hrs. = (*2* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *120* – ECTS = *4*

Prerequisite **- - -**

an intensive introduction to artificial intelligence and its applications to problems of medical diagnosis, therapy selection, and monitoring and learning from databases.

AIE322 Advanced Machine Learning

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE121**

This course emphasizes practical skills, and focuses on giving you skills to make these algorithms work. You will learn in depth the commonly used learning techniques including supervised learning algorithms (logistic regression, linear regression, SVM, neural networks), unsupervised learning algorithms (k-means, Gaussian Mixture Models, spectral clustering), reinforcement learning, as well as learn about specific applications such as anomaly detection and building recommender systems.

AIE323 Data Mining

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE121**

Knowledge discovery in databases. Data mining process and Models. Data cleaning and preparation. Mining association rules, Classification, Prediction, and Clustering. Web mining and Text Mining. Data Warehouse and OLAP Technology for Data Mining. Model Evaluation and Cross Validation. Applications of data mining.

AIE332 Deep Learning

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE 231**

Deep Learning: A revolution in Artificial Intelligence, Limitations of Machine Learning, what is Deep Learning? Advantage of Deep Learning over Machine learning, 3 Reasons to go for Deep Learning, Real-Life use cases of Deep Learning, Review of Machine Learning: Regression, Classification, Clustering, Reinforcement Learning, Under-fitting and Overfitting, Optimization.

AIE342 Advanced Methods for Data Analysis

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE 323**

Introduction and regression, the truth about linear regression, Error and validation, Kernel regression, the bootstrap, Degrees of freedom, smoothing splines, Additive models, Inference with linear smoothers, Logistic regression, Generalized linear models, Principal components analysis, Other dimension reduction techniques, Clustering, High-dimensional regression, Time series.

AIE343 Machine Learning for Text Mining

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE323AI241**

Basic algorithms: the classical algorithms for text analytics, such as pre-processing, similarity computation, topic modelling, matrix factorization, clustering, classification, regression, and ensemble analysis. Domain-sensitive learning: learning models in heterogeneous settings such as a combination of text with multimedia or Web links. The problem of information retrieval and Web search is also discussed in the context of its relationship with ranking and machine learning methods. Sequence-centric mining: various sequence-centric and natural language applications, such as feature engineering, neural language models, deep learning, text summarization, information extraction, opinion mining, text segmentation, and event detection.

AIE351 Robotics Design

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE111**

This course presents an overview of robotics in practice and research with topics including vision, motion planning, mobile mechanisms, kinematics, inverse kinematics, and sensors. In course projects, students construct robots which are driven by a microcontroller, with each project reinforcing the basic principles developed in lectures. Students usually work in teams of three: an electrical engineer, a mechanical engineer, and a computer scientist. Groups are typically self-formed except for the first lab. This course will also expose students to some of the contemporary happenings in robotics, including current robotics research, applications, robot contests and robot web surfing.

AIE417 Selected Topics in Artificial Intelligence 1

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE111**

The course provides topics that are selected from different advanced and recent trends in Artificial Intelligence that are not covered in the description of the courses listed in the curriculum.

AIE418 Selected Topics in Artificial Intelligence 2

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE111**

The course provides topics that are selected from different advanced and recent trends in advanced topics Artificial Intelligence that are not covered in the description of the courses listed in the curriculum.

AIE419 Artificial intelligence for computer games

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **- - -**

Knowledge representation and organization, Search strategies & inference methods, and. AI problem solving tools and techniques. Agent Architecture, Multi-Agent Systems, Reasoning with uncertain or incomplete knowledge;

AIE424 Intelligent Decision Support Systems

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE323**

Artificial intelligence in multi-criteria decision analysis (sorting, ranking, classification, programming in fuzzy environments and rule induction systems); - Intelligent systems in knowledge-based systems (knowledge discovery and representation, approximate reasoning and

management of uncertainty); - GIS-based multi-criteria decision analysis (spatial data mining and visual analytics). The objective of this course is achieving a profound understanding of Intelligent Decision Support Systems in terms of its tools, current practices and impacts. The students should acquire knowledge on how to design IDSS for different decision making problems.

AIE425 Intelligent Recommender Systems

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE323**

Neighborhood-based Collaborative Filtering. Model-based Collaborative Filtering. Content-based Recommender Systems. Knowledge-based Recommender Systems. Evaluation Recommender Systems.

AIE426 Decision Making under Uncertainty

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE323**

The course will cover computational methods for solving decision problems with stochastic dynamics, model uncertainty, and imperfect state information. Topics include Bayesian networks, influence diagrams, dynamic programming, reinforcement learning, and partially observable Markov decision processes. Applications cover: air traffic control, aviation surveillance systems, autonomous vehicles, and robotic planetary exploration.

AIE427 Statistical Pattern Recognition

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE322**

Statistical Pattern Recognition: A Review. Statistical Decision Theory. Notes on Neyman-Pearson decision rule. Notes on error rate of a linear discriminant function. Parameter Estimation. Bayes Estimator for multivariate Gaussian density with unknown covariance matrices. Component analysis and Discriminants. Readings on Isomap and LLE. Principle Component Analysis (PCA). PCA for face Recognition. Non-parametric Technique. Curse of Dimensionality. A Problem of Dimensionality: A Simple Example. Feature Selection: Evaluation, Application, and Small Sample Performance. Decision Trees. Support Vector Machine. Error Rate Estimation, Bagging, Boosting, Classifier Combination. Logistic Regression. Unsupervised and semi-supervised learning. Clustering and Multidimensional Scaling.

AIE444 Question Answering Systems

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE241**

Introduction to QA systems, Answer Validation, Sentence Annotation: Named Entity Annotation, Dependency Parsing, Semantic Role Labeling. Question Analysis, Question Classification, Query Construction, Sentence Retrieval: Sentences vs. Documents, Word Relationship, Answer Extraction, Opinion and Polarity Classification.

AIE452 Cognitive Robotics

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE351**

. Robots: Beyond the computer metaphor in cognitive science. Varieties

of embodiment. Evolution of robots. Developmental robotics. Learning intrinsic environment representations from sensory-motor interactions. Designing sociable robots. Eliza effect and its role in cognitive robotics: Robots and Autistic children. Theory of mind for robots. Internal value system in cognitive robotics architectures. Interaction theory in cognitive robotics.

AIE453 Planning Techniques for Robotics

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE351**

Introduction; What is Planning? search algorithms: Uninformed A*, heuristics, weighted A*, Backward A*. interleaving planning and execution. planning representations: lattice-based graphs, explicit vs. implicit graphs. planning representations: PRM for continuous spaces. planning representations/search algorithms: RRT, RRT-Connect. search algorithms: IDA*, Beam Search, Multi-goal A*. search algorithms: Markov Property, dependent vs. independent variables, Dominant Relationship. planning representations: state-space vs. symbolic representation for task planning. search algorithms: symbolic task planning algorithms. planning under uncertainty.

AIE454 Robot Kinematics &Dynamics

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE351**

transformations. forward kinematics. inverse kinematics. differential kinematics (Jacobians). manipulability. basic equations of motion.

AIE455 Robot Mapping &Localization

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE351**

Introduction. SLAM entities: map, robot, sensor, landmarks, observations, estimator. Motion and observation models. EKF-SLAM. Operations of EKF-SLAM. Geometry (Rotation matrix - Reference frames - Motion of a body in the plane - Polar coordinates - Useful combinations). Probability. Generalities - Gaussian variables - Graphical representation.

AIE456 Human Robot Interaction

3 Cr. Hrs. = (*3* LCT + *0* TUT + *3* LAB + *0* OTH) – SWL = *180* – ECTS = *6*

Prerequisite **AIE351**

The field of human-robot interaction (HRI) is fast becoming a significant area of research in robotics. The basic objective is to create natural and effective interactions between people and robots. HRI is highly interdisciplinary, bringing together methodologies and techniques from robotics, artificial intelligence, human-computer interaction, psychology, education, and other fields. This course is primarily lecture-based, with in-class participatory mini-projects, homework assignments, a group term project that will enable students to put theory to practice, and a final. The topics covered will include technologies that enable human-robot interactions, the psychology of interaction between people and robots, how to design and conduct HRI studies, and real-world applications such as assistive robots. This course has no prerequisites, but some basic familiarity with robots is recommended (programming knowledge is not necessary, but is useful for the term project).

AIE457 Mobile Robot Development

3 Cr. Hrs. = (***3*** LCT + ***0*** TUT + ***3*** LAB + ***0*** OTH) – SWL = ***180*** – ECTS = ***6***

Prerequisite **AIE351**

This course investigates robot mobility, energetics, sensing, computing, software, payload, interface, and operating environment. The context is robotic pursuit of the Moon. Scope incorporates mechanism, electronics, software, locomotion, navigation, communication, sensing, power and thermal considerations. Additionally, space systems address challenges of low mass, energetics, space environment, and reliability of design. Media is incorporated to chronicle and represent the accomplishments. The course is appropriate for a broad range of student disciplines and interests. Course Learning Objectives include formulation, problem solving, robotics and developing space systems. Students work cooperatively in teams with guidance to produce mission-relevant results and practice technical communications through written and oral presentations. Teams generate term papers detailing the design, development, testing and lessons learned.

AIE493 Graduation Project 1

3 Cr. Hrs. = (***2*** LCT + ***0*** TUT + ***0*** LAB + ***0*** OTH) – SWL = ***120*** – ECTS = ***6***

Prerequisite **SENIOR STANDING**

During the first of the two semesters, students will begin their work on the project and are expected to complete at least half the project by the end of the semester. Students will develop and work on their projects under faculty supervision.

AIE494 Graduation Project 2

3 Cr. Hrs. = (***2*** LCT + ***0*** TUT + ***0*** LAB + ***0*** OTH) – SWL = ***120*** – ECTS = ***6***

Prerequisite **- - -**

During the second of the two semesters, students will continue their work on the project and are expected to complete the project by the end of the semester. Students will develop and work on their projects under faculty supervision.

Department of Biomedical Informatics

BMD241 Human physiology

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **BIS241**

Basic physiological functions including circulatory system, digestive system, execration system, nervous system, reproduction system, and immune system. Physiochemical process for each system. Anatomy of the human body. Modelling of human physiological and anatomical systems.

BMD311 Introduction to Bioinformatics

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **- - -**

Introduction to Bioinformatics and Biological Databases. NCBI Tools. Sequence manipulation and analysis. Sequence alignment theory and applications. Sequence alignment and matching. Multiple sequence alignment methods and algorithms. Evolution and Phylogenetic analysis. PCR primer Design. RNA Bioinformatics: secondary structure prediction. Comparative structure modelling.

BMD312 Clinical Informatics

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **BMD311**

Overview of clinical informatics. Medical departments and terminologies. Classification of diseases and biomedical ontologies. Structure and organization of medical data and information, including physiochemical measurement, imaging, genetics, bioanalysis. Standards and regulations in biomedical informatics for data representation, safety, and privacy. Clinical information systems: design, implementation, and operation of clinical information system serving patients of a healthcare entity. Electronic medical records: architecture and design, interoperability, implementation, and operation.

BMD313 Dental informatics

2 Cr. Hrs. = (*2* LCT + *0* TUT + *2* LAB + *0* OTH) – SWL = *120* – ECTS = *4*

Prerequisite **- - -**

Informatics. Dental Informatics. Data Management. Information Extraction. Dental Imaging and digital data.

BMD351 Biomedical Data Acquisition

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **CSE111,BMD241**

Overview of biomedical equipment and types. Physiological (physiochemical) measurements (ECG, EEG, EMG, ECG, etc.), and related devices. Medical imaging, including X-ray, ultrasound, MRI. Life support equipment, including incubators, ventilators, dialysis, heart-lung machines, etc. Laboratory equipment, including bio-analyzers, PCR, and DNA sequencers.

BMD361 Biomedical Statistics

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **BMD311**

Review probability theory and statistical methods. Research methodology in biomedical sciences. Cohorts and groups establishment and power analysis. Hypothesis testing and its applications to group comparisons. Application of classification and clustering techniques in biomedical informatics. Biostatistics efficient association tests.

BMD413 Structural bioinformatics

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **BMD311**

Modelling of Protein and Nucleic Acid Structures. Protein Structure Classification and Databases. Prediction of Protein Structure: Homology Modelling. Prediction of Protein Motion: Molecular Dynamics Simulation. Modelling of Small Molecule Ligands and aspects in Ligand-Protein Interactions. Molecular Docking and Prediction of Protein Binding Site. Recent Approaches in Structural Bioinformatics and Drug Discovery.

BMD414 Selected Topics in Biomedical Informatics 1: Data Analysis &Visualization

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **BMD311**

Introduction to Data Analysis. The NumPy Library. Introduction to Pandas Library. Pandas Reading and Writing data. Pandas In-depth. Machine Learning with scikit-learn. Combining and importing data. Data exploration. Visualizing trends. Plotting 2D arrays. Statistical plots with Seaborn.

BMD415 Selected Topics in Biomedical Informatics 2: Data Mining & Machine Learning

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **AIE121AIE323**

Linear Classification. Non-linear Classification. Clustering Techniques. Dimensionality Reduction and Feature Extraction. Mining unstructured data: text as an example. Finding Similar Items.

BMD421 Biomedical Information systems

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **BMD311**

Hospital information systems: design, implementation, and operation of clinical information system including medical and non-medical components. Structure of complex organizations. Concepts of business processes. Design and implementation of business workflows in hospital information systems. Healthcare information systems on the population scale. Sharing biomedical data among different healthcare entities. Use of geographical information systems. Role of large-scale information systems in public healthcare.

BMD422 Systems Biology

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **BMD311**

Introduction to Complex Systems and Systems biology. Mathematical representation of Biological Systems. Topologies of Biological Networks. Types of Biological Networks. Mathematical Modeling of Biological Networks. Differential Equations for Modeling of Biological Networks. Recent topics in Systems Biology: Synthetic biology. Recent topics in Systems Biology.

BMD431 Medical Image Informatics

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **CSE281**

Introduces the characteristics of medical images and basic techniques for analyzing medical images, including ultrasound images, X-ray images, and MRI images. The course also tackles extra challenges of medical imaging, including noise patterns, movement, tissue structure, and elasticity. Applications of medical image processing in computer aided diagnosis. Management of technical images, including DICOM standard and PACS system.

BMD452 Biomedical text processing

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **BMD311**

Basics of text processing: text parsing, text retrieval, tagging, natural language processing, and information extraction. Medical texts and public databases. Medical Languages systems. Mining biomedical literature: gene name extraction, disease name identification, relation identification.

BMD462 Bio-inspired Computing

3 Cr. Hrs. = (*3* LCT + *2* TUT + *2* LAB + *0* OTH) – SWL = *195* – ECTS = *6*

Prerequisite **BMD311**

An introduction to self-adapting methods also called artificial intelligence or machine learning. Schemes for classification, search and optimization based on bio-inspired mechanisms are introduced. This includes evolutionary computation, artificial neural networks and more specialized approaches like e.g. swarm intelligence and artificial immune systems. Further, an overview of alternative traditional methods will also be included. Bio-inspired hardware and computers. Applications in robotics, problem solving, and optimization problems.

BMD493 Graduation Project 1

3 Cr. Hrs. = (*0* LCT + *0* TUT + *0* LAB + *0* OTH) – SWL = *90* – ECTS = *6*

Prerequisite **SENIORSTANDING**

All students undertake a major project as part of the program. The aim of the project is to provide the students - in groups - with an opportunity to implement the appropriate concepts and techniques to a particular design. Students are required to choose and research the expected project to be designed and implemented in course project-. The student is expected to give an oral presentation to be approved.

BMD494 Graduation Project 2

3 Cr. Hrs. = (*0* LCT + *0* TUT + *0* LAB + *0* OTH) – SWL = *90* – ECTS = *6*

Prerequisite **- - -**

All students undertake a major project as part of the program. The aim of the project is to provide the students - in groups - with an opportunity to implement the appropriate concepts and techniques to a particular design. Students are required to design and implement the project initiated in in course project-. The student is expected to give an oral presentation to be approved.