Final Exam Topics

for students entering the Computer Science Engineering MSc program in school year 2017/2018 or latter

Subject Group I. (Compulsory)

Discrete and Continuous Dynamic Systems

I.1. Continuous and discrete time linear time-invariant systems: input-output and state space representations. Sampling. State transformations, realizations, realization properties. Canonical forms.

I.2. Continuous time time-invariant linear and nonlinear systems. Stability notions (BIBO and asymptotic and conditions, Lyapunov theorem.

I.3. Deterministic automata: definitions, relationship with languages. Unary and binary operations on automata.

I.4. Discrete event systems as nonlinear discrete time systems. Relationships between automata models and state space models of discrete time nonlinear systems. Petri net description of discrete event systems, relationship with automata models.

I.5. Observability and nondeterminism of automata. Observer automaton. Diagnosability, diagnose automaton. Timed automata.

Introduction to the Theory of Computation

I.6. Recursive functions: Primitive Recursive Functions, Primitive recursive relations, Limitations of primitive recursion.

I.7. Turing Machines: Turing Machines, Constructions of Turing Machines, Variants of Turing machines.

I.8 Turing computability: Turing computability, Recursively enumerable languages, Undecidability

Advanced Database Management Systems

I.9. Technologies and considerations related to database server side business logic implementation

I.10. Concepts and technologies related to database replication

I.11. Cloud database technologies

Subject Group II. (Elective)

Subject Group II.1. Software Systems

Cloud Programming

II.1.1. Describe the key characteristics of the various cloud abstraction layers (IAAS, PAAS, SAAS, etc), their typical aplication areas and building components. Choose one of the main cloud providers (Google, Amazon, Microsoft) and using their technology stack, describe the interoperation of these layers.

II.1.2. Describe the key programming steps of a cloud application from the functionality perspective (data transport, server-side business logic, scalability, storing data, security issues, fault tolerance, etc). What level of support is given to developes by the major cloud service providers for implementing these tasks?

II.1.3. Describe the fundamentals of stream data processing, its advantages and typical application scenarios and show the key functionality of a selected stream-oriented data processing framework.

II.1.4. Compare the following technologies with cloud programming: service-oriented systems, grid computing, peer-to-peer systems, web services, message-passing distributed systems. Which one appears and to what extent in current cloud computing technologies?

Security Techniques of Information Systems

II.2.5. Threats of information systems: physical, logical, and human security.

II.2.6. Business process permanence planning: process measuring, planning, development of strategy and action plan.

II.1.7. IT security regulation: data security and protection, OCP, DRP, BCP

System Analysis and Design

II.1.8. Business Process Modeling (BPM): Business Process Diagram (BPD), notation of processes, roles, and interactions between them.

Compilers / Introduction to the Theory of Computation

II.1.9. Lexical analysis: definition of regular grammars and finite automata accepting them

II.1.10. Syntax analysis: definition of context-free grammars and pushdown automata accepting them

Subject Group II.2. Computer Networks

Routing in Enterprise Networks

II.2.1. Routing concepts (role of static & dynamic routing protocols, convergence, route summarization, VPN, IPsec, RIP, RIPv2, RIPng, authentication of routing protocols)

II.2.2. EIGRP (basic operation, topology table, choosing the best path, metrics, stub routing, symmetric & asymmetric load balancing, EIGRP for IPv6)

II.2.3. OSPF (hierarchical structure & basic operation of OSPF, message types, DR/BDR election, passive interfaces, ABR/ASBR routers, virtual links, stub & totally stubby areas, OSPFv3)

II.2.4. BGP (Basic concepts & operation, routing between autonomous systems, BGP path vector, BGP tables & message types, when to use & when not to use BGP, neighbor relationships, eBGP & iBGP, path selection process, attributes (Next-Hop, Local-Preference, MED, Weight), BGP filtering)

Switching in Enterprise Networks

II.2.5. Spanning Tree (standards, basic operation, BPDU, Root Bridge election, PVST+, RSTP, PortFast, BPDU & RootGuard, MST)

II.2.6. VLANs (comparison of end-to-end & local VLANs, role of native VLAN, trunk links, DTP, VTP, inter-VLAN routing, SVI, EtherChannel)

II.2.7. High availability (FHRP, HSRP, VRRP, GLBP)

II.2.8. Security of switched networks (RADIUS, TACACS+, vulnerabilities, MAC flooding attacks, Port Security, Storm Control, DHCP & ARP Spoofing, IP Source Guard, VLAN hopping, PVLAN)

Enterprise Integration Patterns

II.2.9. Messaging Systems (message channel, message, pipes and filters, message router, message translator, message endpoint)

II.2.10. Messaging Channels (point-to-point channel, publish-subscribe channel, datatype channel, invalid message channel, guaranteed delivery, channel adapter)

Subject Group II.3. Engineering Applications

Digital Signal Processing

II.3.1. Time-domain and frequency-domain representation of signals. Fourier series, Fourier Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT) and their properties. The z-transform and its properties.

II.3.2. Digital filters. Finite impulse response (FIR) and infinite impulse response (IIR) filters. IIR filter realizations (direct, canonical, cascade). FIR design principles. Decimation and interpolation filters.

Computer Vision

II.3.3. The pinhole camera model. The calibration of projective cameras. Stereo image forming.

II.3.4. The projection of motion. The fundamental methods for the estimation of optical flow.

Parameter Estimation

II.3.5. Parameter estimation based on least squares and its properties. Least squares parameter estimation for static and dynamic linear models. The unbiasedness of the estimate, the covariance matrix of the estimate. The execution of the parameter estimation: experiment design, the evaluation of the measured data, the evaluation of the quality of the estimate.

Control Theory / Discrete and Continuous Dynamic Systems

II.3.6. Dynamic analysis of continuous and discrete time linear time-invariant systems: the notion and conditions of stability, observability, controllability and reachability.

Artifical Intelligence

II.3.7. Machine Learning: inductive learning, decision tree learning, neural networks in machine learning, back-propagation, reinforcement learning.

Intelligent Control Systems / Discrete and Continuous Dynamic Systems

II.3.8. Formal and graphical description of Petri nets and their operation. Solution of Petri net models, the reachabillity graph. Dynamic analysis of Petri net models: behavioral and structural properties.

Subject Group II.4. Healthcare Applications

Biomedical signal processing

II.4.1. Describe the possible mechanisms and methods of avoiding electromagnetic disturbances in ECG and EEG measurements.

II.4.2. Describe the methods of measuring blood flow and their technological difficulties.

II.4.3. Describe the fundamentals of the measurement technique of medical cross-sectional imaging and the principle of image reconstruction from measured data.

II.4.4. What are the key differences between CT, PET and MRI imaging techniques?

Medical Databases

II.4.5. Recent technologies for modeling and exchanging health data

II.4.6. Security and anonymity of health data, auditing databases