جامعة الملك سعود
كلية علوم الحاسب والمعلومات
قسم هندسة الحاسب
لجنة الدراسات العليا

The Topics of the Comprehensive Exam

- The comprehensive exam consists of two parts: core and concentration.

- The core part covers the main track of the computer engineering department: architecture, networks, and signals; the student will be examined in two topics of these tracks as following:

- ❖ Advanced Computer Architecture;
- ❖ Computer Networks or Digital Signal Processing (based on the student's choice).

- The concentration part of the exam covers one of the three tracks, where the student has the freedom to choose two topics out of four. The topics of each track are chosen as follows:

Signals	Networks	Architecture
Digital Image Processing	Performance Analysis of Local Area Networks	Advanced Parallel Processing
Digital Speech Processing	Wireless and Mobile Networks	Fault Tolerant Systems
Pattern Recognition	Network Security	Parallel Computing
Autonomous Mobile Robots	Internet Protocols and TCP/IP	Advanced Embedded Systems

- The descriptions of the topics included in the comprehensive exam are in the next table:

Track	Topic	Description
Architecture	Advanced Computer Architecture	Fundamentals of Quantitative Design and Analysis in Computer Architecture. Pipelining: Basic and Intermediate Concepts, Instruction-Level Parallelism and Its Exploitation (Speculation, Limits to ILP). Memory Hierarchy Design, including Cache Design and Memory Technology. Data-Level Parallelism (Vector, SIMD, GPU).
	Advanced Parallel Processing	The Principles and Trade-offs in the Design of Parallel Architectures. Naming, Latency, Bandwidth, and Synchronization in Parallel Machines. Parallel Programming Models.

		Implementation Issues in Multiprocessor Systems and Multi-Computer Clusters (Shared Memory, Message Passing).
	Fault Tolerant Systems	Physical Fault Errors and Failures; Fault Analysis and Diagnosis in Digital Circuits; Fault Modelling; Testing Techniques; Test Generation and Fault Simulation; Design for Testability; Built-in-self-Test; Reliability Concepts; Fault prevention (fault intolerance); Fault Tolerance; Replication, Redundancy, and Diversity.
	Parallel Computing	Introduction to Parallel Computers. Message-Passing Computing (MPI). Embarrassingly Parallel Computations. Partitioning and Divide-and-Conquer Strategies. Pipelined and Synchronous Computations. Programming with Shared Memory (OpenMp) and Distributed Shared Memory Systems.
	Advanced Embedded Systems	Cyber-Physical Systems, Design Process, Embedded Processors, Sensors and Actuators, Input and Output, Multitasking, Scheduling, Discrete Dynamics, Composition of State Machines, Concurrent Models of Computation, Quantitative Analysis.
Networks	Computer Networks	OSI and TCP/IP Models; Physical Layer: Transmission Media, Electromagnetic Spectrum, Signal Encoding, Modulation; Data link layer: Framing, Error Control; Medium Access Control, MAC Protocols, Ethernet, Switching, VLANs, Wi-Fi; Network Layer: Routing Algorithms, Circuit and Packet Switching, IP Protocol, ARP, DHCP; Transport Layer: UDP, TCP, Sockets, Flow Control, Congestion Control; Application Layer: Domain Name System, Email, Web, HTTP.
	Performance Analysis of Computer Networks	General Concepts of Performance Evaluation of Computer Networks; Markov Chains; Basic Queuing systems; Separable Queuing Networks; Priority Queuing Systems and Queuing Networks; Applications to Computer Networks and LANs.
	Wireless and Mobile Networks	Basic of wireless communication & channel: electromagnetic spectrum, multipath, noise, and interference path loss, fading, channel modelling. Multiplexing & spread spectrum techniques: FDM, TDM, FHSS, DSSS, CDMA, OFDM. Wireless LAN & MAN networks: Ad hoc networks design, routing, Mobile IP. Wireless LAN: Wireless MAC (CSMA/CA, RTS/CTS, DCF,

		PCF), IEEE 802.11 a/b/g/n, IEEE802.11e for differentiated services (QoS), Security. Bluetooth. Wireless sensor networks: MAC, clustering, energy efficiency, routing, AODV and OLSR. Wireless MAN networks ((IEEE 802.16): architecture, SOHO, MAC design, services, channel model, network initialization and QoS support.
	Network Security	Symmetric and asymmetric cryptography: Block cipher, Stream cipher, and public key encryption; Authentication Protocols: Message Authentication, Digital Signature, Key management, and User Authentication; Network-Layer Security: IPsec, IKE, and P2P network security; Transport-Layer Security: TLS, HTTPS, and SSH; Wireless Security: WEP, WPA, and RSN; Email Security: S/MIME and PGP; Internet Security Systems: firewall, intrusion detection systems, and malware.
	Internet Protocols and TCP/IP	IP protocols, Multicasting, MPLS, IP addressing, Interior, exterior and multicast routing protocols; UDP and TCP protocols, QoS, Congestion control, Flow control; Application Layer Protocols: WWW protocols, DNS, SMTP, Socket application program interface, SNMP, Multimedia protocols and Standards MPEG, JPEG.
Signals	Digital Signal Processing	Sampling Theorem and Filtering Linear Time Invariant Systems Discrete Time Signals Discrete Fourier Transforms (DFT) Fast Fourier Transforms (FFT) Z-transforms, Design of Finite Impulse Response (FIR) Filter and Infinite Impulse Response (IIR) Filter Adaptive Filters, Application on Audio and Image Processing.
	Digital Image Processing	Fundamentals of Digital Image Processing, Basics of Image Enhancement in Spatial and Frequency Domain, Image Restoration, Colour Image Processing, Image Compression.
	Digital Speech Processing	Speech and Language Fundamentals; Speech Perception and Production; Processing Speech Signal: Windowing, Pre-Emphasis, and Framing; Linear Predictive Coding;

		Mel-frequency cepstral coefficients Hidden Markov model Applications of Digital Speech Processing such as Speech Recognition and Synthesis
	Pattern Recognition	Decision Theory, Parameter Estimation, Density Estimation, Non-Parametric Techniques, Supervised Learning, Linear Discriminant Functions, Clustering, Unsupervised Learning, Feature Extraction, Support Vector Machines, Neural Networks, Pattern Recognition Applications
	Autonomous Mobile Robots	Mobile Robot Kinematics and Dynamics, Actuators and Sensors, Mobile Robot Localization (Odometry and Kalman Filter), Path Planning, Intelligent Motion Control, Robotic Vision and Navigation.