## Salahaddin University- Erbil College of Science Department of Computer Science and Information Technology

#### Subjects for qualification exam (2023-2024)

Ph.D. Level

# 1- Networking

## **<u>1-1</u>** Advanced Wireless Networks

- Wireless sensor networks
- MAC protocols for wireless sensor networks
- routing in sensor networks
- Ad-hoc networks
- routing in MANETs
- Wireless PAN
- Wireless LAN
- TCP for Wireless Networks
- Wireless Networks Architecture

#### References

Wireless Networking: Understanding Internetworking Challenges by Julia Andrusenko, Jack L. Burbank, Jared S. Everett, and William T. M. Kach

### <u>1-2 IoT</u>

### Topics

- 1 Internet of Things (IoT) Connectivity Technologies
- 2 Functionality based IoT Protocol Organization
- 3 Application Protocols (MQTT, CoAP)
- 4 6LowPAN: An Open IoT Networking Protocol
- 5 6LowPAN: An Open IoT Networking Protocol Cont's
- 6 Routing in IoT Environment

#### References

The following materials would be useful:

- Internet of Things: A Hands-on Approach, By Arshdeep Bahga and Vijay Madisetti
- Internet of Things Principles and Paradims by Rajkumar Buyya and Amir Vahid Dastjerdi
- Recent publications for case studies

# **<u>1-3 Object Oriented Programing (OOP)</u>**

- Introduction to oop
- Algorithm, Flowchart, and Programming
- Object-Oriented Programming basics and concepts
- Introduction to Encapsulation, Inheritance, and Polymorphism
- Objects and Classes, Constructors, Garbage Collection, and Finalizers
- Inheritance (details with example)
- Polymorphism (details with example), more on Strings
- Assignment Explanation, Basic GUI Components, Packages
- Exception Handling, Files and Directories
- Abstract Classes and Interfaces
- Collections
- Graphics Programming
- Inner classes,
- Event Handling
- GUI Component
- Templates: Function Templates (Definition, Instantiation), Class Templates (Definition, Instantiation), virtual function, file stream

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# **<u>1-4 Artificial intelligence (AI)</u>**

- Introduction to Artificial Intelligent
  - Definition
  - Techniques
  - Branches
  - Applications
- Problem Solving through search
  - Uninformed-Blind Search
    - o Breadth-First
    - Depth-First
    - Depth-Limited
    - o Bidirectional-First search algorithms
  - Inform-Heuristic Search
    - Hill-Climbing
    - Greedy search algorithms
- Knowledge Representation
  - Knowledge and its Types
  - Knowledge Representation Schemes
  - Forward and Backward chaining
  - Advantages and disadvantages of rule-based systems
- ✤ Decision-Making
  - Basics of utility theory
  - Decision theory
  - Sequential decision problems
- Learning and Knowledge Acquisition
  - learning from memorization
  - Learning nearest neighbor
  - naive Bayes
  - decision tree classifiers
- Expert Systems
  - Architecture of an expert system
  - Existing expert systems

- Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, (2002), Prentice Hall, Chapter 1-27, page 1-1057
- Artificial intelligence: A guide to intelligent systems. 2nd edition. MICHAEL NEGNEVITSKY
- Artificial Intelligence and Games, Georgios N. Yannakakis and Julian Togelius, January 26, 2018, Springer

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  - o Behrouz A. Forouzan, TCP/IP Protocol Suite 3rd Edition, 2006

#### 2- Computing

#### **2-1 Cloud Computing**

Introduction
 Three Layers of Computing
 Three Layers in Traditional Computing
 The End of Traditional Computing

2 .Evolution and Enabling TechnologiesThe Evolution of Cloud ComputingComparison between Cluster, Grid and Cloud Computing

3 .Benefits and ChallengesBenefits of Cloud ComputingChallenges of Cloud ComputingHow Cloud Computing Addresses Business Challenges

4 .Cloud Computing Model Standard Cloud Model Cloud Deployment Models

5 .Cloud Computing Services Service Delivery Models Service Abstraction

6 .Security Reference Model The Security Concern in Cloud Cloud Security Working Groups Elements of Cloud Security Model Cloud Security Reference Model

7 .Resource VirtualizationVirtualizing Physical Computing ResourcesOperating System Level Virtualization: Removal of the hypervisorAdvantages of Virtualization

8 .Resource Pooling, Sharing and Provisioning Resource Pooling Commoditization of the Data Center

9 .Scaling in the CloudWhat is Scaling?Scaling in Traditional ComputingScaling in Cloud Computing

10 .Load Balancing
Load Balancing
Importance of Load Balancing in Cloud Computing
How Load Balancing is done in Cloud
Goals of Load Balancing
Categories of Load Balancing
Parameters for Consideration
Load Balancing Algorithms

11 .Security IssuesCloud SecurityThreats to Cloud SecurityInfrastructure SecurityInformation Security

12 .Mobile Cloud Computing and the Internet of Things Mobile Cloud Computing The Internet of Things References : Cloud Computing (Sandeep Bhowmik)

#### **2-2 Parallel Computing**

<u>1</u>.Why Do We Need Parallel Programming
 Why—Every Computer Is a Parallel Computer
 What—Time-Consuming Computations Can Be Sped up

2 .Overview of Parallel SystemsModeling Parallel ComputationMultiprocessor ModelsThe Parallel Random Access MachineThe Local-Memory Machine

The Memory-Module Machine Parallel Computational Complexity Problem Instances and Their Sizes

3 .Programming Multi-core and Shared Memory Multiprocessors Using OpenMP
Shared Memory Programming Model
Using OpenMP to Write Multithreaded Programs
Monitoring an OpenMP Program
Parallelization of Loops
Parallelizing Loops with Independent Iterations
Combining the Results of Parallel Iterations
Distributing Iterations Among Threads
Parallel Tasks
Running Independent Tasks in Parallel
Combining the Results of Parallel Tasks

4 .MPI Processes and Messaging Distributed Memory Computers Can Execute in Parallel Message Passing Interface MPI Operation Syntax MPI Data Types Process-to-Process Communication Measuring Performances Collective MPI Data Manipulations Communication and Computation Overlap Communication Modes Sources of Deadlocks MPI Communicators

5 .OpenCL for Massively Parallel Graphic Processors
Anatomy of a GPU
Introduction to GPU Evolution
A Modern GPU
Scheduling Threads on Compute Units
Memory Hierarchy on GPU
References :Roman Trobec · Boštjan Slivnik Patricio Bulić · Borut Robič Introduction
to Parallel Computing From Algorithms to Programming on State-of-the-Art Platforms

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  - Decision theory
  - Sequential decision problems
- Learning and Knowledge Acquisition
  - learning from memorization
  - Learning nearest neighbor
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- Expert Systems
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  - o Behrouz A. Forouzan, TCP/IP Protocol Suite 3rd Edition, 2006

## 3- AI

## 3-1 Data Mining

- Introduction
- Data & Data Preprocessing
- Classification: Basic Concepts/Methods
- Classification: Advanced Methods
- Association Analysis
- Association Analysis: Advanced Concepts
- Cluster Analysis: Basic Concepts and Algorithms
- Cluster Analysis: Additional Issues and Algorithms
- Anomaly Detection
- Avoiding False Discoveries
- Data Competition and AI in Medicine

#### References

• (Required) Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques (3rd ed), 2011

• (Required) Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, Introduction to data Mining (1st or 2nd ed), 2006

• (Optional) Charu C. Aggarwal, Data Mining: The Textbook, Springer, 2015.

• (Optional) Mohammed J. Zaki and Wagner Meira Jr., Data Mining and Analysis: Fundamental Concepts and Algorithms, 2014.

### **3-2 Pattern recognition and Machine learning**

Course syllabus: The following topics are included:

- Introduction .
- Supervise and unsupervised Learning .
- Decision Trees .
- Naive Bayes .
- perceptron.
- Neural Networks.
- Instance Based Learning,
- Support Vector Machines
- Bias/Variance Tradeoff, Boosting and Bagging,
- Learning Theory. Readings.
- Unsupervised Learning and Clustering.

- Bayesian networks: Representation.
- Final Review.

- T. Mitchell, *Machine Learning*, McGraw-Hill
- C. Bishop, Pattern Recognition and Machine
  Learning, Springer
- Kevin Murphy, Machine Learning: A probabilistic perspective
- Class Notes/Slides

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## 3-4 Artificial intelligence (AI)

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### 4- Images & Machine

#### **4-1 Image Security**

- $\hfill\square$  Introduction to Image Security
- □ Definition and scope of image security
- □ Image representation and formats
- $\Box$  Threats to image security
- □ Image Encryption
- $\Box$  Image encryption techniques
- $\hfill\square$  Symmetric and asymmetric image encryption
- □ Performance metrics for image encryption
- □ Image Steganography
- □ Image steganography techniques
- □ Least significant bit (LSB) steganography
- □ Spatial and transform domain steganography
- □ Image Watermarking
- □ Image watermarking techniques
- $\square$  Robust and fragile watermarking
- $\hfill\square$  Blind and non-blind watermarking
- □ Digital Image Forensics
- □ Image source identification
- $\hfill\square$  Image tampering detection
- $\hfill\square$  Techniques for detecting image and video tampering
- □ Biometrics and Image Security
- □ Different types of biometric modalities
- □ Biometric applications and challenges
- □ Biometric Recognition Systems
- $\square$  Biometric image authentication
- □ Security and privacy concerns in biometric systems
- $\hfill\square$  Biometric template protection and revocation
- □ Multimedia Security
- $\hfill\square$  Video and audio processing
- $\hfill\square$  Video and audio encryption, steganography, and Watermarking
- □ Image Authentication
- □ Image authentication techniques
- $\hfill\square$  Hash functions and digital signatures

- □ Image integrity verification
- $\hfill\square$  Content-based Image Retrieval (CBIR) and Security
- $\hfill\square$  CBIR techniques and systems
- $\Box$  CBIR and privacy concerns
- □ CBIR and image security applications

□ Chen, Z., & Tian, Y. (Eds.). (2018). Multimedia security: Watermarking , steganography, and forensics. CRC Press.

□ Katzenbeisser, S., & Petitcolas, F. A. P. (2012). Information hiding techniques for steganography and digital watermarking. Artech House.

□ Dhir, R., & Gupta, B. B. (2019). Handbook of research on multimedia cyber security. IGI Global.

□ Shi, Y. Q., Sun, Q., & Huang, J. (2016). Image and video encryption: From digital rights management to secured personal communication. Springer

### 4-2 Pattern Recognition and Machine Learning

- □ Introduction to Pattern Recognition and Machine Learning
- □ Definition and scope of pattern recognition and machine learning
- □ Supervised, unsupervised, and reinforcement learning
- □ Classification
- □ Binary and multi-class classification
- $\hfill\square$  Evaluation metrics for classification
- □ Linear Regression
- □ Linear regression models
- □ Gradient descent optimization
- □ Support Vector Machines
- □ Support vector machines and kernel methods
- $\hfill\square$  Soft-margin and hard-margin SVMs
- $\square$  Model selection and cross-validation
- □ Decision Trees and Random Forests
- $\hfill\square$  Decision tree models and algorithms
- □ Random forests and bagging
- □ Boosting techniques
- □ Clustering Algorithms
- □ K-means clustering
- □ Hierarchical clustering

- □ Density-based clustering
- □ Neural Networks
- □ Artificial neural networks and architecture
- □ Backpropagation and optimization
- □ Convolutional neural networks
- □ Deep Learning
- $\hfill\square$  Deep learning architectures and models
- □ Recurrent neural networks
- □ Dimensionality Reduction
- □ Principal component analysis
- □ Linear discriminant analysis
- $\hfill\square$  Nonlinear dimensionality reduction
- □ Reinforcement Learning
- □ Reinforcement learning and Markov decision processes
- □ Q-learning and value iteration
- □ Bayesian Learning
- □ Bayesian networks and Bayesian inference
- □ Naive Bayes and Bayesian regression
- □ Bayesian optimization
- □ Machine Learning Applications
- □ Natural language processing and text classification
- □ Image recognition and object detection
- □ Recommender systems and personalized advertising

- □ Bishop, C. M. (2006). Pattern recognition and machine learning. Springer.
- □ Alpaydin, E. (2010). Introduction to machine learning (2nd ed.). MIT Press.

□ Murphy, K. P. (2012). Machine learning: A probabilistic perspective. MIT Press.

□ Duda, R. O., Hart, P. E., & Stork, D. G. (2012). Pattern classification (2nd ed.) . Wiley.

- □ Shalev-Shwartz, S., & Ben-David, S. (2014). Understanding machine
- learning: From theory to algorithms. Cambridge University Press.

 $\hfill\square$  Aggarwal, C. C. (2018). Neural networks and deep learning: A textbook . Springer

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