Qualifying Examination (QE)

Course Textbook and Topics for the QE

Last updated on 4/26/2022

1) CDA 4102 Computer Architecture

Textbook: Computer Systems: A Programmer's Perspective, 3/E (CS:APP3e) by Randal E. Bryant and David R. O'Hallaron.

QE Topics:

- Intro to computer architecture
- Fundamental of computer design
- Instruction set architecture ISA, RISC system
- Pipelining Concept
- Branch Predictions and exceptions
- Instruction level parallelization
- Memory SRAM, DMA, and memory management
- Cache concept, policies, levels, and performance
- Multicore processor design, message passing, shared memory and consistency
- Multithreading, fine grained, coarse grained, and SMT

2) CDA 4240C Design of Digital Systems

Textbook: Fundamentals of Digital Logic with VHDL Design (3rd Edition), Stephen Brown and Zvonko Vranesic, ISBN 978-0-07-352953-0.

QE Topics:

- Combinational block coding with VHDL
- Sequential logic block coding with VHDL
- FPGAs and programming into FPGAs
- FPGA memories
- VHDL modeling: Structural, Data Flow, Behavioral
- FSM/ASM in VHDL

- Timing Analysis

- Design for Test and Testability and concept of BIST

3) CNT 4007 Communication Networks

Textbook: Computer Networks: A Systems Approach by Larry Peterson and Bruce Davie.

QE Topics:

- Introduction to Computer Networks

    o Applications of computer networks

    o Basic network architectures

    o The OSI layering model

    o Network performance metrics

- Direct-Link Networks

    o Hardware building blocks

    o Types of network links

    o Bit encoding

    o Framing

    o Error detection

    o ARQ: Retransmission mechanisms

- Medium Access

    o The channel allocation problem

    o Multiple access protocols

    o Ethernet, Wireless LAN, Bluetooth, WiFi, and WiMax protocol standards

- Internetworking

    o Simple internetworking

    o Routing algorithms

    o Internet routing, Autonomous systems

    o Multicast routing

- End-to-End Protocols

    o Elementary transport protocols

- A reliable transport service (TCP)

- Flow control mechanisms

● Congestion Control and Resource Allocation

- The resource allocation problem

- Classification of resource allocation methods and evaluation metrics

- TCP congestion control

● Applications

- Electronic mail

- The World Wide Web

- The Domain Name System

4) COP 3530 Data Structures and Algorithm Analysis

Textbooks:

Grokking Algorithms, by Aditya Y. Bhargava -- Manning 2016 ISBN 9781617292231.

Open Data Structures: an introduction, by Pat Morin: https://opendatastructures.org (FREE). Select the "**C++ edition**".

Note: students must use C++ when answering the QE question for COP3530.

QE Topics:

● Fundamental Data Structures and Algorithms

- Linked lists

- Stacks

- Queues

- Sets

- Graphs

- Trees

- Hash Tables

● Algorithmic Strategies

- Algorithm efficiency: growth rates and big-O notation

- Searching: comparison of various algorithms

- Sorting: comparison of various algorithms

5) COP 3410 Data Structures and Algorithm Analysis with Python

Textbook: Michael T. Goodrich, Data Structures and Algorithms in Python, Wiley, ISBN: 9781118290279, 1118290275.

Note: students must use Python when answering the QE question for COP3410.

QE Topics:

- Algorithm Analysis
- Recursion
- Array-Based Sequences
- Stacks, Queues
- Linked Lists and Trees
- Maps, Hash Tables, and Skip Lists
- Search Trees
- Sorting and Selection
- Graphs

6) COP 3540 Introduction to Database Structures

Textbook: Database Management Systems, 3rd edition. Raghu Ramakrishnan and Johannes Gehrke. McGraw-Hill, 2002, ISBN-13: 978-0072465631.

QE Topics:

- Conceptual Database Model

  - Entity-Relationship (ER) Models

- Logical Database Model

  - SQL

  - Relational Algebra

  - Normalization

- Physical Database Model

  - Storage and Access methods (e.g., Disks, buffers)

  - Indexes (B+tree and Linear Hashing)

  - Query Optimization

- Transaction Management / Concurrency and Recovery.

7) COP 4610 Computer Operating Systems

Textbook: Operating Systems: Three Easy Pieces, Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau. FREE, available at https://pages.cs.wisc.edu/~remzi/OSTEP/.

QE Topics:

- Overview of Operating Systems: Functions and Characteristics

- Operating System Principles

- Concurrency

    o Process management -processes and threads

    o Deadlocks and their prevention

- Scheduling and Dispatch

    o Resource allocation and scheduling

    o Process collaboration and synchronization

- Memory Management

    o Memory organization and management

    o Virtual memory organization

    o Virtual memory management

- Virtual machines

8) COT 4400 Design and Analysis of Algorithms

Textbook: Introduction to Algorithms (4th Edition), by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein.

QE Topics:

- Foundations: asymptotic notations, common functions, summations, and recurrences (Master Theorem)

- Sorting: Insertion sort, Merge sort, Heapsort, Quicksort, Sorting in Linear Time

- Medians, minimum and maximum, selection problem

- Divide-and-Conquer

- Basic Data Structures, Binary Search Trees, Hash Tables, Heaps and Priority queues

- Dynamic Programming. Application problems such as Matrix-Chain Multiplication, Longest Common Subsequence

- Greedy Algorithms. Application problems such as Activity-Selection Problem, Huffman Codes

- Elementary Graph Algorithms: graph representation, breadth-first search, depth-first search

- Minimum Spanning Trees: Prim, Kruskal

- Single-Source Shortest Paths: Bellman-Ford, Dijkstra

9) COT 4420 Theory of Computation

Textbook: Peter Linz "An Introduction to Formal Languages and Automata", Sixth Edition, Jones and Bartlett, 2016, ISBN-13: 9781284077247.

QE Topics:

- Deterministic and Non-deterministic Finite Accepters/Automata

- Regular Languages, Regular Expressions and Regular Grammars

- Linear Languages

- Context-Free Languages and Pushdown Automata

- Simplifications of Context-Free Grammars and Normal Forms; three Pumping Lemmas

- Closure Properties of Languages

- Turing Machines

- Hierarchy of Formal Languages and Automata

- The Church-Turing Thesis

- P-NP Classes

10)   EEE 3300 Electronics I

Textbook: Sedra and Smith "Microelectronic Circuits" 8th edition, Oxford Press.

QE Topics:

- Op-Amp applications

- Introduction to PSPICE (or ADS)

- Semiconductor Physics of PN Junctions, BJT Transistors and MOSFET Transistors

- Diodes and applications

- BJT Transistors and applications

- Introduction to MOSFET Transistor circuits

11)   EEE 4361C Electronics II

Textbook: Sedra and Smith "Microelectronic Circuits" 8th edition, Oxford Press.

QE Topics:

- BJT and MOSFET Single Stage Amplifiers

- BJT and MOSFET Differential Amplifiers and Multi-Stage Amplifiers

- BJT and MOSFET Amplifier Bandwidth and the Miller Effect

- BJT and MOSFET Feedback Amplifiers

12)   EEL 3502 Signals and Digital Filter Design

Textbook: James H. McClellan, Ronald W. Schafer and Mark A. Yoder, "DSP First", 2nd Edition, Pearson.

QE Topics:

- Introduction to signal and system representations

- Sinusoids and phasor operations

- Spectrum representation

- Fourier Series Analysis

- Sampling and Aliasing: The Sampling Theorem

- FIR filtering

- Frequency response of FIR filters

- Discrete-Time Fourier Transform

- The z-Transform

- IIR filters

13)   EEL 4512C Principles of Communication Systems

Textbook: Communication Systems 5th Edition by Simon Haykin ISBN-13: 978-0471697909.

QE Topics:

- Introduction to signals and systems

    - Time-invariance and linearity

    - Classification of signals and systems

- Impulse response

- Fourier transforms

- Measures of Bandwidth

- Transmission through linear systems; linear distortion

- Continuous waveform modulation systems

  - Double Sideband-Suppressed Carrier modulation

  - Amplitude modulation (AM) fundamentals

  - AM modulators/demodulators

  - Quadrature Amplitude Modulation/Single Sideband Modulation

  - Angle Modulation

  - Frequency modulation and demodulation

  - Superheterodyne Receiver

14) EEL 4652C Control Systems I

Textbook: Control Systems Engineering, 7th Edition, Norman S. Nise, ISBN-13: 978-1118170519.

QE Topics:

- Basic Concepts: Laplace Transform, Transfer Functions, Block Diagrams, Feedback, Transient Response
- Stability of Feedback Systems
- Steady-State Tracking Error
- Controller Design and Computer-Aided Design by Root Locus and Bode Plots