uCertify

Course Outline

Digital Communications

06 Jul 2024

1. Pre-Assessment
2. Exercises, Quizzes, Flashcards & Glossary

   Number of Questions
3. Expert Instructor-Led Training
4. ADA Compliant & JAWS Compatible Platform
5. State of the Art Educator Tools
6. Award Winning Learning Platform (LMS)
7. Chapter & Lessons

   Syllabus

   Chapter 1: Introduction

   Chapter 2: Signals and Spectra

   Chapter 3: Formatting and Baseband Modulation

   Chapter 4: Baseband Demodulation/Detection

   Chapter 5: Bandpass Modulation and Demodulation/Detection

   Chapter 6: Communications Link Analysis

   Chapter 7: Channel Coding: Waveform Codes and Block Codes

   Chapter 8: Channel Coding: Convolutional Codes and Reed–Solomon Codes

   Chapter 9: Channel Coding: Turbo Codes and Low-Density Parity Check (LDPC) Codes

   Chapter 10: Modulation and Coding Trade-Offs

   Chapter 11: Synchronization

   Chapter 12: Multiplexing and Multiple Access

   Chapter 13: Spread-Spectrum Techniques

   Chapter 14: Source Coding

   Chapter 15: Fading Channels

   Chapter 16: The ABCs of OFDM (Orthogonal Frequency-Division Multiplexing)

   Chapter 17: The Magic of MIMO (Multiple Input/Multiple Output)

   Chapter 18: Encryption and Decryption

   Chapter 19: Appendix A: A Review of Fourier Techniques

1. Pre-Assessment

Pre-Assessment lets you identify the areas for improvement before you start your prep. It determines what students know about a topic before it is taught and identifies areas for improvement with question assessment before beginning the course.

2. Expert Instructor-Led Training

uCertify uses the content from the finest publishers and only the IT industry's finest instructors. They have a minimum of 15 years real-world experience and are subject matter experts in their fields. Unlike a live class, you can study at your own pace. This creates a personal learning experience and gives you all the benefit of hands-on training with the flexibility of doing it around your schedule 24/7.

3. ADA Compliant & JAWS Compatible Platform

uCertify course and labs are ADA (Americans with Disability Act) compliant. It is now more accessible to students with features such as:

- Change the font, size, and color of the content of the course
- Text-to-speech, reads the text into spoken words
- Interactive videos, how-tos videos come with transcripts and voice-over
- Interactive transcripts, each word is clickable. Students can clip a specific part of the video by clicking on a word or a portion of the text.

JAWS (Job Access with Speech) is a computer screen reader program for Microsoft Windows that reads the screen either with a text-to-speech output or by a Refreshable Braille display. Student can easily navigate uCertify course using JAWS shortcut keys.

4. State of the Art Educator Tools

uCertify knows the importance of instructors and provide tools to help them do their job effectively. Instructors are able to clone and customize course. Do ability grouping. Create sections. Design grade scale and grade formula. Create and schedule assessments. Educators can also move a student from self-paced to mentor-guided to instructor-led mode in three clicks.

5. Award Winning Learning Platform (LMS)

uCertify has developed an award winning, highly interactive yet simple to use platform. The SIIA CODiE Awards is the only peer-reviewed program to showcase business and education technology's finest products and services. Since 1986, thousands of products, services and solutions have been recognized for achieving excellence. uCertify has won CODiE awards consecutively for last 7 years:

- **2014**
    1. Best Postsecondary Learning Solution

- **2015**
    1. Best Education Solution

2. Best Virtual Learning Solution
3. Best Student Assessment Solution
4. Best Postsecondary Learning Solution
5. Best Career and Workforce Readiness Solution
6. Best Instructional Solution in Other Curriculum Areas
7. Best Corporate Learning/Workforce Development Solution

- **2016**
    1. Best Virtual Learning Solution
    2. Best Education Cloud-based Solution
    3. Best College and Career Readiness Solution
    4. Best Corporate / Workforce Learning Solution
    5. Best Postsecondary Learning Content Solution
    6. Best Postsecondary LMS or Learning Platform
    7. Best Learning Relationship Management Solution

- **2017**
    1. Best Overall Education Solution
    2. Best Student Assessment Solution
    3. Best Corporate/Workforce Learning Solution
    4. Best Higher Education LMS or Learning Platform

- **2018**
    1. Best Higher Education LMS or Learning Platform
    2. Best Instructional Solution in Other Curriculum Areas
    3. Best Learning Relationship Management Solution

- **2019**
    1. Best Virtual Learning Solution
    2. Best Content Authoring Development or Curation Solution
    3. Best Higher Education Learning Management Solution (LMS)

- **2020**

1. Best College and Career Readiness Solution
2. Best Cross-Curricular Solution
3. Best Virtual Learning Solution

6. Chapter & Lessons

uCertify brings these textbooks to life. It is full of interactive activities that keeps the learner engaged. uCertify brings all available learning resources for a topic in one place so that the learner can efficiently learn without going to multiple places. Challenge questions are also embedded in the chapters so learners can attempt those while they are learning about that particular topic. This helps them grasp the concepts better because they can go over it again right away which improves learning.

Learners can do Flashcards, Exercises, Quizzes and Labs related to each chapter. At the end of every lesson, uCertify courses guide the learners on the path they should follow.

Syllabus

Chapter 1: Introduction

- Organization of the Course
- Additional Course Resources

Chapter 2: Signals and Spectra

- Digital Communication Signal Processing
- Classification of Signals
- Spectral Density
- Autocorrelation

- Random Signals
- Signal Transmission Through Linear Systems
- Bandwidth of Digital Data
- Conclusion
- References
- Problems
- Questions

Chapter 3: Formatting and Baseband Modulation

- Baseband Systems
- Formatting Textual Data (Character Coding)
- Messages, Characters, and Symbols
- Formatting Analog Information
- Sources of Corruption
- Pulse Code Modulation
- Uniform and Nonuniform Quantization
- Baseband Transmission
- Correlative Coding

- Conclusion
- References
- Problems
- Questions

Chapter 4: Baseband Demodulation/Detection

- Signals and Noise
- Detection of Binary Signals in Gaussian Noise
- Intersymbol Interference
- Equalization
- Conclusion
- References
- Problems
- Questions

Chapter 5: Bandpass Modulation and Demodulation/Detection

- Why Modulate?
- Digital Bandpass Modulation Techniques

- Detection of Signals in Gaussian Noise
- Coherent Detection
- Noncoherent Detection
- Complex Envelope
- Error Performance for Binary Systems
- M-ary Signaling and Performance
- Symbol Error Performance for M-ary Systems (M > 2)
- Conclusion
- References
- Problems
- Questions

Chapter 6: Communications Link Analysis

- What the System Link Budget Tells the System Engineer
- The Channel
- Received Signal Power and Noise Power
- Link Budget Analysis
- Noise Figure, Noise Temperature, and System Temperature

- Sample Link Analysis
- Satellite Repeaters
- System Trade-Offs
- Conclusion
- References
- Problems
- Questions

Chapter 7: Channel Coding: Waveform Codes and Block Codes

- Waveform Coding and Structured Sequences
- Types of Error Control
- Structured Sequences
- Linear Block Codes
- Error-Detecting and Error-Correcting Capability
- Usefulness of the Standard Array
- Cyclic Codes
- Well-Known Block Codes
- Conclusion

- References
- Problems
- Questions

Chapter 8: Channel Coding: Convolutional Codes and Reed–Solomon Codes

- Convolutional Encoding
- Convolutional Encoder Representation
- Formulation of the Convolutional Decoding Problem
- Properties of Convolutional Codes
- Other Convolutional Decoding Algorithms
- Reed–Solomon Codes
- Interleaving and Concatenated Codes
- Coding and Interleaving Applied to the Compact Disc Digital Audio System
- Conclusion
- References
- Problems
- Questions

Chapter 9: Channel Coding: Turbo Codes and Low-Density Parity Check (LDPC) Codes

- Turbo Codes
- Low-Density Parity Check (LDPC) Codes
- Appendix 8A: The Sum of Log-Likelihood Ratios
- Appendix 8B: Using Bayes' Theorem to Simplify the Bit Conditional Probability
- Appendix 8C: Probability that a Binary Sequence Contains an Even Number of Ones
- Appendix 8D: Simplified Expression for the Hyper...e Natural Log of a Ratio of Binary Probabilities
- Appendix 8E: Proof that ?(x) = ?–1(x)
- Appendix 8F: Bit Probability Initialization
- References
- Problems
- Questions

Chapter 10: Modulation and Coding Trade-Offs

- Goals of the Communication System Designer
- Error-Probability Plane
- Nyquist Minimum Bandwidth
- Shannon–Hartley Capacity Theorem

- Bandwidth-Efficiency Plane
- Modulation and Coding Trade-Offs
- Defining, Designing, and Evaluating Digital Communication Systems
- Bandwidth-Efficient Modulation
- Trellis-Coded Modulation
- Conclusion
- References
- Problems
- Questions

Chapter 11: Synchronization

- Receiver Synchronization
- Synchronous Demodulation
- Loop Filters, Control Circuits, and Acquisition
- Phase-Locked Loop Timing Recovery
- Frequency Recovery Using a Frequency-Locked Loop (FLL)
- Effects of Phase and Frequency Offsets
- Conclusion

- References
- Problems
- Questions

Chapter 12: Multiplexing and Multiple Access

- Allocation of the Communications Resource
- Multiple-Access Communications System and Architecture
- Access Algorithms
- Multiple-Access Techniques Employed with INTELSAT
- Multiple-Access Techniques for Local Area Networks
- Conclusion
- References
- Problems
- Questions

Chapter 13: Spread-Spectrum Techniques

- Spread-Spectrum Overview
- Pseudonoise Sequences
- Direct-Sequence Spread-Spectrum Systems

- Frequency-Hopping Systems
- Synchronization
- Jamming Considerations
- Commercial Applications
- Cellular Systems
- Conclusion
- References
- Problems
- Questions

Chapter 14: Source Coding

- Sources
- Amplitude Quantizing
- Pulse Code Modulation
- Adaptive Prediction
- Block Coding
- Transform Coding
- Source Coding for Digital Data

- Examples of Source Coding
- Conclusion
- References
- Problems
- Questions

Chapter 15: Fading Channels

- The Challenge of Communicating over Fading Channels
- Characterizing Mobile-Radio Propagation
- Signal Time Spreading
- Time Variance of the Channel Caused by Motion
- Mitigating the Degradation Effects of Fading
- Summary of the Key Parameters Characterizing Fading Channels
- Applications: Mitigating the Effects of Frequency-Selective Fading
- Conclusion
- References
- Problems
- Questions

Chapter 16: The ABCs of OFDM (Orthogonal Frequency-Division Multiplexing)

- What Is OFDM?
- Why OFDM?
- Getting Started with OFDM
- Our Wish List (Preference for Flat Fading and Slow Fading)
- Conventional Multi-Channel FDM versus Multi-Channel OFDM
- The History of the Cyclic Prefix (CP)
- OFDM System Block Diagram
- Zooming in on the IDFT
- An Example of OFDM Waveform Synthesis
- Summarizing OFDM Waveform Synthesis
- Data Constellation Points Distributed over the Subcarrier Indexes
- Hermitian Symmetry
- How Many Subcarriers Are Needed?
- The Importance of the Cyclic Prefix (CP) in OFDM
- An Early OFDM Application: Wi-Fi Standard 802.11a
- Cyclic Prefix (CP) and Tone Spacing

- Long-Term Evolution (LTE) Use of OFDM
- Drawbacks of OFDM
- Single-Carrier OFDM (SC-OFDM) for Improved PAPR Over Standard OFDM
- Conclusion
- References
- Problems
- Questions

Chapter 17: The Magic of MIMO (Multiple Input/Multiple Output)

- What is MIMO?
- Various Benefits of Multiple Antennas
- Spatial Multiplexing
- Capacity Performance
- Transmitter Channel-State Information (CSI)
- Space-Time Coding
- MIMO Trade-Offs
- Multi-User MIMO (MU-MIMO)
- Conclusion

- References
- Problems
- Questions

Chapter 18: Encryption and Decryption

- Models, Goals, and Early Cipher Systems
- The Secrecy of a Cipher System
- Practical Security
- Stream Encryption
- Public Key Cryptosystems
- Pretty Good Privacy
- Conclusion
- References
- Problems
- Questions

Chapter 19: Appendix A: A Review of Fourier Techniques

- Signals, Spectra, and Linear Systems

- Fourier Techniques for Linear System Analysis
- Fourier Transform Properties
- Useful Functions
- Convolution
- Tables of Fourier Transforms and Operations
- sampled data fourier transform

Chapter 20: Appendix B: Fundamentals of Statistical Decision Theory

- Bayes' Theorem
- Decision Theory
- Signal Detection Example

Chapter 21: Appendix C: Response of Correlators to White Noise

Chapter 22: Appendix D: Often-Used Identities

Chapter 23: Appendix E: s-Domain, z-Domain, and Digital Filtering

- The Laplace Transform
- The z-transform
- Digital Filtering

- Finite Impulse Response Filter Design
- Infinite Impulse Response Filter Design

Chapter 24: Appendix F: OFDM Symbol Formation with an N-Point Inverse Discrete Fourier Transform (IDFT)

Chapter 25: Appendix G: List of Symbols

7. Practice Test

Here's what you get

Features

Each question comes with detailed remediation explaining not only why an answer option is correct but also why it is incorrect.

Unlimited Practice

Each test can be taken unlimited number of times until the learner feels they are prepared. Learner can review the test and read detailed remediation. Detailed test history is also available.

Each test set comes with learn, test and review modes. In learn mode, learners will attempt a question and will get immediate feedback and complete remediation as they move on to the next question. In test mode, learners can take a timed test simulating the actual exam conditions. In review mode, learners can read through one item at a time without attempting it.

8. Performance Based Labs

uCertify's performance-based labs are simulators that provides virtual environment. Labs deliver hands on experience with minimal risk and thus replace expensive physical labs. uCertify Labs are cloud-based, device-enabled and can be easily integrated with an LMS. Features of uCertify labs:

- Provide hands-on experience in a safe, online environment
- Labs simulate real world, hardware, software & CLI environment
- Flexible and inexpensive alternative to physical Labs
- Comes with well-organized component library for every task
- Highly interactive - learn by doing
- Explanations and remediation available
- Videos on how to perform

Lab Tasks

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