Course Description of Relevant Courses

<table>
<tr><td>Instructor</td><td colspan="2">Prof. Si-Yu Chen</td><td>University</td><td colspan="2">National Central University</td></tr>
<tr><td>Course Title:</td><td colspan="2">Introduction to Computer Science</td><td>Semester: 1</td><td>Year:</td><td>2013</td></tr>
<tr><td>Credits</td><td>2</td><td>Bachelor year 1</td><td colspan="2">Hours of Lectures:</td><td>36</td></tr>
<tr><td colspan="6">Overview:
1. Codes and Number Systems
2. Boolean Logic
3. Introduction to Computer Architecture
4. Introduction to Operating Systems
5. Data and File structures
6. Introduction to C++
7. Input and Output
8. Decision
9. Iteration – while, for loop
10. Function
11. Array</td></tr>
<tr><td colspan="6">Objectives:
Help students obtain the basic knowledge of computer, including computer architecture, data manipulation & abstraction, operating system, etc. Introduce common tools for CS programming such as C++.</td></tr>
<tr><td colspan="6">Assessment:
Quizzes: 20%
Homework: 20%
Two midterm exams: 35%
Final exam: 25%</td></tr>
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Instructor	Prof. Yi-Chang Lu		**University**		National Taiwan University	
Course Title	Computer Architecture		**Semester:**	1	**Year:**	2016
Credits	3	Bachelor year 4	**Hours of Lectures:**		54	

Overview:

1. Computer Abstractions and Technology
2. Instructions: Language of the Computer
3. Arithmetic for Computers
4. The Processor
5. Large and Fast: Exploiting Memory Hierarchy
6. Parallel Processors from Client to Cloud

Textbook:

D. A. Patterson and J. L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, 5th Edition

Objectives:

This course gives a thorough presentation on the design of modern digital computer systems and their hardware and software interfaces.

Assessment:

Homeworks: 20%
Midterm Exam: 25%
Final Exam: 30%
Final Project: 25%

Instructor	Prof. Jyh-Shing Jang		**University**		National Taiwan University	
Course Title	Data Structures and Algorithms		**Semester:**	2	**Year:**	2016
Credits	3	Bachelor year 1	**Hours of Lectures**		54	

Overview:

Good program comes from appropriately using the "resources" on the computer. There are two types of key resources: computational units (CPU, FPU, etc.) and storage units (memory, disk, etc., along with channels and networks). Data Structures and Algorithms discuss how to use those two types of resources suitably and effectively. Traditionally, data structures aim at the use of storage units, while algorithms aim at the use of computational units. But the two aims are actually inseparable: succinct data structures require coupling with corresponding algorithms; efficient algorithms require coupling with corresponding data structures. The course, designed as a required course for NTU CSIE students in the freshman year, introduces basic data structures and their corresponding algorithms. We will move from the concrete side of implementing basic data structures to the abstract side of analyzing the complexity of storage and computation.

1. Intro to Data Structures and Algorithms
2. C++ primer
3. Arrays, Linked lists, Recursion
4. Analysis tools, Tripe
5. Stacks, Queues, Deques
6. List and Iterator
7. Trees
8. Heaps and Priority Queues
9. Hash Tables, Maps, Skip Lists
10. Strings, Dynamic Programming
11. Graph Algorithms
12. Sorting, Sets, Selection
13. Search Trees

Textbook:

Data Structures and Algorithms in C++, 2nd edition by Goodrich, Tamassia, and Mount.

Objectives:

Use software to synergize two resources effectively

- Computation: CPU, GPU, etc.
- Storage: memory, disk, network, etc.

Assessment:

Quizzes: ~20%
Homework: ~30%
Midterm exam: ~20%
Final exam: ~30%
10% for course participation

Instructor	Prof. Yuh-Dauh Lyuu		**University**		National Taiwan University	
Course Title	Discrete Mathematics		**Semester:**	2	**Year:**	2016
Credits	3	Bachelor year 2	**Hours of Lectures:**		54	

Overview:

This course is on discrete mathematics. It covers combinatorics, boolean logic, computation theory, analysis of algorithms, probability, algebra, number theory, graph theory, set theory, and many other fields. Parts of the book should have been covered in high school and will be skipped or only briefly reviewed. I have in mind basic combinatorics, logic, and basic set theory.

Chapter 1 Fundamental Principles of Counting
Chapter 2 Fundamentals of Logic
Chapter 3 Set Theory
Chapter 4 Properties of Integers: Mathematical Induction
Chapter 5 Relations and Functions
Chapter 7 Relations: The Second Time Around
Chapter 8 The Principle of Inclusion and Exclusion
Chapter 9 Generating Functions
Chapter 10 Recurrence Relations
Chapter 11 An Introduction to Graph Theory
Chapter 12 Trees
Chapter 13 Optimization and Matching
Chapter 14 Rings and Modular Arithmetic
Chapter 16 Groups, Coding Theory, and Polya's Method of Enumeration
Chapter 17 Finite Fields and Combinatorial Designs

Textbook:

Ralph P. Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th ed.,

Objectives:

This course prepares students for foundations of computer science and analysis of algorithms. It is also useful for many applications of computers and mathematics, even social sciences.

Assessment:

Homework: 40%
Midterm exam: 30%
Final exam: 30%

Instructor	Prof. Tei-Wei Kuo		**University**		National Taiwan University	
Course Title	Operating Systems		**Semester:**	2	**Year:**	2016
Credits	3	Bachelor year 3	**Hours of Lectures:**		54	

Overview:

1. Introduction
2. Computer-System Structures
3. Operating-System Structures
4. Processes
5. Threads
6. CPU Scheduling
7. Process Synchronization
8. Deadlocks
9. Memory Management
10. Virtual Memory
11. File Systems

Textbook:

Silberschatz, Galvin, and Gagne, "Operating System Concept," 7th Edition, John Wiley & Sons, Inc. (Asia Edition)

Objectives:

The goal of the course is to present the concepts and algorithms that underlie operating systems. In addition, to help students better understand the operation of modern systems, the concepts and algorithms covered in the course are often based on those used in existing commercial operating systems. particular attention is paid to the microsoft family of operating systems and various versions of unix/linux**.**

Assessment:

Homework: 20%
Midterm exam: 40%
Final exam: 40%

Instructor	Prof. Hsueh-I Lu		**University**		National Taiwan University	
Course Title	Linear Algebra		**Semester:**	1	**Year:**	2017
Credits	3	Bachelor year 2	**Hours of Lectures:**		54	

Overview:

1. Matrices and Gaussian Elimination
2. Vector Space and Linear Equations
3. Orthogonality
4. Determinants
5. Eigenvalues and Eigenvectors
6. Positive Definite Matrices

Textbook:

Linear Algebra, S. H. Friedberg, A. J. Insel, and L. E. Spence, 4th edition.

Objectives:

Let students be familiar with basic concepts and fundamental theories of Linear Algebra as well as its applications.

Assessment:

Homework: 30%
Midterm exam: 40%
Final exam: 30%

Instructor	Prof. Hung-Yi Lee		**University**		National Taiwan University	
Course Title	Machine Learning		**Semester:**	1	**Year:**	2017
Credits	4	Advanced course	**Hours of Lectures:**		72	

Overview:

Machine learning allows computational systems to adaptively improve their performance with experience accumulated from the data observed. This course introduces the basics of learning theories, the design and analysis of learning algorithms, and some applications of machine learning.

1. Regression
2. Where does the error come from, Gradient Descent
3. Classification: Probabilistic Generative Model
4. Classification: Logistic Regression
5. Brief introduction of Deep Learning, Backpropagation
6. Tips for Deep Learning
7. Convolution Neural Network, Tensorflow
8. Recurrent Neural Network, Pytorch
9. Ensemble, Semi-supervised Learning, MXNET
10. Transfer Learning
11. Deep Reinforcement Learning
12. Unsupervised Learning: Linear Dimension Reduction
13. Unsupervised Learning: Word Embedding
14. Unsupervised Learning: Neighbor Embedding
15. Sequence-to-sequence and Attention
16. Unsupervised Learning: Deep Auto-encoder, Deep Generative Model
17. More about Reinforce Learning and New Progress in Deep Learning

[Website Link]

Textbooks:

1. Introduction to Machine Learning, 3rd edition, Ethem Alpaydin
2. Pattern Recognition and Machine Learing ,Christopher M.Bishop

Objectives:

The course is designed to prepare undergraduate students and junior graduate students with a solid background of machine learning and allow them to use machine learning techniques appropriately in their future research or industry projects.

Assessment:

Homeworks(10% each): 60%
Final Project: 40%

Instructor	Prof. Yun-Nung Chen		**University**		National Taiwan University	
Course Title	Algorithm Design and Analysis		**Semester:**	1	**Year:**	2017
Credits	3	Bachelor year 2	**Hours of Lectures:**		54	

Overview:

1. Algorithm Fundamentals: Introduction, Asymptotic Analysis
2. Algorithm Design Strategy: Divide-and-Conquer, Dynamic Programming, Greedy Algorithms
3. Algorithm Analysis: Amortized Analysis, NP Completeness
4. Graph and Selected Topics: Graph Algorithms, Others

[Website Link]

Textbook:

Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein. Introduction to Algorithms. 3rd edition, MIT Press, 2009

Objectives:

After taking this course, you should be able to

1. Design correct and efficient algorithms
2. Implement the designed algorithms
3. Prove the correctness of algorithms
4. Analyze the complexity of algorithms

Assessment:

1. Homework Assignments (40%):
   - 4 in total; once per 2-3 weeks
   - Programming problems
   - Non-programming problems
2. Mini-homework (10%)
   - Once every week
   - Due before the next week class
3. Midterm (20%)
   - Course content before midterm
4. Final (25%)
   - All course content
5. Class Participation (5%)
   - Asking questions during the class
   - Providing opinions during class discussion
   - Going to office hours
   - Helping your peers

Instructor	Prof. Ai-Chun Pang		**University**		National Taiwan University	
Course Title	Computer Networks		**Semester:**	1	**Year:**	2017
Credits	3	Bachelor year 3	**Hours of Lectures:**		54	

Overview:

1. Introduction: Get "feel" and terminology
2. Application Layer: Popular application-level protocols
3. Transport Layer: Reliable data transfer and congestion control
4. Network Layer: Data forwarding and routing
5. Data Link Layer: Medium access control

Textbook:

Computer Networking: A Top Down Approach Featuring the Internet, 6th edition, Jim Kurose and Keith Ross, Addison-Wesley

Objectives:

This course will cover the basic principles of networking with a focus on protocols, implementations, and issues specific to the Internet. We will selectively implement new protocols and network services; In addition, we will discuss new ideas and issued published in recent network papers in SDN, 5G/B5G, ….

Assessment:

Midterm exam: 30%
Final exam: 30%
Programming Assignments: 30%
Attendance: 10%

Instructor	Prof. Tony Tan		**University**		National Taiwan University	
Course Title	Formal Languages and Automata Theory		**Semester:**	1	**Year:**	2017
Credits	3	Bachelor year 3	**Hours of Lectures:**		54	

Overview:
The purpose of this course is to introduce the finite automata theory and formal language. A formal treatment of the subjects will be emphasized and the students will be more comfortable with formal proofs and will be more mature in mathematical reasoning.

Objectives:
Lesson 1. Preliminaries
Lesson 2. Deterministic finite state automata
Lesson 3. Nondeterministic finite state automata
Lesson 4. Regular expressions
Lesson 5. Context-free languages
Lesson 6. Pumping lemma and push-down automata
Lesson 7. CFG = PDA
Lesson 8. Turing machines and decidable languages
Lesson 9. Variants of Turing machines
Lesson 10. Universal Turing machines and Halting problem
Lesson 11. Reducibility
Lesson 12. Time and space complexity
Lesson 13. NP-complete problems
Lesson 14. NLog- and PSPACE-complete problems
[Website Link]

Textbook:
1. Introduction to Theory of Computation by M. Sipser.
2. Introduction to Automata Theory, Languages, and Computation by J. Hopcroft and J. Ullman, 1st edition.

Assessment:
Four assignments weigh 10% each
The midterm and final exams weigh 30% each

Instructor	Prof. Shih-Hao Hung		**University**		National Taiwan University	
Course Title	Computer Architecture		**Semester:**	1	**Year:**	2017
Credits	3	Bachelor year 3	**Hours of Lectures:**		54	

Overview:
Prerequisite: Assembly Language, C Language, Logic Design.
Students are required to attend a 3-hour lecture every week, complete 5 homework assignments, midterm exam, and final exam.

This course provides a basic introduction to the fundamentals of current computer designs. It focuses on the border between hardware and software. The course first gives an overview of the computer systems and a discussion of performance. The ARM assembly instruction set is used to discuss the hardware-software interface of a computer. Then, the major components in a modern computer system are discussed in further details, including the design of processors, memory, storage, I/O, multicore, and clusters.

Textbook:
Computer Organization and Design, 5th edition: The Hardware/Software Interface (The Morgan Kaufmann Series in Computer Architecture and Design)

Objectives:
This course provides a basic introduction to the fundamentals of current computer designs. It provides the knowledge and analytic skills for student to understand a modern computer system.

Assessment:
Homeworks: 30%
Class Participation: 10%
Midterm Exam: 30%
Final Exam: 30%

Instructor	Prof. Ming Ouhyoung		**University**		National Taiwan University	
Course Title	Virtual Reality		**Semester:**	2	**Year:**	2017
Credits	3	Advanced course	**Hours of Lectures:**		54	

Overview:

Part I: Virtual Reality

1. Look real, sound real, feel real, smell real, react realistically and in real-time
2. 3D Sound, directional sound
3. Environment Walkthrough, Distributed Interactive Simulation (DIS)
4. Tracking devices: space tracker, tracking algorithms
5. Immersive display: Head Mounted Display, BOOM, Stereo shutter glasses
6. Force Feedback Devices (Joystick, PHANToM etc.)
7. Trajectory prediction algorithms

Part II: Display and Visualization

1. Modeling (Solid modeling, build large models, physically based modeling, motion dynamics)
2. Global illumination algorithms (radiosity, volume rendering, scientific sualization)
3. Texture mapping and advanced animation
4. Graphics packages: OpenGL (X window, WinXP), DirectX (WinXP)

Part III: Hardware and accelerators

1. High performance graphics architectures (Pixel-Planes, Pixel Machine, SGI reality engine, PC Graphics (NVIDIA, ATI), Accelerator Chips & Cards)

Part IV: Virtual reality paper survey and term project

Textbook:

Understanding Virtual Reality: Interface, Application, and Design (The Morgan Kaufmann Series in Computer Graphics), William Sherman, Alan Craig

Objectives:

1. To understand VR technology.
2. Can do a VR project, including writing a software that can be executed in a NB or mobile smartphone/Pad (Apple or Android).
3. Can read related papers and comments on the pros and cons of these papers.

Virtual reality (VR), the use of computer modeling and simulation that enables a person to interact with an artificial three-dimensional (3-D) visual or other sensory environment. VR applications immerse the user in a computer-generated environment that simulates reality through the use of interactive devices, which send and receive information and are worn as goggles, headsets, gloves, or body suits. In a typical VR format, a user wearing a helmet with a stereoscopic screen views animated images of a simulated environment. The illusion of “being there” (telepresence) is affected by motion sensors that pick up the user’s movements and adjust the view on the screen accordingly, usually in real time (the instant the user’s movement takes place). Thus, a user can tour a simulated suite of rooms, experiencing changing viewpoints and perspectives that are convincingly related to his own head turnings and steps. Wearing data gloves equipped with force-feedback devices that provide the sensation of touch, the user can even pick up and manipulate objects that he sees in the virtual environment.

Assessment:

Homework: 40%
Midterm exam: 30%
Final project: 30%

Instructor	Prof. Ming Ouhyoung		**University**		National Taiwan University	
Course Title	Digital Systems Design and Laboratory		**Semester:**	2	**Year:**	2017
Credits	3	Bachelor year 2	**Hours of Lectures:**		54	

Overview:

1. Digital System Labs
2. Introduction to Boolean Algebra and Digital System Design
3. The Process of Design, Rapid Electronic System Prototyping
4. Minimization of Boolean Function
5. Combinational Circuits
6. Programmable and Steering Logic
7. Sequential Logic Design (Reverse Engineering and Forward Design)
8. Finite State Machine Design, Hardware Description Languages
9. Case Study (ALU design, Memory Control, etc.)
10. Programming Language VHDL and verilog

Textbook:

C. H. Roth, Jr. and L. Kinney, Fundamentals of Logic Design, International Edition, paper back.

Objectives:

Expected capabilities after taking this course:

1. Understand the Digital System Design principles
2. Can write a program for Reverse Engineering (Read a circuit from the System Design, and explain its function, by a program)
3. Can write a program for Forward Design (Read a finite automata or finite state machine, then generate the circuits with logic gates)

Assessment:

Labs & Homework: 33%
Midterm: 33%
Final Exam: 34%

Instructor	Prof. Yi-Ping Hung		**University**		National Taiwan University	
Course Title	Probability		**Semester:**	2	**Year:**	2017
Credits	3	Bachelor year 2	**Hours of Lectures:**		54	

Overview:

1. Introduction: Mean, Variance, Standard Deviation; Axioms and Properties of Probability; Methods of Enumeration; Condition Probability; Independent Events; Bayes' Theorem

2. Discrete Distributions: Random Variables of Discrete Type; Mathematical Expectation; Moment Generating Function; Bernoulli Trials and Binomial Distribution; Geometric and Negative Binomial Distribution; The Poisson Distribution

3. Continuous Distributions: Random Variables of the Continuous Type; Exponential, Gamma, and Chi-square Distributions; Normal Distribution; Additional Models

4. Bivariate Distributions: Bivariate Distributions of the Discrete Type; Correlation Coefficient; Conditional Distributions; Bivariate Distributions of the Continuous Type; Bivariate Normal Distributions

5. Distributions of Functions of Random Variables: Function of One Random Variable; Transformations of Two Random Variables; Several Random Variables; Moment-Generating Function Technique; Random Functions Associated with Normal Distribution; Central Limit Theorem; Approximations for Discrete Distributions; Chebyshev's Inequality and Convergence in Probability – Law of Large Numbers

Textbook:

R.V. Hogg and E. A. Tanis, D. L. Zimmerman, Probability and Statistical Inference, 9th ed., Pearson, 2015

Objectives:

This course will give a mathematical introduction to Probability. It will also cover some basic topics and methods in Statistics.

Assessment:

One Final exam: 40%
Two midterm exams: 30%
Homework assignments: 25%
In-class performance: 5%

Instructor	Prof. Yung-Yu Chuang		**University**		National Taiwan University	
Course Title	Special Research		**Semester:**	2	**Year:**	2017
Credits	2	Bachelor year 3	**Hours of Lectures:**		36	

Overview:

This course aims at studying a certain paper and implementing the concept of the paper. Students are required to attend a meeting once a week to present the implementing progress. Also, Python programming ability and Machine Learning knowledge are the prerequisite for taking this course, since most topic are related to the applications of Machine Learning.

Objectives:

1. Cultivate the ability to realize scientific papers in Computer Science
2. Implement the concept of the papers
3. Present the results of the research project

Assessment:

2 Presentations: 80%
Participation: 20%