VIET NAM NATIONAL UNIVERSITY – HO CHI MINH CITY
UNIVERSITY OF SCIENCE
FACULTY OF INFORMATION TECHNOLOGY
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COURSE DESCRIPTIONS

BACHELOR OF SCIENCE
Advanced Program in Computer Science

Ho Chi Minh City – March 2021

TABLE OF CONTENT

VIET NAM NATIONAL UNIVERSITY
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Independence - Freedom - Happiness
_____o 0 o_____

CS161 – Introduction to Computer Science I

❖ General information

- Course ID : **CS161**
- Knowledge block : **Compulsory – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

This course is designed to introduce students to problem solving by programming in C++. Programming fundamentals include program structure, assignment, data types, repetition, input/output, flow of control, and functions. Program design development and testing is emphasized. The course focuses on problem solving and the introduction to C++ programming using built-in data types, string, array and selection, and repetition structures. Students will learn and understand the standard input/output, selection and repetition control structures, user-defined functions, user-defined simple data types, string data type, and arrays. Students also learn how to store data into text files on external storage.

❖ Course goals

At the end of the course, students are able to

- Work independently or cooperate with other members in a group to solve programming problems
- Distinguish the English terminologies
- Demonstrate the understanding of the standard input/output, selection and repetition, functions, strings, arrays, structs, and text files.
- Apply the built-in data types, string, array and struct to solve programming problems in C++

❖ Course content

- Introduction to Computer Science
- Introduction to problem solving, algorithm and programming with C++ (variables, statements, general form of a C++ program, standard input/output etc.)
- Selective execution: operator precedence, logical structures, if control statement...
- Repetition (while, do...while, for)
- Functions: independent modules, functions with and without arguments
- Midterm

- Working with character strings and arrays of elements
- Working with external storage and manipulating data stored in text files
- Structures
- Review

❖ **Resources**

Textbooks

- C++ Primer Plus, Stephen Prata, SAMS.
- Absolute C++, Sixth Edition, by Walter Savitch, Addison Wesley.

Others

- The C++ Programming Language, Bjarne Stroustroup.
- Nhập môn lập trình (in Vietnamese), Tran Dan Thu et. al.

Tools

- N/A

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_____o 0 o_____

CS162 – Introduction to Computer Science II

❖ General information

- Course ID : **CS162**
- Knowledge block : **Compulsory – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Introduction to Computer Science I**

❖ Course description

The course is the continuation of the Introduction to Computer Science I (CS161). It is designed to teach students arrays, pointers, linked list, file handling and an introduction to object-oriented programming. The course focuses on dynamic data structures, such as dynamically allocated arrays, linked lists (singly, doubly, and circular), stacks and queues. Students will also learn about recursion and how to read and write data to binary files.

❖ Course goals

At the end of the course, students are able to

- Work independently or cooperate with other members in a group to solve programming problems
- Distinguish the English terminologies
- Demonstrate the understanding of the characteristics and the implementation of dynamic data structures (array, linked list, stack and queue) and recursion
- Apply the dynamic data structures and recursion to solve programming problems

❖ Course content

- Overview of the course & review CS161
- Arrays and Struct
- Program Design Methodology & ADT
- Dynamic memory and pointers
- Singly linked list
- Other types of linked lists (doubly, circular, and non-linear list)
- Midterm
- Stack and Queue
- Recursion
- Binary File
- Review for the final exam

❖ Resources

Textbooks

- Starting Out with C++: From Control Structure to Objects, 9th edition, Gaddis, Tony, Scott/Jones Publisher, Inc, 2017.
- C++ Primer Plus, Stephen Prata, SAMS, 2011.

Others

- The C++ Programming Language, Bjarne Stroustroup, 2013.
- Nhập môn lập trình (in Vietnamese), Tran Dan Thu et. al.
- Kỹ thuật lập trình (in Vietnamese), Tran Dan Thu et. al.

Tools

- N/A

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CS163 – Data Structures

❖ General information

- Course ID : **CS163**
- Knowledge block : **Compulsory – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Introduction to Computer Science II**

❖ Course description

The course is designed to teach students popular data structures used in computer programming, including hash table, linked lists (singly, doubly, and circular), stacks, queues, trees (binary tree, binary search tree, 2-3 tree, 2-3-4 tree, B-tree, AVL tree, and graphs. It also provides students knowledge on basic algorithms, such as sorting, searching, recursion and hashing. The course will focus on the implementation of various algorithms and data structures. The students are introduced the performance and the efficiency of the program based on different data structures used.

❖ Course goals

At the end of the course, students are able to

- Work independently or cooperate with other members in a group to solve programming problems
- Distinguish the terminologies and understand the description of the data structures in English
- Demonstrate the understanding of the characteristics and the implementation of each data structure
- Apply the data structures to solve programming problems
- Apply different data structures together to solve a complex project with a holistic view

❖ Course content

- Introduction to CS163
- Table Abstractions & Hashing
- Introduction to Trees, Binary Trees
- Binary Search Trees, 2-3 Tree, B-Tree
- 2-3-4, AVL, and Red-Black tree
- Heap structure
- Review& Midterm
- Graph: Bread-First Search, Depth-First Search, Adjacency Matrix/List

- Graph (cont.): Minimum Spanning Tree, Shortest Path (Dijkstra), Eulerian cycle, Hamiltonian cycle
- Sorting: Insertion, Selection, Bubble, Radix Sort, MergeSort, QuickSort
- Review for the final exam

❖ **Resources**

Textbooks

- Data Structures and Program Design in C++, Robert L. Kruse and Alexander J. Ryba, Prentice Hall

Others

- Data Structures and Algorithm Analysis in C++, Mark Allen Weiss.
- C++ plus Data Structures 3rd Ed, Nell Dale.

Tools

- N/A

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CS201 – Computer Systems Programming

❖ General information

- Course ID : **CS201**
- Knowledge block : **Compulsory – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Introduction to Computer Science I, Introduction to Computer Science II**

❖ Course description

The course is an introduction to computer systems from a software perspective. Topics include: Basic machine organization; System programming using C and assembly language; Introduction to system programming tools (gcc, makefile, gdb); Data representation (bits & bytes, characters, integers, floating point numbers), Implementation of control flow, procedure class, and complex data types at machine level; Linking and loading; Exceptions and interrupts; Process control and signals; System calls, File I/O; Timing and improving program performance; Introduction to memory hierarchy, dynamic memory allocation techniques.

❖ Course goals

At the end of the course, students are able to

- Explain common bit-level representations of numeric values (unsigned, two's complement, floating point) and the consequent mathematical properties of arithmetic and bit level operations on them
- Recognize the relation between programs expressed in C and in assembly code, including the implementation of expressions, control, procedures, and data structures
- Demonstrate ability to understand basic intention of a program through its binary representation and apply these skills to debugging programs
- Explain the concepts of computer memory and how it works, analyze the consequences of imperfect system usage, such as poor memory and CPU performance and apply to write better and faster programs

❖ Course content

- Introduction
- Bits and Bytes
- Integers and Floating points
- Machine Programming: Basics and Control
- Machine Programming: Procedures

- Review
- Midterm Exam
- Machine Programming: Array and data
- Machine Programming: Advanced topics
- Memory Hierarchy
- Cache Memories
- Virtual Memory (optional)
- Review

❖ **Resources**

Textbooks

- Computer Systems: A programmer's Perspective by Bryant O'Hallaron (main)

Others

- Digital Design and Computer Architecture by David Money Harris & Sarah L.Harris (reference)

Tools

- N/A

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CS202 – Programming Systems

❖ General information

- Course ID : **CS202**
- Knowledge block : **Compulsory – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Introduction to Computer Science II**

❖ Course description

The course is designed to provide students the object-oriented concepts, problem analysis, design and solving. The course helps students to differentiate between procedural programming and object-oriented programming. Students are also introduced and instructed with more advanced C++ concepts and features such as class, inheritance, polymorphism, operator overloading, templates, exception handling, and some design patterns. In particular, students could describe key object-oriented concepts, such as encapsulation, data hiding, inheritance and dynamic binding, and are able to solve problems using object-oriented programming. In addition, students are also guided to work in groups on a substantial computer program during the term, providing a user's manual and external design documentation. Students are also gained reading comprehension skills and learn to write simple reports in English.

❖ Course goals

At the end of the course, students are able to

- Work independently or in groups to solve problems using object-oriented concepts.
- Perform reading comprehension skills, write and present simple reports in English
- Use object-oriented, analysis and design concepts to solve real-world problems.
- Comprehend the OOP concepts: class, object, data hiding, encapsulation, inheritance, dynamic binding...
- Describe the key differences between C++, C#, and Java on some OOP topics
- Solve problems in C++ using OOP

❖ Course content

- Introduction to Object-Orient Concepts and Programming
- Class, constructors and destructor
- Operator overloading
- Inheritance
- Inheritance and polymorphism
- Const correctness & Review

- Midterm
- Templates and meta-programming
- Exception handling & RAII
- Standard template library (STL): vector, string, streams
- Design patterns: Singleton, Composite
- Review for the final exam

❖ **Resources**

Textbooks

- C++ Primer Plus, Stephen Prata, 6th edition, Addison-Wesley, 2011.

Others

- The C++ Programming Language, Bjarne Stroustroup.
- Design Patterns: Elements of Reusable Objected-Oriented Software, Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, Addison-Wesley, 1995.
- Effective Modern C++: 42 Specific Ways to Improve Your Use of C++11 and C++14 1st Edition, Scott Meyers, O'Reilly Media, Incorporated, 1st edition, 2014.
- Phương pháp lập trình hướng đối tượng, Trần Đan Thư, Đinh Bá Tiến, Nguyễn Tấn Trần Minh Khang, Nhà xuất bản Khoa học và Kỹ thuật, 2018.

Tools

- Visual Studio C++
- Dev C/C++

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_____o 0 o_____

CS250 – Discrete Structures I

❖ General information

- Course ID : **CS250**
- Knowledge block : **Compulsory – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

The course is designed to help students study fundamental mathematical structures and logical principles that are essential to computer science. Discrete Structures is the study of mathematical structures that are countable or otherwise distinct and separable. The topics covered include logic, mathematical proofs, set theory, functions, counting, recursion, relations, graphs, and trees.

❖ Course goals

At the end of the course, students are able to

- Explain propositional logic and mathematical proofs
- Perform operations on sets and functions
- Use mathematical induction to prove mathematical statements
- Apply methods of combinatorics and recursive relations to solve counting problems
- Identify and understand relations and their properties
- Explain basic concepts and algorithms of graphs and trees and apply them in real-world problems

❖ Course content

- Propositional Logic
- Propositional Equivalences
- Predicates and Quantifiers
- Rules of Inference
- Introduction to Proofs
- Quiz 1
- Sets
- Functions
- Mathematical Induction
- Strong Induction
- Recursive Definitions

- The Basics of Counting
- Permutations and Combinations
- Generalized Permutations and Combinations
- Recurrence Relations
- Midterm Exam
- Relations and Their Properties
- Representing Relations
- Equivalence Relations
- Partial Orderings
- Quiz 2
- Graphs: Definitions and Basic Properties
- Euler and Hamilton Paths
- Shortest-Path Problems
- Introduction to Trees
- Tree Traversal
- Spanning Trees

❖ **Resources**

Textbooks

- K. H. Rosen, Discrete Mathematics and Its Applications, 8th ed., McGraw Hill, 2019.
- Stein, Drysdale and Bogart, Discrete Mathematics for Computer scientists, Addison-Wesley, 2010.

Tools

- Computation software: Maple

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_____o 0 o_____

CS300 – Elements of Software Engineering

❖ General information

- Course ID : **CS300**
- Knowledge block : **Compulsory – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Basic application programming skills**

❖ Course description

This course is one of the first courses in software engineering. This course introduces basic concepts, principles, practices, methods, and tools in software engineering. It covers core elements of the software development lifecycle, including software requirements, analysis & design, implementation, testing, integration, maintenance, and management. The students will also have opportunities to apply software engineering principles, methods, techniques, and tools by working on multi-person teams to develop and deliver software products.

❖ Course goals

At the end of the course, students are able to

- Understand basic concepts, principles, methods, and techniques in software engineering
- Be able to apply requirements engineering concepts to define system requirements
- Be able to analyze and design a software system
- Be able to design and write a test plan and test cases for a software system
- Be able to apply software testing techniques to test a software system
- Be able to determine a suitable process for a software project based on its characteristics
- Ability to practice project management activities
- Ability to practice teamwork

❖ Course content

- Class introduction.
- Introduction to software engineering
- Software processes
- Project management
- Software configuration management
- Software requirements
- Requirements engineering
- Software analysis and design 1

- Software analysis and design 2
- User interface design
- Software reuse
- Verification and Validation
- Software testing
- Review
- Project presentation

❖ **Resources**

Textbooks

- Software Engineering, 9th Edition (8th Edition is also OK) , Ian Sommerville, Addison-Wesley, 2010, ISBN-13: 978-0137035151

Others

- The Mythical Man-Month, F. Brooks, Addison-Wesley, 1995, ISBN 0-2-1083595-9

Tools

- N/A

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_____o 0 o_____

CS305 – Social, Ethical, and Legal Issues

❖ General information

- Course ID : **CS305**
- Knowledge block : **Compulsory – Computer Science**
- Number of credits : **2**
  - Credit hours for theory : **20**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **15**
- Prior-course :

❖ Course description

The advancement of information technology has changed the way we leave, interact, and work. However, it also results in social, ethical, and legal issues that we have to address. This course will introduce students important social and professional issues related to information technology and provide opportunities for students to discuss real-world situations where social, ethical, and legal implications are relevant to the information technology profession.

❖ Course goals

At the end of the course, students are able to

- Recognize social, ethical, and legal issues related to computing.
- Understand major ethical theories and apply them to reason social, ethical, and legal issues related to computing.
- Understand basic legal principles that may be applied to address legal issues.
- Recognize their responsibilities to adhere to the professional and ethical standards.
- Practice presentation skills through a talk on a topic related to social, ethical, and legal implications of computing.
- Research and write a professional-quality paper on a topic related to social, ethical, and legal implications of computing.

❖ Course content

- Class Introduction
- History of Computing
- Ethics
- Networking
- Technical Writing Tips
- Intellectual Property
- Computer & Network Security
- Privacy
- Computer Reliability

- Professional Ethics
- Notes on Presentation
- Students' presentations

❖ **Resources**

Textbooks

- Ethics for the Information Age (7th ed.), Michael Quinn. Pearson.

Others

- On Liberty and Utilitarianism, John Stuart Mill, Bantam Books, NY
- Philosophy of Science: A Very Short Introduction (2nd ed.), Samir Okasha, Oxford University Press
- Justice: What's the Right Thing to Do (reprint ed.), Michael Sandel, Farrar, Straus and Giroux
- Bàn về tự do, John Stuart Mill, NXB Tri Thuc (Vietnamese)
- Tự do kinh tế và chính thể đại diện, F. A. Hayek, NXB Tri Thuc (Vietnamese)
- Nền dân trị Mỹ, Alexis De Tocqueville, NXB Tri Thuc (Vietnamese)
- (Other books from the Book Reading Challenge).

Tools

- N/A

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_____o 0 o_____

CS333 – Introduction to Operating Systems

❖ General information

- Course ID : **CS333**
- Knowledge block : **Compulsory – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Computer Systems**

❖ Course description

This course covers the important problems in operating system design and implementation. It will also cover the tradeoffs that can be made between performance and functionality during the design and implementation of an operating system. Particular emphasis will be given to three major OS subsystems: process management (processes, threads, CPU scheduling, synchronization, and deadlock), memory management (segmentation, paging, swapping), and file systems; and on operating system support for distributed systems.

❖ Course goals

At the end of the course, students are able to

- Learn a lot of practical information about how programming languages, operating systems, and architectures interact and how to use each effectively.
- Learn about how concurrency and distributed systems communicate and work correctly
- Have knowledge to more effectively use and manipulate computers and computer program
- Team work & Independent thinking
- Understanding keywords

❖ Course content

- Overview
- A brief of History
- Architecture
- Processes and Threads
- Synchronnization
- CPU Schedule
- Memory management
- Virtual memory
- Disk
- File systems

- Review

❖ **Resources**

Textbooks

- Operating System Concepts 10th Edition, by Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Wiley; 10th edition (May 2, 2018), ISBN-10 : 1119456339, ISBN-13 : 978-1119456339

Tools

- Linux Operation System at https://github.com/torvalds/linux

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_____o 0 o_____

CS486 – Introduction to Database Systems

❖ General information

- Course ID : **CS486**
- Knowledge block : **Compulsory – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Discrete Mathematics**

❖ Course description

The course is designed to provide students the overview of the needs for databases in enterprises, as well as other organizations. The course will provide the background knowledge of database systems on where the relational model is emphasized. Moreover, the techniques, tools and skills are provided for students to design, manipulate, and exploit the database via a relational database management system. The course also mentions future trends in database systems research.

❖ Course goals

At the end of the course, students are able to

- Explain roles and basic concepts of a database in an information system
- Apply common data models for modeling data
- Master query languages to exploit the relational database
- Design a good database schema
- Describe how main components of Database Management System (DBMS) work
- Practice skills of building databases and queries in DBMS

❖ Course content

- Overview database system
- Entity relationship model
- Relational data model
- Query languages
- Integrity constraint
- Functional dependency and normal forms
- Transaction, scheduler and locking
- Recovery methods
- Other database issues

❖ **Resources**

Textbooks

- Database Systems: The Complete Book (2nd Edition), Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, Prentice Hall, 2008.
- Fundamentals of Database Systems (7th Edition), Ramez Elmasri, Shamkant B. Navathe, Addison Wesley, 2017.

Others

- Database system concepts (6th Edition), Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill, 2015.
- Database Management System (3rd Edition), Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill, 2009.

Tools

- MS SQL Server: T-SQL
- Visual studio.NET: C#, ASP.NET Framework

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_____o 0 o_____

ECE341 – Computer Hardware

❖ General information

- Course ID : **ECE341**
- Knowledge block : **Compulsory – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **System Programming**

❖ Course description

An overview of computer architecture and programming from a hardware viewpoint. Topics covered include: digital logic; arithmetic operations; pipelining; CISC/RISC; datapath design; memory hierarchy; virtual memory; input/output techniques; computer system components.
End Goal: To understand the hardware implementation of different components of a modern computer

❖ Course goals

At the end of the course, students are able to

- Apply digital logic gates, flip flops to build a function block.
- Describe basic functional units of computer.
- Conduct a basic computer architecture – data path, control, and buses
- Describe CISC & RISC architectures

❖ Course content

- Digital logic design
- Sequential logic
- Registers, Counters, FSM
- Decoders, Multiplexers, PLD
- Computer Arithmetic
- Fast Adders, Multipliers
- Basic Organization of Computers
- Basic Processing Unit
- Pipeline
- Memory System
- Cache Memory
- Basic Input/Output
- Direct Memory Access (DMA)

- Final Exam

❖ **Resources**

Textbooks

- Computer Organization and Embedded Systems, 6th Edition, Hamacher, Vranesic, Zaky and Manjikian. McGraw-Hill, 2011. ISBN 9780073380650 / 0073380652

Others

- Logic and computer design fundamentals, 5th Edition, Mano, Kime and Martin. Pearson, 2013. ISBN 9780133760637/0133760634
- Computer Organization and Design: the Hardware software interface, RISC-V Edition, Morgan Kaufmann, 2017. ISBN 9780128122754/0128122757

Tools

- N/A

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_____o 0 o_____

CS251 – Logical Structures

❖ General information

- Course ID : **CS251**
- Knowledge block : **Compulsory Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Discrete Structures**

❖ Course description

Logic has been called the "calculus of computer science": just as sciences such as physics that deal with continuous realm rely on calculus techniques, we rely on logic. Indeed, so many areas of computer sciences are based on logic: from designing circuits to determining complexity of problems; from verifying correctness of algorithms and devising database queries to automated reasoning in artificial intelligence.
This course is intended to be an introduction to mathematical logic with emphasis on Computer Science applications and methodologies. In particular, we will cover propositional and predicate logic. Throughout the course, we will discuss semantics in logic together with basic proof theory, again with computer science applications including proving algorithm correctness. If time permitted, we will also discuss impossibility results, in particular Goedel's incompleteness theorem.

❖ Course goals

At the end of the course, students are able to

- Have a rigorous background in logics for computer science.
- Understand the role of logics in computer science.
- Have a knowledge of a wide variety of applications of logics.
- Have a general understanding of the relationships of logics to other subjects in theoretical computer science.
- Able to apply logic as an abstract framework; first to understand and second, to improve or design computational models.

❖ Course content

- Declarative sentences
- Semantics of propositional logic
- Propositional logic as formal language
- Natural deduction
- Normal forms

- The need for a richer language
- Predicate logic as a formal language
- Semantics of predicate logic
- Proof theory of predicate logic
- Undecidability of predicate logic
- Exercises and Review

❖ **Resources**

Textbooks

- Logics in Computer Science – modelling and reasoning about systems, Second Edition, Michael Huth and Mark Ryan, Cambridge University Press.

Others

- Logic for Computer Science: Foundations of Automatic Theorem Proving, Second Edition, Jean H. Gallier, Dover Publications

Tools

- N/A

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CS311 – Computational Structures

❖ General information

- Course ID : **CS311**
- Knowledge block : **Compulsory Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Discrete Structures I Data Structures**

❖ Course description

This course provides a challenging introduction to some of the central ideas of theoretical computer science. The course formalizes the notion of computation, using 3 models of computation of increasing power: finite automata, push down automata, and Turing machines - a kind of automata that can define all the languages that can reasonably be said to be definable by any sort of computing device. The course also explains the relationship between these models and different classes of languages: regular, context-free, Turing-decidable (or recursive), and Turing-semidecidable (or recursively enumerable). These concepts form the core of natural language processing, compiler design, speech recognition, theory of programming languages, …

❖ Course goals

At the end of the course, students are able to

- Categorize the classes of automata, classes of formal grammars and classes of formal languages
- Analyze the strengths and the limitations of computational models
- Construct finite automata, regular expressions, push-down automata, context-free grammars, Turing machines
- Analyze properties of classes of formal languages
- Describe the role of the theory of automata and formal languages in computer science
- Describe and explain commonly used English terms in the field of theoretical computer science

❖ Course content

- Introduction to the course
- Introduction to the basic mathematics
- Introduction to automata and formal languages
- Finite automata: deterministic finite automata, nondeterministic finite automata, finite automata with epsilon transitions

- Regular expressions
- The equivalence between regular expressions and finite automata
- Properties of regular languages: pumping lemma, closure properties of regular languages
- Minimization of automata
- Context-free grammars and context-free languages
- Push-down automata and deterministic push-down automata
- Properties of context-free languages: pumping lemma for context-free languages
- Turing machines
- Church-Turing thesis
- The Chomsky Hierarchy and Beyond

❖ **Resources**

Textbooks

- Nguyễn Thanh Phương, Lý thuyết ngôn ngữ hình thức, NXB Khoa học và Kỹ thuật, 2018.

Others

- Hopcroft, J. E., Motwani, R., Ullman, J. D. Introduction to Automata Theory, Languages, and Computation, 3rd edition, Pearson, 2006.
- Linz, P. An Introduction to Formal Languages and Automata, 6th edition, Jones & Bartlett Learning, 2017.
- Sipser, M. Introduction to the Theory of Computation, 3rd edition, Cengage Learning, 2012.

Tools

- N/A

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CS320 – Principles of Programming Languages

❖ General information

- Course ID : **CS320**
- Knowledge block : **Compulsory Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **CS 202 Programming Systems Object-oriented programming, practical data structures, Java, CS 251 Data Structures II Mathematical logic and proofs, CS 311 Computational Structures Formal languages and grammars, automata and Turing machines**

❖ Course description

This course is about principles of programming languages
End Goal: Students learn the essentials of computer programming languages. Older languages such as Fortran, Pascal and Lisp will be mentioned, but main focus will be C++, Java, and C. Final goals is to enable students to make rational choices: Which language for a major SW project shall be selected. Conflicting goals general are: easy of design and coding, speed of execution, portability of source program, and reliability and security of running object programs.

❖ Course goals

At the end of the course, students are able to

- Understand programming language concepts
- Differentiate syntax, semantics, grammars
- Illustrate the features and characteristics of different programming paradigms, including procedural, functional, and object-oriented programming
- Describe and apply the basic concepts of type systems, including primitive types, compound, and recursive types, abstract data types, and type equivalence models
- Explain basic approaches and applications for the formalization of programming language semantics

❖ Course content

- Introduction, program overview
- Language syntax, associated semantics, grammars
- Interpreters and compilers
- Language paradigms, procedure, functional programming
- OO programming

- Binding, scope, types
- Functions and environments
- Type systems and type checking
- Formal semantics and program correctness
- Final Exam: In class, closed books, no phones or Internet

❖ **Resources**

Textbooks

- Kenneth C. Louden and Kenneth A. Lambert, Programming Languages: Principles and Practice, 3rd ed., Course Technology CENGAGE Learning, 2012.
- Ray Toal, Rachel Rivera, Alexander Scheider and Eileen Choe, Programming Language Explorations, Chapman and Hall/CRC; 1st edition (September 20, 2016).

Tools

- IDE (Windows and Linux-based Systems): https://visualstudio.microsoft.com/
- Text Editor (Linux based Systems): Vim, gedit

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CS350 – Algorithms and Complexity

❖ General information

- Course ID : **CS350**
- Knowledge block : **Compulsory Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Calculus I**

❖ Course description

This course introduces students to the analysis and design of computer algorithms. There are case studies of existing algorithms (sorting, searching, graph algorithms, dynamic programming, etc). Upon completion of this course, students will be able to do the following:

- Analyze the asymptotic performance of algorithms.
- Demonstrate a familiarity with major algorithms and data structures.
- Apply important algorithmic design paradigms and methods of analysis.
- Synthesize efficient algorithms in common engineering design situations.
- Apply algorithms, data structures, and programming skills to solve real problems.

❖ Course goals

At the end of the course, students are able to

- Prove the correctness of algorithms using inductive proofs.
- Analyze worst-case running times of algorithms using asymptotic analysis. Compare the asymptotic behaviors of functions obtained by elementary composition of polynomials, exponentials, and logarithmic functions. Describe the relative merits of worst-case, average-case, and best-case analysis.
- Analyze average case running times of algorithms whose running time is probabilistic.
- Explain the basic properties of randomized algorithms and methods for analyzing them. Explain the difference between a randomized algorithm and an algorithm with probabilistic inputs
- Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it. Synthesize divide-and-conquer algorithms. Derive and solve recurrences describing the performance of divide-and-conquer algorithms
- Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it. Synthesize dynamic-programming algorithms, and analyze them
- Describe the greedy paradigm and explain when an algorithmic design situation calls for it. Synthesize greedy algorithms and analyze them.

- Explain the major algorithms for sorting. Analyze these algorithms and understand the design strategies that the algorithms embody. Derive lower bounds on the running time of comparison-sorting algorithms, and explain how these bounds can be overcome
- Explain the major graph algorithms and their analysis. Employ graphs to model engineering problems, when appropriate. Synthesize new graph algorithms and algorithms that employ graph computations as key components, and analyze them

❖ **Course content**

Chapter 1. Introduction to Algorithms
1.1 Introduction to Algorithms.
1.2 Analysis of Algorithms
1.3 Asymptotic Complexity
1.4 Divide-and-conquer Design Paradigm
Chapter 2. Sorting and Order Statistics
2.1 Quick Sort
2.2 Heap Sort
2.3 Linear Time Sorting
2.4 Order Statistics
Midterm Examination
Chapter 3. Searching and Data Structure
3.1 Linear Search
3.2 Binary Search Tree
3.3 Hashing
Chapter 4. Optimization Algorithms
4.1 Dynamic Programming
4.2 Greedy Algorithms
Chapter 5. Graph Algorithms
5.1 Bread-first Search and Depth-first Search Algorithms
5.2 Single-source-shortest Path Algorithms
- Bellman-Ford Algorithm
- Single-source-shortest Paths in DAG
- Dijkstra's Algorithm
Review

❖ **Resources**

Textbooks

- Introduction to Algorithms, Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, 2nd ed. MIT Press, Cambridge, MA, ISBN: 0262032937.
- Fundamental Algorithms, the Art of Computer Programming, Vol. 1, Donald E. Knuth, Addison-Wesley, 1968, Second Edition, 1973
- Fundamental Algorithms, the Art of Computer Programming, Vol. 3, Donald E. Knuth, Addison-Wesley, 1968, Second Edition, 1973
- Algorithms Unplugged, Berthold Vöcking, Helmut Alt, Martin Dietzfelbinger, Rüdiger Reischuk, Christian Scheideler, Heribert Vollmer, Dorothea Wagner, Springer, 2016
- How to Solve It: A New Aspect of Mathematical Method, G. Polya, Princeton Science Library, 2014
- Competitive Programming 3: The New Lower Bound of Programming Contests, Steven Halim, Felix Halim, Lulu, 2013

- Handbook of Applied Algorithms Solving Scientific, Engineering, and Practical Problems, Amiya Nayak, Wiley-IEEE Press, 2008
- Powerpoint Slides

Tools

- N/A

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CS420 – Artificial Intelligence

❖ General information

- Course ID : **CS420**
- Knowledge block : **Compulsory Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Data Structures and Algorithms**

❖ Course description

The course is designed to provide students fundamental knowledge of Artificial Intelligence through the main unifying theme of an intelligent agent. We start with the formulation of AI problems and how problem-solving agents find solutions to those problem using general-purpose search algorithms.

We study different search strategies that facilitate myriad purposes of searching. Some strategies work solely on the problem definition, while the others can do quite well given some guidance on where to look for solutions. Advanced search problems that involve multiple agents (adversarial search) or large state spaces usually need appropriate consideration, and that leads to the need of studying adversarial search, local search, and constraint satisfaction problem. The second part of the course study how to represent information in knowledge-based agent, which is usually more flexible than the previous problem-solving agent. By separating into the knowledge module and the inference module, this type of agent may adapt to the changes of environment and tasks better. Propositional and first-order logic are helpful means for bridging the gap of understandings between human and computers. Finally, a rational agent could not be practical without the ability of improving their skills through experience. Students spend the last weeks to learn basic machine learning to obtain the very first view of how an intelligent agent can fully developed. Throughout the courses, students are encouraged to strengthen their core skills, as well as soft skills, by solving several case studies, assignments, and projects, either individually or in teamwork.

❖ Course goals

At the end of the course, students are able to

- Discover the properties of the problem being considered and from that, choose appropriate concepts and means in AI to formulate the problem
- Differentiate various search strategies in term of algorithm complexity and information exploited
- Manipulate the knowledge-based agents by handing the knowledge bases and inference algorithm using either propositional logic or first-order logic
- Demonstrate simple learning agents that learn by observations

- Hypothesize from observations and verify them through theoretical and/or empirical evaluations
- Continue to improve their skills on critical thinking, programming and communication through person / teamwork assignments

❖ **Course content**

- Introduction to AI
- Intelligent Agents
- Solving Problem by Searching: Basic concepts and Uninformed search
- Solving Problem by Searching: Informed search
- Local Search
- Adversarial Search
- Constraint Satisfaction Problem
- Midterm Examination
- Inference with Propositional Logic
- Inference with First-order Logic
- Inference when there is uncertainty
- Machine learning: Basic concepts and ID3 Decision tree
- Linear regression and Logistic regressions

❖ **Resources**

Textbooks

- Stuart Russell and Peter Norvig. 2020. Artificial Intelligence: A Modern Approach (4th ed.). Pearson.
- Lê Hoài Bắc and Tô Hoài Việt. 2014. Giáo trình Cơ sở Trí tuệ nhân tạo. Khoa Công nghệ Thông tin.

Others

- Negnevitsky, Michael. Artificial intelligence: A guide to intelligent systems. Pearson Education, 2005.

Tools

- N/A

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CM101 – Communication Management

❖ General information

- Course ID : **CM101**
- Knowledge block : **Compulsory – Non Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

The course is designed to provide students skills and knowledge, i.e. critical thinking, abstraction/generalization, communications, and team-working to help them success in learning at Undergraduate level programs. The course wants to break students' habits from high school and equip them with better, more suitable tools to participate in undergraduate activities. The course is best suited for first semester first year student. Nevertheless, the contents of the course are designed with a wide of range of audience in mind.

❖ Course goals

At the end of the course, students are able to

- Aquire critical thinking skills. Look at the problem at multiple perspective and know the essence of the problem.
- Know and can construct a message in communication. Know the encoding and decoding message process. Know the direct and indirect techniques to deliver messages.
- Know what abstraction is. Can use abstraction and generalization to express ideas.
- Know and can use the Observation/Active Listening/Giving Feedbacks process.
- Know basics of Facts and Opinions. Can use facts in Persuasion and Negotiation situations. Can distinguish Persuasion and Negotiation.
- Know the basic of teamworking. Can apply the knowledge in team working activities in the class.

❖ Course content

- Structure, Strategy, and Critical Thinking
- Abstraction
- Observation, Active Listening, Feedback
- Persuasion and Negotiation
- Team working
- Midterm

- Final Project

❖ **Resources**

Textbooks

- This course does not have an official textbook

Others

- Lori Breslow, and Terence Heagney. 15.279 Management Communication for Undergraduates. Fall 2012. Massachusetts Institute of Technology: MIT OpenCourseWare, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.
- Graham Ramsay, and Holly Sweet. ES.240 Composing Your Life: Exploration of Self through Visual Arts and Writing. Spring 2006. Massachusetts Institute of Technology: MIT OpenCourseWare, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.

Tools

- N/A

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SC203 – Scientific Method

❖ General information

- Course ID : **SC203**
- Knowledge block : **Compulsory – Non Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

The course is designed to provide students skills to define an experimental project, invest on their capabilities to observe, develop a hypothesis, state project objective(s) and success criteria. Through lectures and practical in-class exercises aiming at developing scientific aptitudes, students are exposed to relevant methods, processes, and techniques for:

- Reading and Analyzing scientific articles,
- Raising a Hypothesis that reflects a Question to be answered,
- Designing the experiments to test the raised hypothesis,
- Implementing the experimentation,
- Executing the tests and Analyzing the obtained data,
- Documenting the obtained results

❖ Course goals

At the end of the course, students are able to

- Read general and/or specialized scientific articles
- Generate interrogations from any observations
- Formulate overall objectives and success criteria for an experimental evaluation project aiming at finding answers to the raised questions (hypothesis or interrogation)
- Develop, as a multi-person team, the strategy, and tactics for the design of experiments and for the collection of experimental data
- Setup and run the experiments and collect experimental data, and perform data analysis in the direction set out to achieve the above objectives
- Effectively communicate, orally and in writing, the key aspects of the project, from the concept to the conclusion of the findings

❖ Course content

- Lecture 1: Introduction
  Highlights in Computer Science
- Lecture 2: What is Science?

- Lecture 3: Fundamental Blocks
  Teams present their initial ideas
- Lecture 4: Methods
  Practical experience of how to choose and read valuable scientific papers
  Tools: Python and GitHub, as well as other tools for programming and work sharing
  Teams present their refined topics and methods
- Lecture 5: Design of Experiments
  Tools: OpenCV, R, Scikit-learn, TensorFlow and Keras
  Teams present their data and preliminary experimental results
- Review

❖ **Resources**

Textbooks

Others

- VNU-HCM University of Science, Pr. Vu N. Duong, for the APCS undergraduate course entitled Scientific Method © 2006-2009
- VNU-HCM University of Technology and University of Science faculty member, Pr. Vu N. Duong, for the course entitled Methods and Models in Scientific Research © 2003-2009
- MIT faculty members, Pr. Edward M. Greitzer & Pr. EarllMurman, Dept of Aeronautics and Astronautics, for the course entitled Experimental Project I & II © 2003.
- Cranfield University faculty member, Pr. Paul Burgress, for the course entitled Nature and Practices of Science © 2007 in which many points were referenced to Hugh Gauch of Cornell University, Scientific Method in Practice, Cambridge University Press, 2003.
- Linkopings University faculty member, Dr. Monica Tatvanti, for the document entitled Introduction to Design of Experiments and Statistical Data Analysis for the Innovative Research Unit, EUROCONTROL Experimental Center © 2003.

Tools

- N/A

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WR227 – Technical Writing

❖ General information

- Course ID : **WR227**
- Knowledge block : **Compulsory – Non Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Scientific Research Methodologies**

❖ Course description

The course is designed to provide students skills to write technical documents with particular emphasis on academic papers. The students are first introduced to the principles of readers analysis and the general process of composing a technical document, so that they are able to aware of the mission and importance of technical writing. Students then go through primary parts of an academic paper to recognize how to collect appropriate information and where to put these pieces of data while pursuing a coherent idea. Tips for good style and rules of writing ethically are also discussed. These skills ensure the standard quality for the paper that students write now and in the future. Students are required to diligently improve their technical writing abilities through a series of personal/group assignments.

❖ Course goals

At the end of the course, students are able to

- Understand the basic elements of an academic papers and things that decide the quality of the paper
- Employ supporting tools for writing text and demonstration effectively
- Develop critical thinking and analytic skills to present the proposed ideas into an academic paper
- Develop communication skills and group-work spirits

❖ Course content

- S02-GoodStyle
- K01-Composing and writing for your reader
- K02-Achieving a readable style
- S03-Abstract
- K03-Writing ethically
- K04-Designing and formatting documents
- S04-Introduction
- K05-On grammar

- K06-Creating and managing text
- Corrections on abstracts
- Latex and Overleaf
- S05-BodyOfPaper
- K07-Developing the main elements
- K08-Creating tables and figures
- Corrections on Introductions
- K09-Creating reports for any occasion.pdf
- K10-Developing analytical reports.pdf
- Final report on scientific research works
- Corrections on Outline your papers
- Corrections on Proposed methods (Writing)
- Corrections on Experimental results (Writing)
- Full paper submission
- Camera-ready paper

❖ **Resources**

Textbooks

- Justin Zobel. 2014. Writing for Computer Science (4th. ed.). Springer.
- Jong C. Park, KAIST. 2014. Technical Writing for Computer Science. Presentation slides CS790, Fall Semester.

Others

- DUONG Nguyen Vu, EUROCONTROL EEC. 2008. Technical and Scientific Writing. RIVF 2008 Tutorial.
- Simon Peyton Jones, Microsoft Research, Cambridge. How to write a great research paper.
- David Salesin, Adobe. 2012. How to Write a SIGGRAPH Paper: A Guide to Choosing a Good Research Topic, Doing the Research, and Writing It Up. SIGGRAPH Tutorial.

Tools

- N/A

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MTH251 – Calculus I

❖ General information

- Course ID : **MTH251**
- Knowledge block : **Compulsory – Math**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **30**
  - Credit hours for self-study : **0**
- Prior-course :

❖ Course description

The course is designed to provide students with fundamental knowledge of the differential and integral calculus on functions of one variable. The course provides mathematical background for courses in Computer Science. The course emphasizes all three aspects: conceptual understanding, computational and problem solving ability, and exposure to applications.

❖ Course goals

At the end of the course, students are able to

- Recognize properties of functions and their graphs
- Explain meanings of the concepts of limits, continuity, derivatives. Use fundamental properties involving these concepts to resolve basic problems involving these concepts, including problems in real-world settings.
- Explain the concept of definite integrals. Use fundamental properties of integrals to resolve basic computational integral problems.
- Use differential and integral calculus to resolve application problems, and use computational softwares to assist.

❖ Course content

Chapter 1
- 1.1 Four ways to represent a Function
- 1.2 Model and Curve Fitting
- 1.3 New Functions from Old Functions
- 1.4 Graphing Calculators and Computers
- 1.5 Exponential functions
- 1.6 Inverse Function and Logarithms
- 1.7 Parametric Curves

Chapter 2
- 2.1 The Tangent and Velocity Problems
- 2.2 The Limit of a Function

2.3 Calculating Limits Using Limit Laws
2.4 Continuity
2.5 Limits Involving Infinity
2.6 Limits of Sequences

Chapter 3
3.1 Derivatives
3.2 The Derivative as a Function
3.3 Differentiation Formulae
3.4 Derivatives of Trigonometric Functions
3.5 Rates of Changes in the Natural and Social Sciences
3.6 The Chain Rule
3.7 Implicit Differentiation
3.8 Derivative of Logarithmic Functions
Midterm Exam
3.9 Related Rates
3.10 Linear Approximations and Differentials

Chapter 4
4.1 Maximum and Minimum Values
4.2 The Mean Value Theorem. Derivatives and the Shapes of Curves
4.3 Graphing with Calculus and Calculators
4.4 Indeterminate Forms and l'Hospital's Rule
4.5 Optimization Problems
4.6 Application to Business and Economics
4.7 Newton's Method
4.8 Antiderivatives

Chapter 5
5.1 Area and Distances
5.2 The Definite Integral
5.3 Evaluating Definite Integrals
5.4 The Fundamental Theorem of Calculus
5.5 The Substitution Rule
5.6 Integration by Parts
5.7 Approximate Integration
5.8 Improper integrals

❖ **Resources**

Textbooks

- Calculus, Concepts and Contexts, James Stewart, Thompson Brooks/Cole, 4th Edition, 2010.

Others

- Giáo trình phép tính vi tích phân, Bộ môn Giải tích, Khoa Toán - Tin học https://sites.google.com/view/math-hcmus-edu-vn-giaitich
- http://www.calculus.org

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MTH252 – Calculus II

❖ General information

- Course ID : **MTH252**
- Knowledge block : **Compulsory – Math**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **30**
  - Credit hours for self-study : **0**
- Prior-course : **Mth 251, Calculus I**

❖ Course description

The course is designed to provide students with the fundamental ideas of Improper Integrals & Applications, Differential Equations and Infinite Sequences and Series.

❖ Course goals

At the end of the course, students are able to

- Applications of Integration
- Polar Coordinates. Integrals in Polar Coordinates
- Concept and Techniques of Improper Integrals
- Introduction to Differential Equations
- The Theory of Infinite Series, in particular Power Series

❖ Course content

0. Review of Integration
1. Applications of Integration
   1.1 More about Areas
   1.2 Volumes
   1.3 Arc Length
   1.4 Average value of a Function
   1.5 Applications to Physics and Engineering
   1.6 Applications to Economics and Biology
2. Polar Coordinates
   2.1 Polar Coordinates System
   2.2 Curves in Polar Coordinates
   2.3 Areas and Lengths in Polar Coordinates
   2.4 Conic Sections in Polar Coordinates.
3. Improper Integrals
   3.1 Improper Integrals of Type 1: Infinite Intervals
   3.2 Improper Integrals of Type 2: Discontinuous Integrands

3.3 A Comparison Test
4. Differential Equations
4.1 Modeling with Differential Equations
4.2 Direction Fields and Euler's Method
4.3 Separable Equations
4.4 Exponential Growth and Decay
Midterm Exam
4.5 The Logistic Equation
4.6 Predator-Prey Systems
5. Infinite Sequences and Series
5.1 Sequences: Limit Laws for Sequences. Monotonic Sequence Theorem
5.2 Series: Geometric series. Properties of Convergent Series
5.3 The Integral and Comparison Tests
5.4 Other Convergent Tests
5.5 Power Series.
5.6 Representations of Functions as Power Series
5.7 Taylor and Maclaurin Series
5.8 The Binomial Series
5.9 Applications of Taylor Polynomials in Approximations and Physics
5.10 Fourier Series and integrals
Review

❖ **Resources**

Textbooks

- Calculus, Concepts and Contexts, James Stewart, Thomson Brooks/Cole, 2016, 8th Edition
- Presentations Slides in Power Point

Tools

- Computer Algebra System MAPLE

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MTH261 – Introduction to Linear Algebra

❖ General information

- Course ID : **MTH261**
- Knowledge block : **Compulsory – Math**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **30**
  - Credit hours for self-study : **0**
- Prior-course : **Calculus I & II**

❖ Course description

On successful completion of this course, students will be equipped with an introduction to the topics in Linear Algebra and its applications, namely:

- Systems of linear equations,
- Matrices and determinants,
- V ector spaces and linear transformations.
- An introductory treatment of inner products and eigenvalues, eigenvectors is also considered

❖ Course goals

At the end of the course, students are able to

- Solve a Linear system by Gaussian and Gauss Jordan Elimination Method
- Manipulate various techniques to calculate matrices and determinants
- Understand the fundamental concepts of vector spaces: basis, dimension, the solution space of a linear system
- Understand the fundamental concepts of Linear transformations: standard matrix, change of basis
- Work with inner products and orthogonality:
- Orthogonal projection on a subspace
- Find the least-square solution of an inconsistent linear system with the application to find the least-square line
- Find the characteristic polynomial of a square matrix and the eigen values and eigen vectors of the matrix.

❖ Course content

1. Systems of Linear Equations and Matrices
   1.1 Introduction to Systems of Linear Equations
   1.2 Gaussian Elimination
   1.3 Matrices and Matrix Operations

1.4. Inverses; Rules of Matrix Arithmetic
1.5 Finding Inverse by Elementary Matrices
1.6 Further Results on Systems of Equations and Invertibility
1.7 Diagonal, Triangular, and Symmetric Matrices

2. Determinants
   2.1 The Determinant Function
   2.2 Properties of the Determinant Function
   2.3 Cofactor Expansion; Cramer's Rule
3. Vectors in 2-Space and 3-Space
   3.1 Norm of a Vector; Vector Arithmetic
   3.2 Dot Product; Projections
   3.3 Cross Product
4. Euclidean Vector Spaces
   4.1 Euclidean n-Space
   4.2 Linear Transformation from Rn to Rm
   4.3 Properties of Linear Transformation from Rn to Rm
5. General Vector Spaces
   5.1 Real Vector Spaces
   5.2 Subspaces
   5.3 Linear Independence
   5.4.Basis and Dimension
   5.5 Row Space, Column Space, and Null Space
   5.6 Rank and Nullity
6. Inner Product Spaces
   6.1 Inner Products
   6.2 Orthogonality in Inner Product Spaces
   6.3 Orthonormal Bases
   6.4 Gram-Schmidt Process; QR-Decomposition
   6.5 Best Approximation; Least Squares
   6.6 Orthogonal Matrices; Change of Basis
7. Eigenvalues, Eigenvectors
   7.1 Eigenvalues and Eigenvectors
   7.2 Diagonalization
   7.3 Orthogonal Diagonalization
   Review

❖ **Resources**

Textbooks

- Elementary Linear Algebra, Application Version, Howard Anton & Chris Rorres, eleventh edition, 2013

Others

- Elementary Linear Algebra with Application, Richard Hill, Eleventh edition, 2014 (Reference Book)
- Presentations Slides in Power Point

Tools

- Computer Algebra System MAPLE

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STAT451 – Applied Statistics for Engineers and Scientists I

❖ General information

- Course ID : **STAT451**
- Knowledge block : **Compulsory – Math**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **30**
  - Credit hours for self-study : **0**
- Prior-course : **Discrete Structures I, Logical Structures**

❖ Course description

This course is for students who want to learn basic theory and methods of statistics in order to analyze simple real data and experiments.
Students will be provided with readily understandable and intuitive descriptions of statistical analyses.
We will discuss the following topics: basic probability theory, discrete and continuous random variables and their distributions, joint probability distributions and random samples, statistical inference.

❖ Course goals

At the end of the course, students are able to

- Work at an individual level and collaborate on a team basis
- An ability to reading materials, interpreting technical terms and concepts in English
- Explain basic concepts, terminology
- Understand at a basic level of Statistics
- Solve problems by using the Statistics

❖ Course content

1.1 – Basic statistical concepts
1.2 – Methods in descriptive statistics
2.1 – Sample spaces and Events
2.2 – Properties of Probability
3.1 – Random Variables
3.2 – Probability dist's for discrete RVs
3.6 – Poisson distribution
4.1 – Probability density function
4.4 – Exponential and Gamma distributions
4.5 – Other continuous distributions
4.6 – Probability plots

Midterm Exam
5.5 – Distribution of a linear combination
6.1 – Point estimation
6.2 - Methods of point estimation
7.3 – Confident interval for a normal population
7.4 – Confident interval for variance and standard deviation
8.3 – Tests about a population proportion
8.4 – p-value method
9.2 – Two-sample t test
9.3 – Analysis of Paired Data
Review

❖ **Resources**

Textbooks

- Probability and Statistics for Engineering and the Sciences (9th edition) by Jay Devore, Brooks/Cole, Cengage Learning, 2016.
- Probability and Statistics for Computer Scientists (2nd edition) by Michael Baron, CRC Press, Taylor and Francis Group, 2014.

Others

- Machine Learning: A Probabilistic Perspective by Kevin P. Murphy, MIT Press, 2012.
- Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis (2nd edition) by Michael Mitzenmacher and Eli Upfal, Cambridge University Press, 2017
- Mind on Statistics (5th edtion) by Jessica M. Utts and Robert F. Heckard, Cengage Learning, 2015.

Tools

- N/A

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PH211 – General Physics I

❖ General information

- Course ID : **PH211**
- Knowledge block : **Compulsory – Physics**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **30**
  - Credit hours for self-study : **0**
- Prior-course : **Algebra and trigonometry at a high school level None**

❖ Course description

The course covers the principles of mechanics, heat, and thermodynamics. The main goals of this course are to demonstrate how the Universe works and to teach you scientific methodology General Physics I is a problem-solving course. The students are instructed the ability to solve problems using algebra and trigonometry, and not just to quote facts, laws, and formulas. The course consists of both hours of lecture and hours of practice. A detailed schedule of topics can be found in this syllabus.

❖ Course goals

At the end of the course, students are able to

- Understand and recognize the basic concepts of classical mechanics, heat, and thermodynamics
- Analysis and solve problems involving motion in one and two dimensions; motion, gravitation, waves, and vibrations; thermodynamics
- Know the importance of the application of physics in science, engineering, and technology
- To have gained increased understanding of physical science and the nature of scientific research.
- Understand and develop the skills for reading and studying of physics and science in English

❖ Course content

- Physics and measurement
- Motion in One Dimension
- Motion in Two Dimensions
- The Laws of Motion
- Circular Motion and Other Applications of Newton’s Laws
- Energy of a System
- Conservation of Energy

- Linear Momentum and Collisions
- Midterm
- Rotation of a Rigid Object About a Fixed Axis
- Angular Momentum
- Universal Gravitation
- Temperature
- The First Law of Thermodynamics
- The Kinetic Theory of Gases
- Heat Engines, Entropy, and the Second Law of Thermodynamics

❖ **Resources**

Textbooks

- Serway & Jewett, Physics for Scientists and Engineers with Modern Physics, 10th edition, Brooks/Cole, 2018.

Others

- Halliday, Resnick, Walker, Fundamentals of physics, 11th edition, Wiley, 2018.
- Kleppner & Kolenkow, Introduction to Mechanics, 2nd edition, Cambridge University Press, 2013.
- Atkins, Four Laws That Drive the Universe, Oxford University Press, 2007

Tools

- N/A

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PH212 – General Physics II

❖ General information

- Course ID : **PH212**
- Knowledge block : **Compulsory – Physics**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **30**
  - Credit hours for self-study : **0**
- Prior-course : **General Physics I Calculus I**

❖ Course description

This course is the second course of introductory physics. The course helps students understand the basic phenomena of electricity and magnetism by introducing the concepts of electromagnetic fields and forces. In addition, the course discusses the elements of circuits with selected applications, Maxwell's equations, and electromagnetic waves. Students are instructed to develop better intuition about, and conceptual models of, physical phenomena in electricity and magnetism.

❖ Course goals

At the end of the course, students are able to

- To describe, in English, the ways in which various concepts in electromagnetism come into play in particular situations
- To represent these electromagnetic phenomena and fields mathematically in those situations
- To predict outcomes in other similar situations

❖ Course content

- Introduction, Electric charge and Coulomb's Law
- Electric field, Electric flux, Gauss's law
- Electric potential, Electric energy
- Capacitance, Dipoles, Dielectrics
- Current, Resistance, direct-current Circuits, Kirchhoff's Rules
- Magnetic field, magnetic force
- Source of magnetic field, Biot-Savart Law, Ampère's Law
- Faraday's Law, Lenz's law, Inductance
- LC and RLC circuits, Alternating-current circuits
- Maxwell's Equations, Electromagnetic waves

❖ **Resources**

Textbooks

- Serway & Jewett, Physics for Scientists and Engineers with Modern Physics, 10th edition, Cengage, 2018

Others

- Walker, Fundamentals of Physics, Extended, 11th edition, Wiley, 2018

Tools

- Mathematica, Wolframalpha.com

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PH213 – General Physics III

❖ General information

- Course ID : **PH213**
- Knowledge block : **Compulsory – Physics**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **30**
  - Credit hours for self-study : **0**
- Prior-course : **General Physics I, II, Calculus I, II**

❖ Course description

The course covers the fundamental ideas of geometrical and wave optics and of modern physics (relativity, quantum, atomic and nuclear physics). It thus gives an understanding of the nature and behaviors of light, electrons and atoms, which are fundamental to a wide range of modern technologies. Tracing the historical development of optics and modern physics, it explains why relativity and quantum mechanics are needed, the key equations and concepts, and their use in diverse fields from telecommunications to nuclear power.

❖ Course goals

At the end of the course, students are able to

- To describe the basic concepts of geometrical and wave optics and of modern physics (relativity, quantum physics, atomic, nuclear and particle physics).
- To develop the problem-solving skills, and able to creatively apply the knowledge obtained to solve a wide range of practical problems.
- To understand and explain the physics underlying the operation of important modern technologies such as optic fibers, liquid crystal displays, lasers and nuclear power stations.
- To have gained increased understanding and appreciation of the historical development of modern scientific theories and the nature of scientific research.
- To understand and develop the skills for reading and studying of physics and science in English

❖ Course content

Chapter 1 Geometrical Optics
1.1 Reflection & Refraction
1.2 Images in Mirrors
1.3 Images in Lenses
1.4 Optical Instruments
1.6 Images in Lenses

1.7 Optical Instruments

Chapter 2 Wave Optics

2.1 Light as an Electromagnetic Wave
2.2 Polarization & Scattering
2.3 Interference
2.4 Thin Films
2.5 Diffraction Gratings

Chapter 3 Relativity

3.1 The Michelson-Morley Experiment
3.2 Simultaneity
3.3 The Relativity of Space and Time
3.4 The Lorentz Transformations
3.5 Momentum and Energy

Chapter 4 Quantum Physics

4.1 The Structure of Matter
4.2 Light as Particles
4.3 Electrons as Waves
4.4 Wave-Particle Duality
4.5 The Heisenberg Uncertainty Principle
4.6 The Bohr Model of Hydrogen

Chapter 5 Quantum Mechanics

5.1 The Wave Function
5.2 The Schrödinger Equation
5.3 Hydrogen Revisited
5.4 The Zeeman Effect
5.5 The Dirac Equation and Antimatter

Chapter 6 Nuclear Physics

6.1 The Strong Interaction and the Structure of the Nucleus
6.2 Radioactive Decay and the Neutrino
6.3 Nuclear Fission and Fusion

Chapter 7 Particle Physics

7.1 Quarks & Leptons
7.2 The Weak Nuclear Interaction
7.3 General Relativity

❖ **Resources**

Textbooks

- Serway & Jewett, Physics for Scientists and Engineers with Modern Physics, 10th edition, Brooks/Cole, 2018.

Others

- Halliday, Resnick, Walker, Fundamentals of physics, 11th edition, Wiley, 2018.
- Serway et al, Modern Physics, 3ed, Thomson, 2005
- https://ocw.mit.edu/courses/physics/
- https://www.edx.org/

Tools

- N/A

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MTH253 – Calculus III

❖ General information

- Course ID : **MTH253**
- Knowledge block : **Elective – Math**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **30**
  - Credit hours for self-study : **0**
- Prior-course : **Calculus 1, Calculus 2**

❖ Course description

The course is designed to equip the students with the concepts, techniques, and applications of calculus of several variables, including partial differentiation, multiple integration, vector calculus. The course provides mathematical background for courses in Computer Science. The course emphasizes all three aspects: conceptual understanding, computational and problem solving ability, and exposure to applications.

❖ Course goals

At the end of the course, students are able to

- Recognize properties of geometry, functions and their graphs in three dimensional spaces
- Explain meanings of the concepts of limits, continuity, partial derivatives of functions of many variables. Use fundamental properties involving these concepts to resolve basic problems such as rate of changes, extrema, including problems in real-world settings.
- Explain the concept of multiple integrals. Use fundamental properties of integrals to resolve basic computational integral problems including repeated integrals and change of variables.
- Use the concepts of vector calculus in dimesions 2 and 3 to do basic calculations, including line integrals and Green formulas.
- Use differential and integral calculus to resolve application problems, and use computational softwares to assist

❖ Course content

Chapter 1: Differentiation
1.1 Spaces
Geometry in R^3
Lines and planes
1.2 Functions of several variables

Limits and continuity
1.3 Partial derivatives
Tangent planes and linear approximations, higher partial derivatives
1.4 Vector functions
The chain rule
Directional derivatives and the gradient vectors
1.5 Extremum of functions of several variables
Lagrange multipliers
Chapter 2: Integration
Integration over rectangles
Integrals over general regions, Volume, Properties
Fubini formula
Change of variables
Applications
Midterm Exam
Chapter: Vector Calculus
Line integrals
The Fundamental Theorem for Line Integrals
Green's Theorem
Surface integrals
Reviews

❖ **Resources**

Textbooks

- Calculus, Concepts and Contexts, James Stewart, Thompson Brooks/Cole, 4th Edition, 2010

Others

- Giáo trình phép tính vi tích phân, Bộ môn Giải tích, Khoa Toán - Tin học, https://sites.google.com/view/math-hcmus-edu-vn-giaitich
- http://www.calculus.org

Tools

- Mathematical computation softwares: Maxima, or Maple, or Matlab, or Wolfram Alpha, or GeoGebra …
- Software for typesetting mathematics: LaTeX, or LyX.

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MTH344 – Group Theory

❖ General information

- Course ID : **MTH344**
- Knowledge block : **Elective – Math**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **30**
  - Credit hours for self-study : **0**
- Prior-course : **Discrete Mathematics**

❖ Course description

The course aims to provide students with basic notions of group theory and its applications. After giving the basic definitions for groups, we introduce fundamental properties of groups: homomorphisms, normal subgroups and factor groups, cyclic groups, permutation groups. Especially, some important applications of groups to number theory, computer science, and other domains will be presented.

❖ Course goals

At the end of the course, students are able to

- Show the understanding on basic notions of group theory and its applications.
- Comprehend the fundamental properties of groups: homomorphisms, normal subgroups and factor groups, cyclic groups, permutation groups.
- Aim at some important applications of groups to number theory, computer science, and other domains.

❖ Course content

Chapter 0. Concepts and terminology
- Set and mappings
- Equivalence relations
- Laws of composition (binary operations)
- Semi-groups and monoids
- Problems
- Case study

Chapter 1. Groups and examples
- Definition of groups
- Some common examples
- Properties
- Subgroups and generators
- Finite groups

- Cosets and Lagrange Theorem
- Problems
- Case study

Chapter 2. Homomorphisms

- Definition of group-homomorphisms
- Properties of homomorphisms
- Kernel of a homomorphism
- Isomorphism
- Automorphism
- Group of homomorphisms
- Problems
- Case study

Chapter 3. Cyclic groups

- Definition of cyclic groups
- Generators
- Order of an element
- Properties of cyclic groups
- Problems
- Case study

Chapter 4. Normal subgroups

- Definition of normal subgroups
- Factor groups
- Normalizer and centralizer
- Homomorphism and isomorphism theorems
- Tower of subgroups
- Problems
- Case study

Chapter 5. Permutation groups

- Definition and notations
- Sign of a permutation
- Alternating group
- Solvable groups
- Problems
- Case study

❖ **Resources**

Textbooks

- Serge Lang, Algebraic Structures. Addison-Wesley, 1968.
- Georges Papy, Groupes. Dunod, 1961.
- Frank Ayres Jr. and LLoyd R.Jaisingh, Schaum's outline of theory and problems of abstract algebra (2nd edition). McGraw-Hill, 2005.
- Robert B. Ash, Basic Abstract Algebra: For Graduate Students and Advanced Undergraduates. Dover Publications, 2006.
- Thomas W Judson, Abstract Algebra: Theory and Applications. VCU(1) Mathematics Textbook Series, 2009.

Tools

- N/A

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MTH346 – Number Theory

❖ General information

- Course ID : **MTH346**
- Knowledge block : **Elective – Math**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **30**
  - Credit hours for self-study : **0**
- Prior-course : **Basic calculus, Programming, Algorithms and Data structures, Algorithms Analysis**

❖ Course description

The aim of this course is to provide students specialized in computer science basic knowledge on number theory. We start from basic notions, such as divisibility and primality, congruences and finish with some practical problems of algorithmic number theory: finding generators and discrete logarithms in Zp*, computing squares roots, primality tests. The theory will be provided in algebraic form with an emphasis on algorithms and applications.

❖ Course goals

At the end of the course, students are able to

- To know the basic notions of number theory such as divisibility, primality, congruences
- To solve intermediate problems in number theory, both in theoretical and algoritmical representations
- To understand the role of complexity of algorithms in practical applications

❖ Course content

- Basic properties of the integers
- Congruences. Fermat Last Theorem in Elementary Illustration.
- Computing with large integers
- Euclid's Algorithm
- Distribution of primes
- Finding Generators and Discrete Logarithms in Zp*
- Quadratic reciprocity and computing modular square roots

❖ **Resources**

Textbooks

- Kenneth H. Rosen, Elementary Number Theory and Its Applications, AddisonWesley Publishing Company, 1993.
- Hà Huy Khoái, Phạm Huy Điển, Số học thuật toán, Nhà xuất bản ĐHQG Hà Nội, 2003.
- Joachim Gathen, Jurgen Gerhard, Modern Computer Algebra, Cambridge University Press, 1999.
- www.cmi.ac.in/~ramprasad/studenttalks/primality/primality.pdf

Tools

- Maple

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STAT452 – Applied Statistics for Engineers and Scientists II

❖ General information

- Course ID : **STAT452**
- Knowledge block : **Elective – Math**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **30**
  - Credit hours for self-study : **0**
- Prior-course : **Applied Statistics for Engineers and Scientists I**

❖ Course description

The course is designed to provide students

- Basic notions of descriptive statistics and probability.
- Goodness of fit test for the probability density function of a population.
- Multiple regression model and its matrix representation.
- Analysis of data when the response variable is quantitative via linear regression.

❖ Course goals

At the end of the course, students are able to

- Work at an individual level and collaborate on a team basis
- An ability to reading materials, interpreting technical terms and concepts in English
- Explain basic concepts, terminology
- Understand at a basic level of Statistics
- Use a statistical programming language to perform
- statistical data analysis.

❖ Course content

- Descriptive Statistics
- Common probability distributions
- Simulation on common probability distributions
- Simulation on sampling theory
- Linear regression, ordinary least squares method
- Midterm
- Interval estimations and hypothesis testing on mean, variance and proportion
- Inference on simple regression models
- Multiple linear regression
- Inference on multiple regression
- Goodness-of-fit Tests

- Review

❖ **Resources**

Textbooks

- J. Devore, Brooks/Cole, Probability and Statistics for Engineering and the Sciences, Cengage Learning, 9th, 2016.

Others

- Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning: with Applications in R, Springer, 2015.
- Jared P. Lander, R for Everyone: Advanced Analytics and Graphics, 2nd Edition, Addison-Wesley, 2017.
- R. E. Walpole, R. H. Myers, S. L. Myers, and K. Ye, Essentials of Probability & Statistics for Engineers & Scientists, Pearson, 2013.

Tools

- R

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CS411 – Computer Graphics

❖ General information

- Course ID : **CS411**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

This class will introduce about concepts, structures, and programming techniques for display of 2D and 3D objects. It will include drawing algorithms (line, circle), rasterization (triangle and polygon), 2D geometrical transformation, 3D geometrical transformations, 3D projections (orthographic and perspective), surface shading, 2D and 3D clipping, and ray tracing. OpenGL will be the main toolbox for experiments.

❖ Course goals

At the end of the course, students are able to

- Knowledge about 2D coordinate, pixel and basic solutions for line drawing, circle drawing, clipping, 2D transformation and color filling
- Descriptions about fundamental knowledge of linear algebra, geometry for computer graphic
- Description about 3D object viewing in terms of wireframe, hidden line/hidden surface removal, illumination models, 3D transformation, and shading methods
- Description color system in computer graphic
- Enhance computer programming using OpenGL toolkit
- Read and understand research papers

❖ Course content

- Math review and introduction of computer graphic
- Line drawing and circle drawing in discrete space
- Clipping algorithms
- 2D transformation and its applications
- Color system and algorithms of filling color
- 3D viewing, perspective and parallel projection
- 3D transformation and its applications
- Curve and curve surface
- Hidden line / hidden surface removal

- Illumination models and shading

❖ **Resources**

Textbooks

- Computer Graphics with Open GL (4th Edition), Donald D. Hearn, M. Pauline Baker, Warren Carithers. Pearson.

Others

- Computer Graphics Principles and Practice, Second Edition, Foley, van Dam, Feiner, and Hughes. Addison-Wesley.

Tools

- N/A

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CS412 – Computer Vision

❖ General information

- Course ID : **CS412**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

Computer vision course will provide knowledge about how to define and detect the features of image and video. Some basic problems of computer vision will be explained in this course such as image segmentation, object detection, object tracking, object recognition, stereo matching, etc. This course will also provide a skill of computer programming using OpenCV through project final.

❖ Course goals

At the end of the course, students are able to

- Knowledge about features of images and video
- Descriptions about applications of computer vision
- Description basic solutions for fundamental problems of computer vision
- Description similarity measurement in Computer Vision
- Enhance computer programming using OpenCV toolkit
- Read and understand research papers

❖ Course content

- Camera Modeling and Camera Calibration
- Image features, Edge, Measurement
- Project Introduction
- Corner detection, blob and DoG
- SIFT, HOG features
- Color and global features
- Generic features using deep learning model
- Similarity measurement
- Object detection
- Object tracking

❖ **Resources**

Textbooks

- Richard Szeliski, Computer Vision: Algorithms and Applications (Texts in Computer Science), Springer 2010.

Others

- Nikos Paragios , Yunmei Chen , Olivier D. Faugeras, Handbook of Mathematical Models in Computer Vision, Springer 2010
- Olivier Faugeras, Three-Dimensional Computer Vision (Artificial Intelligence), The MIT Press 1993.
- Published papers in Computer Vision conferences.

Tools

- N/A

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CS414 – Machine Learning

❖ General information

- Course ID : **CS414**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **90**
  - Credit hours for self-study : **30**
- Prior-course : **MTH261, MTH253**

❖ Course description

The course is designed to provide a broad introduction to techniques for building computer systems that learn from experience; conceptual grounding and practical experience with several learning systems; and grounding for advanced study in statistical learning methods, and for work with adaptive technologies used in speech and image processing, robotic planning and control, diagnostic systems, complex system modeling, and iterative optimization. Students gain practical experience implementing and evaluating systems applied to pattern recognition, prediction, and optimization problems

❖ Course goals

At the end of the course, students are able to

- Describe the main components of a machine learning system and the major classes of approaches to machine learning
- Describe the general learning algorithm and special techniques for several machine learning models, including shallow learning and deep learning.
- Explain the relative advantages and disadvantages of each of these methods and list several potential areas of application for these methods.
- Design training sets and testing sets for machine learning tasks.
- Use several public domain machine learning tools.
- Design and run experiments that test the effectiveness of each of the methods listed above and write up the results of such experiments.

❖ Course content

- Overview database system
- Entity relationship model
- Relational data model
- Query languages
- Integrity constraint
- Functional dependency and normal forms
- Transaction, scheduler and locking

- Recovery methods
- Other database issues

❖ **Resources**

Textbooks

- Shai Shalev-Shwartz, Shai Ben-David (2014). Understanding Machine Learning: From Theory to Algorithms [https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/understandingmachine-learning-theory-algorithms.pdf]
- Ian Goodfellow, Yoshua Bengio and Aaron Courville (2016) Deep Learning [http://www.deeplearningbook.org/]

Others

- Andrew Ng, Machine Learning (Coursera): www.coursera.org/learn/machine-learning

Tools

- MS SQL Server: T-SQL
- Visual studio.NET: C#, ASP.NET Framework

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CS415 – Optimization Methods

❖ General information

- Course ID : **CS415**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

This course introduces the principal algorithms for linear, network, discrete, nonlinear, dynamic optimization and optimal control. Emphasis is on methodology and the underlying mathematical structures. Topics include the simplex method, network flow methods, branch and bound and cutting plane methods for discrete optimization, optimality conditions for nonlinear optimization, interior point methods for convex optimization, Newton's method, heuristic methods, and dynamic programming and optimal control methods.

❖ Course goals

At the end of the course, students are able to

- Provide a unified view of optimization.
- Cover the main areas of optimization applications.
- Cover the main optimization algorithms.

❖ Course content

- Applications of linear optimization
- Geometry of linear optimization
- Simplex method
- Duality theory
- Sensitivity analysis - Robust optimization - Large scale optimization
- Network flows
- Applications of discrete optimization
- Branch and bound and cutting planes
- Lagrangean methods
- Heuristics and approximation algorithms - Dynamic programming
- Applications of nonlinear optimization - Optimality conditions and gradient methods
- Line searches and Newton's method
- Conjugate gradient methods
- Affine scaling algorithm - Interior point methods - Semidefinite optimization I

❖ **Resources**

Textbooks

- Bertsimas, Dimitris, and John Tsitsiklis. Introduction to Linear Optimization. Belmont, MA: Athena Scientific, 1997. ISBN: 9781886529199.

Others

Tools

- N/A

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CS416 – Data Modeling and Integration

❖ General information

- Course ID : **CS416**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Software engineering class, database class**

❖ Course description

The course CS416 is an advanced course (at the end of Bachelor, or begin of Master studies) in Information Modeling, Modeling Methodology, and Model Based Information Integration. Modeling as well classical databases and information systems as well as highly heterogeneous distributed information systems, in conjunction with dynamic (processes and behavior) modeling approaches for these classes of information systems.
The foundations of modeling languages as well in formal semantics as also using metamodelling approaches will be treated in detail. The given languages and our (meta-) modeling methodology will be applied to practical examples of model-based integration of software and data components for heterogeneous distributed information systems (HDIS) in several business domains.
Therefore, the module covers all aspects of ‚model management' starting from model building and modeling, via the formal foundations of modeling and metamodeling, via model transformations and model integration (matching/merging), the persistent storage of (meta-) models in model repositories to, finally, the handling of consistency and evolution of models and metamodels.

❖ Course goals

At the end of the course, students are able to

- Critically and responsibly choose (or even develop) an appropriate set of modeling techniques and the modeling methodology for complex information modeling tasks by understanding the foundations of modeling languages (semantics and metamodeling approaches) and modeling methodology (course objective #1)
- Apply modeling and metamodeling techniques in the variety of process modeling, structure & information modeling and modeling of knowledge/constraints for information management, information integration and business intelligence solutions (course objective #2)
- Develop domain specific (modeling) languages for relevant areas like health care, finance, facility management and other relevant business areas

- Understand models and metamodels of other authors in order to improve them, to integrate them, and to prepare information integration solutions

❖ **Course content**

- Intro/Repetition: Information Modeling & OO Modeling & Semi-structured Data Models
- Intro/Repetition: Modeling of Workflows and Business Processes
- Abstraction and Modularization in Software & Information Modeling
- Foundations of Models and Modeling Languages
- Metamodels / MOF-Hierarchy
- Semantics of Modeling Languages
- Combining Different Modeling Paradigms
- (Modeling) Language Extensions via Metamodels and/or Math. Formalisms
- Model Management: Model Transformation, Model Integration (matching/ merging/ …)
- Semantic Modeling – Management of Knowledge: Thesaurus &Taxonomy Relationships, Semantic Nets, Ontologies
- Information Management & Information Integration
- Semantic Information Integration
- Model-Based Software & Data Integration (in general…)
- Domain Specific Languages
- Business Applications of Model-Based Software & Data Integration (domain-specific)

❖ **Resources**

Textbooks

- [BRJ99] G. Booch, J. Rumbaugh, I. Jacobson: The Unified Modeling Language User Guide. Addison-Wesley, 1999.
- [CE2000] K. Czarnecki and U. Eisenecker, Generative Programming: Methods, Techniques, and Applications. Addison-Wesley, 2000

Others

- OMG standards: UML – Unified Modeling Language
  - [UML 2003] OMG: Unified Modeling Language, v1.5, March 2003, formal /03-03-01.
  - [UML 2011a] OMG: Unified Modeling Language (UML) Spec., v2.4.1, Infrastructure Specification, August 2011, formal /2011-08-05
  - [UML 2011b] OMG: Unified Modeling Language (UML) Spec., v2.4.1, Superstructure Specification, August 2011, formal /2011-08-06
- OMG standards: MOF – Meta Object Facility
  - [MOF 2002] OMG: Meta Object Facility (MOF) Specification, v1.4, April 2002, formal /2002-04-03.
- OMG standards: XMI – XML Metadata Interchange
  - [XMI 2013] OMG: MOF 2 XMI Mapping Specification, v2.4.1, Juni 2013, formal /2013-06-03
- OMG standards: BPMN – Business Process Model and Notation
  - [BPMN 2013] OMG: Business Process Model and Notation (BPMN), v2.0.2, December 2013, formal /2013-12-09

Tools

- N/A

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CS417 – Game Theory, Multi-Agents and Social Algorithms

❖ General information

- Course ID : **CS417**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

There has been an explosive growth of online communities in recent years. These communities involve millions of users and span a wide range of media and platforms from instant messaging, to blogging and social networking. This leads to complex and intricate interactions between users in these communities. The course aims at giving you an introduction to some of the fields that might shed light on how certain behaviors or phenomena arise in these highly connected systems. Specifically, we will cover various topics in game theory, multi-agent systems, and social algorithms with sufficient depth to tackle challenging technical problems. However the main goal is for you to find an area that piques your interest to further pursue it.

❖ Course goals

At the end of the course, students are able to

- We will cover various topics in game theory, multi-agent systems, and social algorithms with sufficient depth to tackle challenging technical problems. However the main goal is for you to find an area that piques your interest to further pursue it.

❖ Course content

- Normal Form Games: Normal Form Definitions, Dominance, and Nash Equilibrium
- Extensive Form Games: Extensive Form Definitions, Centipede Game, Backward Inductions, Imperfect Information, and Subgame Perfect Equilibrium
- Repeated Games: Finitely Repeated Games, Indefinitely Repeated Prisoner's Dilemma, and Folk Theorems
- Games with Richer Representations: Stochastic Games, Congestion Games, and Compact Representations
- Games of Incomplete Information and Auctions: Bayesian Games, First Price Auctions, and other basic auction formats
- Computation in Game Theory: Computing Nash Equilibrium, Complexity of Nash Equilibrium, Compact Representation, and Coalition Game Theory

- Multi-Agent Learning: Rational Learning, Reinforcement Learning, Replicator Dynamics and Evolutionarily Stable Strategies
- Social Choice: Social Choice, Computational Social Choice and Voting Manipulation
- Mechanism Design: Basic Mechanism Design, Applications and Constrained Mechanism Design
- Basic Network Properties: Degree Distribution, Path Length, and Clustering Coefficient
- Random Graph Model: Erdos-Renyi Random Graph, Expansion, and Evolution
- Small World Phenomena: 6-degree Separation, and Watts-Strogatz Model
- Network with Signed Edge: Signed Network, Structural Balance, Theory of Status, and Sign Prediction
- Decentralized Search: Small world Model, Kleinberg's Model, and the Hierarchical Model
- Network Community Detection: Strength of Weak Ties, Modularity, and Trawling.
- Overlapping Communities: Objective Functions, Community Scores, and Clique Percolation Method
- Network Effects and Cascading Behavior: Game Theoretic and Decision Based Models of Cascades
- Link Analysis: HITS and PageRank
- Link Prediction: Link Prediction via Proximity, and Supervised Random Walks
- Network Inference: Cascade Diffusion Model

❖ **Resources**

Textbooks

- Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations by Yoav Shoham and Kevin Leyton-Brown
- Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley and Jon Kleinberg

Tools

- N/A

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CS418 – Introduction to Natural Language Processing

❖ General information

- Course ID : **CS418**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

This is an in-depth course about the problems of reducing the ambiguities of natural language problems. This course will focus on the corpus-based approach to address the problem of reducing the ambiguities of natural language in terms of morphology (such as Vietnameses word boundary), text-type, syntax and the semantics of the words. This module will also introduce some advanced applications of natural language processing such as automatic translation, text summary, ...

❖ Course goals

At the end of the course, students are able to

- Understanding and applying knowledge about the knowledge of natural language processing according to the corpus-based approach in language problems such as: part-of-speech tagging and sentence parsing by statistical method; word sense disambiguation; information retrieval; text classification; statistical machine translation.
- Understanding the aspects of natural language such as morphology, grammar, and semantics
- Understanding and applying morphological, grammatical and semantic analysis techniques for text, especially Vietnamese text
- Understanding and applying methods to evaluate performance of natural language processing systems
- Capable of independent research, problem solving, analysis, lifelong learning

❖ Course content

- Introduction to natural language processing: the characteristics of natural language, English characteristics, Vietnamese characteristics
- Linguistic-based approach: linguistic criteria, labeled linguistic material
- Language model in natural language processing
- Morphological analysis techniques in language

- Analytical techniques of grammar studies in language
- Analytical techniques for semantics in language
- Corpus linguistics: collecting, constructing and labeling data
- Open source tools for natural language processing
- Components in a natural language processing system
- Evaluate the performance of a natural language processing system
- Characteristics of the Vietnamese language processing system
- Coursework report

❖ **Resources**

Textbooks

- Daniel Jurafsky, James H. Martin. "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition". 2009
- Đinh Điền. "Xử Lý Ngôn Ngữ Tự Nhiên". NXB ĐHQG, 2006

Others

- Christopher D. Manning, Hinrich Schütze. "Foundation of Statistical Natural Language Processing". MIT Press, 2001
- Vaclav Brezina. "Statistics for Corpus Linguistics". Cambridge University Press, 2018
- Adam Przepiórkowski, Maciej Piasecki, Krzysztof Jassem, and Piotr Fuglewicz. "Computational Linguistics: Applications". Springer, 2013
- Đinh Điền. "Ngôn ngữ học ngữ liệu". NXB ĐHQG, 2019

Tools

- N/A

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CS419 – Introduction to Information Retrieval

❖ General information

- Course ID : **CS419**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Introduction to programming language, Data Structure, Calculus, Linear Algebra**

❖ Course description

The course is designed to provide students:
Basic knowledge of Information Retrieval, Visual Information Retrieval.
The course includes core parts such as information representation, information organization, information retrieval models, evaluate performance of information retrieval system.

❖ Course goals

At the end of the course, students are able to

- Report and Apply knowledge in IR at individual and group level.
- Translate English documents in IR
- Analyze and solve problems related to IR
- Interpret and apply methods of information representation
- Interpret and apply methods of information organization
- Interpret and Apply information retrieval models, Evaluate information retrieval system performance.

❖ Course content

- Introduction to Visual Information Retrieval
- The basic concepts of Visual Information Retrieval
- The basic concepts of Information Retrieval
- Visual Information Representation based on Global Features
- Visual Information Representation based on Local features
- Visual Information Organization based on Global Features.
- Visual Information Organization based on Local Features.
- Visual Information Retrieval models based on Global features
- Visual Information Retrieval models based on Local features
- Evaluate the performance of information retrieval system
- Review

❖ **Resources**

Textbooks

- Digital Image Processing. Rafael C. Gonzalez, Richard E. Woods, Prentice-Hall, Inc, 2004.
- Visual Information Retrieval. Alberto Del Bimbo, Morgan Kaufmann Publishers, Inc. 1999.
- Visual Indexing and Retrieval. Jenny Benois-Pineau, Frédéric Precioso, Matthieu Cord. Springer Publishers, 2012.
- An Introduction to Information Retrieval. Christopher D.Manning, Prabhakar Raghavan, Hinrich Schutze, 2009.

Tools

- N/A

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CS421 – Software Requirement

❖ General information

- Course ID : **CS421**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Introduction to Software Engineering**

❖ Course description

This course introduces the methods and techniques that support collecting, identifying, analyzing, specifying, testing, and managing (software) requirements. The content of this course focuses on introducing and guiding students to implement the process of analyzing and managing requirements with a specific methodology (currently RUP).

❖ Course goals

At the end of the course, students are able to

- Explain the basic concepts of software requirements engineering
- Select the appropriate requirements elicitation techniques to identify their requirements
- Effectively analyze their requirements
- Create a requirements specification to communicate their requirements
- Utilize various requirements validation techniques to critically evaluate their requirements and to identify defects
- Manage change to their requirements
- Apply use cases to software development initiatives
- Build a use case-based requirements model
- Write user stories and brief, casual, fully developed use cases
- Model user interface using mock-ups
- Using tools to draw UC Diagram, manage the requirements

❖ Course content

- Course Introduction + Project Introduction + Skills
- RE Concepts + RE Process
- Requirement Development – Elicitation + Techniques
- Seminar Tools Presentation + Requirement Analysis
- Mid-term + Requirement Specification
- Prototype

- Requirement Validation
- Requirement Management
- Final Presentation

❖ **Resources**

Textbooks

- Karl E. Wiegers (2003) , "Software Requirements, Second Edition", Microsoft Press.
- Ralph R.Young (2004), "The Requirement Engineering Handbook"
- Alistair Cockburn (1999-2000) Writing Effective Use Cases, Addison Wesley.
- Kotonya G, Sommerville I (2000) Requirements engineering – processes and techniques, John Wiley & Sons UK
- Lauesen, S (2002) Software requirements: styles and techniques, Addison-Wesley, London, UK
- Loucopoulos P, Karakostas V (1995): System requirements engineering, McGraw-Hill
- Macaulay LA (1996) Requirements engineering. Springer-Verlag, New York, London

Tools

- N/A

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CS422 – Software Analysis and Design

❖ General information

- Course ID : **CS422**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

This course introduces the common principles to analyze and design software from software requirements.
The content of this course focuses on object oriented techniques (using UML) to analyze, to design architecture, interface, business logic, and data.
Several advanced topics can be optionally introduced (e.g. design patterns, service oriented architecture…)

❖ Course goals

At the end of the course, students are able to

- Describe the common principles to analyze and design software from software requirements
- Apply object oriented methods and techniques to analyze and design software
- Recognize, analyze and evaluate basic pros and cons of an existing analysis or design model, the architecture of a software system, the communication between components in a given system.
- Apply basic object oriented techniques to optimize analysis/design models to enhance the evolution and flexibility of software systems.

❖ Course content

Part 1: Overview and Revision
- Concepts in Software Engineering
- Best Practices in Software Development
- Concepts in Object-Oriented Programming

Part 2: Requirements
- Feasibility study and Requirements elicitation and analysis
- Requirement Classification
- Several Techniques for Requirement Elicitation

Part 3: Requirement Modeling

- Requirement Modeling with UML
- Data Flow Diagram (DFD)

Part 4: Use-case Analysis

- (Analysis) Class Diagrams
- State Machine diagrams

Part 5: Data(base) Design

- Relational Database Design
- Introduction to Software Architecture
- Layers and Tiers
- Some guidelines for Software Architecture Analysis and Design

Part 6: Software Architecture

- Introduction to Software Architecture
- Layers and Tiers
- Some guidelines for Software Architecture Analysis and Design

Part 7: (User) Interface Design

- Introduction
- Examples and applications
- Several Techniques to Enhance Qualities of User Interfaces

Part 8: Miscellaneous

- Design Patterns
- Software Refactoring
- Late-binding functions
- Web services (SOAP, REST) and Service Oriented Architecture
- Model-Driven Architecture
- Mashups and Widgets

❖ **Resources**

Textbooks

Others

- Roger S Pressman, Roger Pressman (2004), Software Engineering: A Practitioner's Approach, McGraw-Hill Science/Engineering/Math
- Ian Sommerville (2006), Software Engineering: (Update) (8th Edition) , Addison Wesley
- Mike O'Docherty (2005), Object-Oriented Analysis and Design - Understanding System Development with UML 2.0, John Wiley & Sons
- Bernd Oestereich (2001), Developing software with UML - Object-oriented analysis and design in practice, 2nd Edition, Addison Wesley
- Grady Booch et. al. (2007), Object-oriented Analysis and Design with Applications, 3rd Edition, Addison Wesley
- Craig Larman (2001), Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and the Unified Process, 2nd Edition, Prentice Hall PTR
- Dennis de Champeaux, Douglas Lea, Penelope Faure (1993). Software Engineering - Object-Oriented System Development, Addison Wesley
- Len Bass, Paul Clements, Rick Kazman (2003), Software Architecture in Practice, 2nd edition, Addison Wesley
- Sherif M. Yacoub, Hany H. Ammar (2003), Pattern-Oriented Analysis and Design: Composing Patterns to Design Software Systems, Addison Wesley.

- Alan Shalloway, James R. Trott (2004), Design Patterns Explained – A New Perspective on Object Oriented Design, Addison Wesley

Tools

- N/A

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CS423 – Software Testing

❖ General information

- Course ID : **CS423**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **OOP, Database, Software Engineering, Web Application Development**

❖ Course description

This course is for professionals and students who wish to gain a better understanding of software testing techniques and/or specialize in software quality engineering. The course will cover selected techniques for black box and white box testing, testing tools, and process and management issues. The seminar will be a blend of software testing concepts and theories with practical hands-on experience…

❖ Course goals

At the end of the course, students are able to

- Appreciate the fundamentals of software testing and its application through the software life cycle.
- Develop skills in designing and executing software tests suitable for different stages in the software life cycle.
- Work cooperatively in groups to complete small projects required by the subject.
- Build the test plan for software projects.
- Design and evaluate the test cases based on the software testing techniques
- Understand and appreciate the role of software testing in systems development, deployment, and maintenance.
- Develop a continuing interest in software testing, and obtain satisfaction from its study and practice
- Use appropriate methods and CASE Tools to test the software.

❖ Course content

- Course Introduction
- List of seminar topics
- Software Testing Concepts
- Software Testing Process
- Software Testing Classification

- Software Testing Tools
- Test Case template
- Test Plan
- Problem Report
- Test automation
- Bug tracking system
- Test Management
- Test Roles
- Domain Testing
- State transition Testing
- Code Coverage
- Unit Testing (Control Flow)
- Document Testing
- Mid-Term Exam
- Seminar
    - DB Testing
    - GUI Testing
- Seminar
    - Automation Testing for Web
    - Automation Testing for Mobile
    - Automation Testing for Desktop
- Seminar
    - Performance Testing
    - Code Coverage
- Seminar
    - Mock/API Testing
    - CI/CD
    - BDD
- Review

❖ **Resources**

Textbooks

- Testing computer Software, Second Edition, by Kaner, Falk, and Nguyen, Wiley Publishers, 1999.
- Effective Methods for Software Testing, Second Edition, by William E. Perry, Wiley Publishers, 2006.

Others

- Software Testing Course by Cem Kaner. http://www.testingeducation.org/
- Software Testing Tutorials https://www.guru99.com/software-testing.html

Tools

- Test Complete, Winrunner
- Mantis Bug Tracking

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CS424 – Web Application Development

❖ General information

- Course ID : **CS424**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Introduction to Computer Science, Introduction to Databases, Elements of Software Engineering**

❖ Course description

This course introduces the methods and techniques in the field of Quality, Assurance (QA) and Quality Control (QC). After finishing this course, students can use basic techniques, to design the test cases, test plan and use the open source tools to test the software. Besides that, student can organize and manage the software testing project, deploy the bug tracking system…

❖ Course goals

At the end of the course, students are able to

- Understand the basic protocols of Internet and WWW
- Present the steps in building a website
- Apply the basic principles of website design, HTML and CSS to design website
- Differentiate among the web application models
- Apply web technologies to develop and deploy web applications
- Understand the issues in web security
- Use techniques and tools in testing the web applications

❖ Course content

- Course Introduction
- Introduction to Web & Internet
- Steps to develop a website
- Web Design Overview
- Using Photoshop, HTML & CSS to design your website
- Introduction to Javascript, DOM
- Working with Jquery
- Introduction to ASP.NET
- Understanding ASP.NET Events
- Working with ASP.NET controls

- Customize your website appearance with
- MasterPage, Skins and Themes
- Displaying data objects to data sources
- Accessing data using ADO.NET
- 3 layers concept of data handling
- State management
- Membership & Role management
- Seminar Topics
    - Search Engine Optimization
    - Web Security
    - Web Testing
    - Web Services
    - Web Technologies
    - Web Development Framework

❖ **Resources**

Tools

- Web Server: IIS (Internet Information Services)
- Web Design: Adobe Photoshop, Dreamweaver
- IDE: Visual Studio.NET 2005/2008/2010
- Database Management System: Microsoft SQL Server/Express 2005/2008/2010
- Version controls: SVN
- Bug tracking: Bugzilla
- Web testing tools

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CS426 – Mobile Device Application Development

❖ General information

- Course ID : **CS426**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Programming Systems**

❖ Course description

This course aims to provide students with an overview of the field of Mobile Device Application Development and the background knowledge related to key components in the area of Mobile Device Application Development (platforms, environments & tools, specific design, libraries to support development, testing and deployment of mobile applications). The main topics in the course include: user interface design; application lifecycle management; data storage & access; multi-thread processing; data sharing between applications; manage background services; communication between processes; develop web services; develop map & GPS services; develop telecommunication functions related to calls & messages, graphics, animation, multimedia, performance management, and security. The mobile platform illustrated in the subject will vary according to technology trends in Vietnam and the world. The course content is currently illustrated based on Android environment.

❖ Course goals

At the end of the course, students are able to

- Work on a personal and team level to develop an application for mobile devices
- Recognize and explain English terminology in the field of Mobile Device Application Development
- Explain the basic concepts, terms, responsibility and fundamental ethical principles in the field of Mobile Device Application Development
- Identify and categorize software development platforms and environments for Mobile Device Application Development.
- Identify and apply techniques in the field of Mobile Device Application Development
- Build a small scale software product
- Use the software tools support

❖ Course content

- Session 1: First Application. Java review. Git basics.
- Session 2: Layouts, Views

- Session 3: Layouts, Views (cont'd)
- Session 4: ListView.
- Session 5: RecyclerView.
- Session 6: Activity. Fragment. Application Lifecycle
- Session 7: Intent. Broadcast receiver
- Session 8: Maps
- Session 9: Preferences. Background task.
- Session 10: Background task. AsyncTask. (cont)
- Session 11: Midterm Exam
- Session 12: Services. Notifications.
- Session 13: Application Architecture (UI Layer). MVW Slide: A Journey Through MV Wonderland
- Session 14: Application Architecture (UI Layer). ViewModel. LiveData Reading
- Session 15: Customized UI
- Session 16: Content Provider. Search
- Session 17: 2D Graphics
- Session 18: Firebase
- Session 19: Advanced Topics
- Session 20: Advanced Topics

❖ **Resources**

Textbooks

- Head First for Android Development 2th edition, Dawn Griffiths, David Griffiths, O'Reilly Media, 2017.
- Professional Android 4th edition, Reto Meier and Ian Lake, Wrox, 2018.

Tools

- Android Studio
- GitHub

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CS427 – 3D Visualization and Game Development

❖ General information

- Course ID : **CS427**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Programming Systems**

❖ Course description

This course covers all significant technical aspects of the game development process from design to application. The course content aims to provide students with a solid understanding of game technologies, including game architectures, game programming, and game engines. Via lectures, hands-on labs, and projects, the course mainly focuses on 2D and 3D graphics with a broad range of knowledge and skills in building characters, animation, environment, physics system, input system, interaction events, graphical user interface, sound as well as optimization techniques. This course also introduces modern technologies (virtual reality, augmented reality, wearable devices, etc.) for interactive-rich applications and principles in data visualization.

❖ Course goals

At the end of the course, students are able to

- Participate actively in group discussions; ability to share the work and coordinate the work according to the plan in a small-scale group (consisting of 2-3 students); be aware of the roles and responsibilities of team members
- Read and understand specialized materials in English in building games, applications as well as the technologies used; explain English terminologies in the process of making games; present (in the form of a report in the prescribed form) and make presentations about the group's game making and application project.
- Present the overview of game development industry
- Apply algorithms, methods, tools and technologies to build 2D graphic and animation components
- Apply algorithms, methods, tools and technologies to build 3D graphic and animation components
- Apply knowledge, skills, methods, tools and technologies to build other components in the game (audio, network, event handling and scripting, artificial intelligence, interaction ...)
- Develop a 3D game or visualization application

- Be aware of the responsibility of game developers and the impact of games on society; consciously learning to use other languages, tools, and environments to develop games

❖ **Course content**

- Session 1:
  - Introduction to Games and Game Engines
- Session 2:
  - Basic concepts and components in 2D Games: Sprites, Camera and Animations
- Session 3:
  - 2D Game Physics, Input Systems and Interaction Events
- Session 4:
  - Graphics Rendering Pipeline and 2D Game Effects with Shader
- Session 5:
  - Introduction to 3D virtual world and 3D Games, 3D objects procedure concept and 3D Camera transformation
- Session 6:
  - Introduction to 3D Terrains, terrain painting techniques and building 3D environments
- Session 7:
  - 3D game optimizations
  - 3D world lighting concepts
  - Lighting models to procedure light in 3D scenes
- Session 8:
  - 3D camera effects
  - 3D effects with particle systems (spell, fire, rain, …)
  - Raycasting techniques and application
- Session 9:
  - 3D characters and animation
  - Introduction to future technologies
- Session 10: Future technologies seminar:
  - Virtual Reality
  - Augmented Reality
  - Hologram
- Session 11: Basic game artificial intelligent system and pathfinding with mesh navigation system
- Session 12:
  - High definition rendering pipeline
  - Physically based rendering
- Session 13: Design Patterns for game development
- Session 14: Monetize game with Ads services and in-app purchase
- Session 15, 16: Multiplayer networking online game developement
- Seminar
- Review

❖ **Resources**

Textbooks

- Jesse Schell, The Art of Game Design: A book of lenses, Morgan Kaufmann, 2008

- K. Salem, E. Zimmerman, The Rules of Play: Game Design Fundamentals, MIT Press, 2004
- Flint Dille, The Ultimate Guide to Video Game Writing and Design, Lone Eagle, 2008
- Paris Buttfield-Addison, Unity Game Development Cookbook, O'reilly, 2019
- Jeremy Gibson, Introduction to Game Design, Prototyping and Development, 2014

Others

- Unity Technologies, Unity Learn, https://learn.unity.com/
- Brackeys Channel for Game Development, http://brackeys.com/

Tools

- Github for Windows
- Visual Studio 2017, 2019

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CS428 – Electronic Commerce

❖ General information

- Course ID : **CS428**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

The course briefly provides students with fundamental knowledge of electronic commerce (e-commerce), traditional and online business models, e-commerce infrastructures and software, electronic payment models, Internet marketing and advertising strategies, and Web technologies. The course also mentions to emerging e-commerce platforms, other support services such as order fulfillment, supply chain management, and customer relationship management.

❖ Course goals

At the end of the course, students are able to

- Explain underlying theories of e-commerce and the current situation of e-commerce in Vietnam
- Use critical thinking to apply online models, web technologies, and security solutions into e-commerce systems
- Desbribe marketing and advertising strategies for electronic marketplaces
- Coordinate with group members to develop a complete e-commerce system by intergration and implementation
- Work in team to present e-commerce topics

❖ Course content

- Chapter 1: Overview of e-commece
- Chapter 2: Electronic marketplaces
- Chapter 3: E-Commerce business models
- Chapter 4: Techniques for marketing and advertisement
- Chapter 5: E-Commerce software
- Chapter 6: E-Commerce infrastructure
- Chapter 7: E-Commerce security
- Chapter 8: Electronic payment systems
- Chapter 9: Other e-commerce issues

- Review

❖ **Resources**

Textbooks

- Efraim Turban, Jon Outland, David King, Jae Kyu Lee, Ting-Peng Liang, and Deborrah C. Turban, Electronic Commerce 2018: Managerial and Social Networks Perspective (9th Edition), Springer.
- Gary Schneider, Electronic Commerce, 12th Edition, Course Technology, Cengage Learning, 2016.

Others

- Kenneth C. Laudon and Carol Guercio Traver, E-Commerce 2019: Business, Technology and Society (15th Edition), Pearson.

Tools

- Microsoft Visual Code 2019
- MEAN Stack technology for website building

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CS429 – Mining on Big Data

❖ General information

- Course ID : **CS429**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Data mining, Machine learning**

❖ Course description

The course is designed to provide students techniques/algorithms in data mining and machine learning to analyze very large amounts of data. The emphasis will be on Map/Reduce programing model for implementing parallel algorithms that can process big data. This course also provides students a practical understanding of the tools in the Apache's Spark system in three modes such as local, standalone and Yarn cluster.

❖ Course goals

At the end of the course, students are able to

- Describe how basic methods of data mining/machine learning work
- Explain techniques used to mine the large amounts of data
- Analyze algorithms following the Map/Reduce programing model or Spark programming model
- Manipulate the Apache Spark system on any operating systems
- Practice to write codes and debug with Apache Spark

❖ Course content

- Introduction
- MapReduce, Hadoop, Spark
- Frequent Itemset
- Clustering
- Classification
- Midterm
- Regression
- Recommendation System
- Review

❖ **Resources**

Textbooks

- Jure Leskovec, Anand Rajaraman, and Jeff Ullman, Mining Massive Datasets, Third Edition, Cambridge University Press, 2020.

Tools

- Oracle VM VirtualBox
- Ubuntu
- Vagrant
- Spark 2.4.7
- Jupyter Notebook

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CS430 – Human-Computer Interaction

❖ General information

- Course ID : **CS430**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

- Why do people love iPhone?
- Why do people keep using Facebook?
- How did Instagram become a $4B company?
- Why do users of your website complain even when you spent 12 months working on it?

It turns out that there is the same answer to those questions. The successful companies know that they need to delight users with their products. Not frustrating them. They know the right Human-Computer Interaction principles, processes, and techniques to apply. Not being ignorant of them.

If you miss this course, you'll miss out on how to efficiently come up with product ideas, to rapidly prototype multiple alternatives, to design beautiful interfaces, and to verify whether users like them. Among other things!

If you want to build difficult-to-use, ugly and ineffective products/interfaces, don't come to this course.

❖ Course content

Week 1: The Right Idea: Concept Discovery
- Needfinding techniques: Contextual Design and other techniques
- Personas
- Value Proposition: Problem/Solution Fit

Week 2: The Right Design: Prototypes & Initial Evaluation
- Storyboard
- Wireframes, Paper and Video prototyping
- Prototype evaluation and comparison: Heuristic Evaluation and other techniques

Week 3: The Beautiful Design: Visual and Interaction Design
- Visual Design Principles & Typography
- Information Architecture & Navigation
- Interaction Patterns

Week 4: The Intuitive Design: User Experience & Usability Evaluation

- Evaluation methods and techniques: Heuristic evaluation, Think aloud, Shadowing, Survey
- Fieldwork vs Controlled Experiments
- Qualitative and Quantitative Analysis

Week 5: The Next Design: Product Strategy & Design for the Future

- Minimal Viable Product
- Current hot topics in HCI & UX world
- Wrapping it up

❖ **Resources**

Textbooks

Others

Tools

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CS431 – Wireless Network

❖ General information

- Course ID : **CS431**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

Wireless networks and the use of wireless networks in industry environments. Topics include reasons why current technology of wired networked cannot be directly apply for wireless environments; key issues affects the design and implementation of wireless network hardware and software; different models (infrastructure vs. adhoc) and technologies in wireless network (802.11, Wifi, Bluetooth, cellular phones, satellite phones, sensor); different protocols in wireless networks; programming with different wireless networks (Bluetooth, 802.11, J2ME); programming with mobile devices (smart phone, laptops), securities in wireless networks; routing in wireless networks; location aided in wireless network. May cover some advanced topic: programming with robots for wireless networks.

❖ Course goals

At the end of the course, students are able to

- Comprehend the wireless networks and the use of wireless networks in industry environments.
- Comprehend the key issues affects the design and implementation of wireless network hardware and software
- Recognize different models (infrastructure vs. adhoc) and technologies in wireless network (802.11, Wifi, Bluetooth, cellular phones, satellite phones, sensor)
- Recognize different protocols in wireless networks
- Program with different wireless networks (Bluetooth, 802.11, J2ME); mobile devices (smart phone, laptops).
-

❖ Course content

- Course Overview
- Wireless and Mobile Networking: Facts, Statistics and Trends
- Introduction to Wireless Coding and Modulation
- Introduction to Wireless Signal Propagation

- IEEE 802.11 Wireless LANs (802.11a/b/g/n/ac)
- Introduction to 60 GHz Millimeter Wave Gigabit Wireless Networks
- Introduction to Vehicular Wireless Networks
- Internet of Things
    - Wireless Protocols for IoT
    - Bluetooth and Bluetooth Smart
- Low Power WAN Protocols for IoT
- Introduction to Cellular Networks: 1G/2G/3G
- Introduction to LTE (4G)/5G

❖ **Resources**

Textbooks

- David Tse , Pramod Viswanath, "Fundamentals of Wireless Communication", 1st Edition, Cambridge University Press, 2005.
- Agus Kurniawan, "Smart Internet of Things Projects", Packt Publishing

Tools

- N/A

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CS432 – Cryptography

❖ General information

- Course ID : **CS432**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

This course introduces the fundamentals in the field of cryptography. After finishing this course, students can understand the background knowledge of cryptography, including symmetric/ asymmetric encryption, digital signatures, methods of security for database, etc. This is the first stage for further study in cryptography.

❖ Course goals

At the end of the course, students are able to

- Understand the background materials in foundations of cryptography
- Understand the key concepts of cryptography, from encryption and digital signatures to some cryptographic protocols

❖ Course content

- Introduction to Cryptography: overview and terminology
- Fundamental algorithm: Euclid and Bezout
- Improved version of Euclid and Bezout algorithm: Binary Euclid, Binary Bezout
- Fundamental theorems:
  - Euler theorem
  - Little Fermat theorem
  - Chinese Remainder Theorem
- Field Zm
- Operations in field Zm
- Role of big integers
- Fast operations on big integers
- Primes and pseudo-primes
- Primes testing
- Primes generating
- Basic symmetric encryption:

    - Block ciphers (DES/ AES) and/or Stream cipher
    - Attacks
- Basic asymmetric encryption:
    - RSA
    - ElGamal
    - Attacks
- Digital signatures
- Security for database
- Advanced topics
- Review

❖ **Resources**

Textbooks

- Nguyễn Đình Thúc - Bùi Dzõan Khanh, Mã hóa thông tin với Java (tập 2), NXB Lao động Xã hội
- Bùi Dzõan Khanh - Nguyễn Đình Thúc, Mã hóa thông tin, NXB Lao động Xã hội.
- Bùi Dzõan Khanh - Nguyễn Đình Thúc – Trần Đan Thư, Cơ sở lý thuyết số trong an toàn – bảo mật thông tin, NXB Giáo dục.
- Dương Anh Đức, Trần Minh Triết, Mã hóa và ứng dụng.

Tools

- N/A

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CS433 – Network Security

❖ General information

- Course ID : **CS433**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Computer networks**

❖ Course description

This is an advanced study of network security. Topics include historical and recent network-based attacks including denial of service attacks, a study of network security monitoring procedures including anomaly and signature-based detection, firewalls, and an in-depth study of defensive techniques at various layers of the ISO stack, including modern cryptographic protocols like IPSEC, SSL, and other application-layer security protocols.

❖ Course goals

At the end of the course, students are able to

- Understand classic and modern cryptography
- Program hashing function
- Program cryptographic network protocol.
- Explain crypto protocols like SHA-x, Kerberos, SSL/TLS, IPSEC.
- Describe/analyze various network attacks.
- Determine pros/cons of network security tools.
- Analyze network security design.
- Analyze tradeoffs in crypto including trust assumptions.
- Understand security ethical challenges.

❖ Course content

- Historic and recent network attacks including the architecture of those attacks.
- Cryptographic function review (symmetric, asymmetric, key-management, message-digest, authentication principles, network security policy)
- Firewall functionality at layer 3, layer 7, mixed hybrid schemes.
- Wireless security
- IPSEC and layer 3 security issues.
- Layer 7 security issues including email and secure protocols including kerberos, PGP.
- Network monitoring including anomaly-based and signature-based detection systems.

❖ **Resources**

Textbooks

- Network Security. Private Communication in a Public World. Second Edition. Kaufman, Perlman, Speciner. Prentice-Hall, 2002.

Tools

- N/A

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CS434 – Computer Security

❖ General information

- Course ID : **CS434**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Programming Systems**

❖ Course description

The course is roughly divided in two separate parts. The first provides a broad introduction to cryptography and communication security mechanisms based on cryptography. The first part covers fundamental aspects such as security evaluation criteria and the mathematical constructs (briefly) underlying cryptographic primitives as well as applied aspects like the design of major encryption and hashing algorithms, details of security mechanisms relying on cryptography such as data encryption, integrity, digital signature, authentication, key management, and public-key infrastructures.
The second part of the course deals with introducing to practical security concepts. The goal is to understand common attacks and countermeasures in a range of topics: Windows and Unix Security Basics, Race Conditions, Memory Corruption, Digital Forensics, Web Security, Wireless Security, Network Security, Malware, Mobile Security. The part is practice oriented, it describes real attacks and countermeasures. Students will practice attacks on a dedicated server (similar to a Capture the Flag competition).

❖ Course goals

At the end of the course, students are able to

- Work on a personal and team level to learn the basic concepts of applied cryptography and network, system and computer security
- Know and explain English terminology in the field of Computer Security
- Understand the basic concepts, terms, responsibility and fundamental ethical principles in the field of Computer Security
- Identify and categorize cryptography algorithms for real world application and Computer Security problems.
- Understand and apply techniques in the field of applying cryptography and Computer Security
- Apply and attack cryptography and perform some exploitation in Computer Security
- Use the CTF (Capture the Flag) tools support

❖ **Course content**

- Session 1: Introduction to Computer Security
- Session 2: Cryptography
- Session 3: Symmetric Cryptography
- Session 4: Asymmetric Cryptography (cont.)
- Session 5: Data Encryption Mechanism
- Session 6: Hash Functions and Integrity
- Session 7: Digital Signature and Non-repudiation
- Session 8: Authentication
- Session 9: Key Management
- Session 10: Introduction to Unix
- Session 11: Windows and Linux Operating System Security
- Session 12: Race Condition
- Session 13: Memory Corruption
- Session 14: Introduction to Forensics
- Session 15: Mobile Security
- Session 16: Network Security
- Session 17: Web Security
- Session 18: Wireless Security
- Session 19: Practice: Binary Exploitation and Pwn.
- Session 20: Practice: Introduction to Malware Analysis.

❖ **Resources**

Textbooks

- Handbook of Applied Cryptography, Alfred Menezes, Paul van Oorschot, Scott Vanstone, 1996.
- Cryptography and Network Security 4th edition, William Stallings, 2005.
- Hacking: The Art of Exploitation 2nd edition, Jon Erickson, 2003.
- The Web Application Hacker's Handbook: Discovering and Exploiting Security Flaws 2nd edition, Dafydd Stuttard and Marcus Pinto, Wiley Publishing, Inc, 2011.

Tools

- N/A

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CS494 – Internetworking Protocols

❖ General information

- Course ID : **CS494**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Introduction to Programming (C, C++, Java) or equivalent**

❖ Course description

The course is designed to provide students the fundamentals of computer networking, the operation of the protocols in the TCP/IP suite, Internet, LANs, packet-switching networks, network architecture. Using the Internet as a vehicle, this course introduces the underlying concepts and principles of modern computer networks, with emphasis on protocols, architectures, and implementation issues. Topics include network applications (email, ftp, http, dns, etc.), Internet in a top-down fashion: Application, Transport, Network, Data Link and Physical layers. The course will also cover some advance topics including network security and wireless networking.

❖ Course goals

At the end of the course, students are able to

- Understand the basic concepts of the 5/7 Internet layers
- Write new protocols for application layer
- Optimize networking code for better performance
- Know the history of the Internet
- Understand the pros and cons of packet switch vs. circuit switch network

❖ Course content

- Introduction: Overview of the Internet, client/server paradigm, circuit switching, packet switching, physical media, queuing delay and packet loss
- Introduction (cont.): Overview of TCP/IP and OSI reference models, Internet Protocol Stack
- Application Layer: Service requirements; Client-server model vs. P2P model; Protocols: WWW, HTTP, FTP
- Application Layer (cont.): Protocols: Electronic Mail, Domain Name System, Socket programming
- Transport Layer: Service models, Multiplexing/Demultiplexing, Connection-less transport (UDP), Principles of reliable data transfer

- Transport Layer: Connection-oriented transport (TCP), TCP congestion control, TCP Variants
- Network Layer: Two main tasks: routing and forwarding; Forwarding in VC and Datagram networks; IP protocol
- Network Layer: ICMP, Routing algorithms, Routing in the Internet, Multicast
- Link Layer and Local Area Network (LAN): Link layer services, Error detection and correction, Multiple Access Protocols
- Link Layer and Local Area Network (LAN): Link layer addressing, Ethernet, Hubs and switches, Point-to-Point Protocol

❖ **Resources**

Textbooks

- Kurose and Ross. Computer Networking: A Top-down Approach (5th Ed. or later). Publisher: Addison Wesley

Tools

- N/A

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CS404 – Internship

❖ General information

- Course ID : **CS404**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **0**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **120**
- Prior-course : **CM101, CS202, CS300, CS486, SC203, WR227**

❖ Course description

This course is to give students opportunities to know and experience the real working context at a Computer Science company or professional organization as full-time interns. The (student) interns will be able to take part in the company's real projects. They can discover organization structures, roles and responsibilities within that structure, the processes applied at the company; demonstrate their own knowledge, techniques and professional skills; and comprehend the company culture or etiquette rules. Through the course, students could make more connections with people in the same professional field, gain insight into a career path for their future job, and build their professional manners and attitude to adapt in the business and industrial environment.

Students can choose which company to take the internship by their own based on the "Call for Internship" posts in the official faculty or university websites, or in other websites, media, etc. The company is not limit in Ho Chi Minh city or in Viet Nam. Students are encouraged to take their internship in foreign countries.

The internship is required related to Computer Science field (for examples, application/system design, application/system analysis, application/system building, application/system testing, etc.), and not limit to any programming languages, frameworks, operation systems, types of application. The internship must be full time and not less than 10 weeks.

❖ Course goals

At the end of the course, students are able to

- Apply what they have learned in the classroom to the corporate setting, and make professional contributions to the organization in which the student is placed.
- Adapt the business and industrial environment in which a computer professional must learn to function.
- Develop the personal, interpersonal skills and charactersitics in the working environment.
- Improve their foreign language skills.

❖ **Course content**

- Before the start of the internship: Students are required to submit an offer letter from an industry or a professional organization outlining the duties and expectations during the internship. The letter must also include start date, end date, hours to be worked, and name, email, phone of the on-site supervisor.
- After finishing the internship: Students are requested to write a report on what they have done during their internship. There will be no template for the report. But, as a recommendation, this report should have (not limit to) following parts: overview of the company; information about the internship, the project, intern role in the project; ways of communications; models/solutions/techniques applied in the project; (success and/or failure) lessons learned from this internship, etc. This report should be formatted as a technical report with cover, table of contents, references, etc.
- Also, students have to declare the following statement in the report: "I declare that this internship report is my own work and does not involve in plagiarism or collusion. I accept heavy penalty for any cheating or plagiarism".

❖ **Resources**

Textbooks

- No required text book.

Others

- John Mongan, Noah Suojanen Kindler, Eric GiguÃ¨re, Programming Interviews Exposed: Coding Your Way Through the Interview (4th Edition), Wrox, 2018.
- Adnan Aziz, Tsung-Hsien Lee, Amit Prakash, Elements of Programming Interviews: The Insiders' Guide (2nd Edition), CreateSpace Independent Publishing Platform, 2012.
- Gayle Laakmann McDowell, Cracking the Coding Interview: 189 Programming Questions and Solutions (6th Edition), CareerCup, 2015.
- Wladston Ferria Filho, Computer Science Distilled: Learn the Art of Solving Computational Problems, Code Energy LLC, 2017.

Tools

- www.fit.hcmus.edu.vn
- www.linkedin.com
- (Article) 50 Most Common Interview Questions, URL: https://www.glassdoor.com/blog/common-interview-questions/ (Accessed: November 2020).

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CS405 – Open Economy, Entrepreneurship and Education

❖ General information

- Course ID : **CS405**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

The course is divided in 2 phases. Phase will be course work introducing different mechanisms of OpEEE (e.g. sharing economy, collaborative models, open source, Do It Yourself / Makers approaches, open science & research, empowering innovations) & practical tools to efficiently conduct projects. A strong emphasis will be put on digital tools and networking skills during all the class. Students will also have a chance to meet with players active in this new economy. Phase 2 will be dedicated to field work. Subjects will be co-defined with host companies / organizations. Students, then in group of 3-4 people, will apply the different mechanisms of OpEEE in order to initiate the very first concepts. Interactions with different players (companies, communities of end users, stakeholders) in related ecosystems will be crucial to iterate & validate the final concept. A prototype is highly recommended in order to have a concrete result but it is not obligatory.

❖ Course goals

At the end of the course, students are able to

- Understand the main mechanisms of Open Economy, Education & Entrepreneurship
- Initiate a concept aiming at solving local issues based on OpEEE mechanisms
- Work & coordinate with host enterprises / organizations to get the best output from available resources
- In team, to start, iterate & finalize a prototype

❖ Course content

- Unlocking the collective wisdom
- Collective intelligence
- Collaborative models
- Sharing economy
- Do It Yourself / Makers movements
- Empowering innovations / jugaad innovation
- Open education /open research

- Smart cities
- Sustainable lifestyles
- Sustainable solutions: ecosystems, local loops, green energy, food

❖ **Resources**

Textbooks

- Most textbooks we refer to can be viewed on line in videos such as TED talks, or pdf versions. We assume that, for financial reasons as well as well as being update in real time, students will rather browse the following list of links. Paperback versions can all be bought through e-commerce sites online.

Others

- Four principles of open world, Don Tapscott, 2012, http://goo.gl/mM2xE2
- The era of open innovation, Charles Leadbeater, 2005, http://goo.gl/F2XAs7
- The Connection Economy, why it matters, Seth Godin, 2013, http://goo.gl/vK5wGq
- The birth of Wikipedia, Jimmy Wales , 2005, http://goo.gl/fgWtgZ
- Jugaad innovation, Navi Radjjou, 2012, paperback edition or TED talk
- Open sourced cancer research, Jay Bradner, 2011, http://goo.gl/hWabf7
- Changing Education Paradigm, Ken Robinson, 2010, http://goo.gl/l4gck3
- What is mine is yours, Rachel Botsman, 2010, paperback edition or TED talk
- The wisdom of the crowds, James Surowiecki, 2005, paperback edition or TED talk

Tools

- N/A

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CS407 – Technology-based Innovation and Leadership

❖ General information

- Course ID : **CS407**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Scientific Methods**

❖ Course description

The course is designed to provide students with a basic understanding of the innovators' mindset and provide students the opportunity to self-develop behaviors correlated with disruptive innovators. Skills to be developed – through coaching on assignments and in-class exercises – include observation of status-quos, idea generation by associating known solutions to solve status-quos or through lateral thinking; networking with people to identify technological contributions, optimizing creativity, seeking feedback, and prototyping or mockup design. The side impacts of this course include development of out-of-the-box thinking, with imagination in an original manner to all problems identified through careful observation of status-quos. Innovation means transformation of technology into values and in the course, students have the opportunity to test their imagination about new generations of products (devices, software, tools, apps) or methods/procedures and estimate the impacts of their innovations to life.

❖ Course goals

At the end of the course, students are able to

- Observe status-quos in real life
- Identify core elements leading to status-quos and propose mitigation strategy or replacement principles
- Generate innovative ideas (associating known solutions to status-quos or with lateral thinking techniques)
- Optimize ideas through networking and discussion with team
- Teamwork to construct the future of which the working innovation enters into real-world
- Think and act with greater self-confidence and self-awareness about how technologies (IT) could be applied to solve real-world problems

❖ **Course content**

- What is Innovation? Why do we need Innovations? Different approaches to innovations (cases of Starbucks, Toyota, Apple iPhone, etc.)
- Observing status-quo's;
- Identify "problems" out of daily life scenarios
- Creativity - Where does it come from?
- Examples of disruptive innovators, how they think and imagine are "out-of-the-box"
- Hands-on exercises of observing status-quos. Team formation and Project definition
- Identifying solutions to problems (improving status-quos)
- Examples of Associating known solutions to solve new problems
- Optimizing innovative ideas
- Team-based innovation
- Imagining the future product/process
- Mock-up design
- Presentation of Team/Individual Projects

❖ **Resources**

Textbooks

- J. Dyer & C.M. Christensen (2011) The Innovator's DNA – Mastering the Five Skills of Disruptive Innovators. Harvard Business Review Press

Others

- Case studies mostly from Harvard Business School

Tools

- N/A

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CS408 – Computational Finance

❖ General information

- Course ID : **CS408**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course :

❖ Course description

In this course, we will present the principles of computational finance and financial data analysis, focusing on research problems of algorithmic interest, including online algorithms, short-term trading strategies, technical analysis, etc.

❖ Course goals

At the end of the course, students are able to

- Grasp concepts
- Understand reasonings for most results, methods, techniques in at least one aspect: algebraic, geometric, numeric
- Utilize concepts, results, and techniques for computations in various settings

❖ Course content

- Introduction to Markets
- Introduction to Derivatives
- Pricing Futures
- The Capital Assets Pricing Model
- Properties of Stock Options
- Financial Time Series Data
- Linear Time Series Analysis
- Random Walk Models
- Competitive Analysis
- Technical Analysis
- Review
- Final Thoughts on the Market

❖ **Resources**

Textbooks

- John C. Hull, Options, Futures, and Other Derviatives Prentice Hall, Fifth Edition, 2003.
- Ruey S. Tsay, Analysis of Financial Time Series John Wiley, 2001.

Tools

- N/A

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CS409 – Enterpreneurship

❖ General information

- Course ID : **CS409**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **30**
- Prior-course : **Social, Ethical, and Legal Issues**

❖ Course description

This course is designed to give IT-background students the first look at Startup and Entrepreneurship, guide them from aspiring to action by providing guidelines, self-learning resources, and connections to the local startup communities.
CS409 is not about how to start a startup that is well-covered by Startup School (by Y-combinator). Instead, this course is focused on preparing for those who have little or no working experience, giving them a general understanding of Startup - a semantic tree of knowledge - so they can quickly kick-start their entrepreneur journeys after taking the course if they choose so.

❖ Course goals

At the end of the course, students are able to

- Understand the concept of IT-based Startup, Entrepreneurship and Innovation in Startup.
- Understand the concept and frameworks to plan a new business.
- Develop business ideas through networking and discussion with team.
- Build a solid business plan for an IT-based Startup.
- Pitch / Present the business idea and business plan to investor.

❖ Course content

- Course Introduction
- The entrepreneurship framework (1)
  - Step 0: The starting point
  - Step 1: Market Segmentation
  - Step 2: Beachhead Market
- Market and business model
- Innovation in Startup: Product, Process, Business Model Innovation
- The entrepreneurship framework (2)
  - Step 3: End User Profile

    - Step 4: Total Addressable Market (TAM)
    - Step 5: Persona of Beachhead market
- Products
- The entrepreneurship framework (3)
    - Step 6: Full Life Cycle Use Case
    - Step 7: High Level Product Specification
    - Step 8: Quantify the Value Proposition
- Market research & define core competencies
- Go-to-market Archetypes
- The entrepreneurship framework (4)
    - Step 9: Identify your next 10 customers
    - Step 10: Define your core
    - Step 11: Chart your competitive position
- Market research & define core competencies (cont)
- The entrepreneurship framework (5)
    - Step 12: Determine the Customer's Decision Making unit
    - Step 13: Map the process to acquire the paying customers
    - Step 18: Map the sales process to acquire a customer
- Venture builder
- Raising fund and Startup's ground rules
- The entrepreneurship framework (6)
    - Step 15: Design a business model (Business Model Canvas)
    - Step 16: Set your pricing framework
- Marketing & Pricing
- The entrepreneurship framework (7)
    - Step 17: Calculate the life time value (LTV) of a customer
    - Step 19: Calculate the Cost of Customer Acquisition (COCA)
- Pivot
- The entrepreneurship framework (8)
    - Step 20: Identify Key Assumptions
    - Step 21: Test Key Assumptions
    - Step 22: Define the Minimum Viable Business Product (MVBP)
- Launching plan
- The entrepreneurship framework (end)
    - Step 23: Show that "The Dogs Will Eat the Dog Food"
    - Step 24: Develop a Product Plan
- Final Presentation

❖ **Resources**

Textbooks

- Bill Aulet (2013) Disciplined Entrepreneurship: 24 steps to a Successful Startup. Wiley

Others

- Alexander Osterwalder & Yves Pigneur (2010) Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. Wiley.
- Others material mostly from Y-combinator & Antler.

Tools

- N/A

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CS469 – Capstone Project I

❖ General information

- Course ID : **CS469**
- Knowledge block : **Elective – Graduation Projects**
- Number of credits : **5**
  - Credit hours for theory : **0**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **150**
- Prior-course : **Any programming-intensive CS elective, CS350, CS320, CS333, CS300**

❖ Course description

This course emphasizes teamwork in small groups on a substantial project that will be performed for a real customer. Projects are chosen to provide interdisciplinary content with project proposals being solicited from the community at large. Projects that involve students as well as customers from other disciplines are encouraged. Lectures will be directed towards the management of software development projects such as those being carried out by the teams. It is the intent of the course to provide a capstone experience that integrates the material contained in the remainder of the CS curriculum through work on a project that applies this material in another discipline. Each team member will contribute to the design, documentation, and testing phases of the project. This course creates an obligation for participation for two consecutive quarters.

❖ Course goals

At the end of the course, students are able to

- Demonstrate a professional attitude
- Demonstrate the ability to integrate the different disciplines required
- Communicate effectively with clients and sponsors
- Communicate effectively in both written work and in group situations
- Effectively manage, monitor, and control the activities involved in a development project
- Determine an appropriate process and accompanying set of deliverables for their project
- Show the ability to document appropriately the deliverables for their project - software specifications, project plans, source code, technical reports…
- Select and justify an appropriate methodology for their project
- Demonstrate a professional attitude

❖ **Course content**

Initially, the Capstone class will have a structure like that of most other classes. Saturday morning meetings will consist of lecture and class interaction. The goal of these lectures will be to help reinforce students' knowledge of commonly accepted software engineering and project management practices. However, by the second term of the Capstone Sequence, the structure of the course will have morphed to something unlike any other course you have taken here. A major goal of the Capstone is to accustom you to a corporate team environment, where responsibility for getting things done belongs to the team and its members.
Each team will arrange a regular half hour status meeting with the Instructor each week. This will provide some visibility into team performance, dynamics, and effort invested by individual team members. In addition, the status meetings will ensure that each team makes steady, consistent progress towards completing the project.

- Introduction and game
- Game review and Projects presentation
- Project Management Skills
- Project Interview
- Requirement Engineering
- Kickoff Meeting
- Proposal presentation
- Proposal Review
- Meeting
- Meeting
- Meeting
- Project presentation (first phase)

❖ **Resources**

Textbooks

- Software Engineering (9th Edition): Ian Sommerville

Others

- All software engineering books

Tools

- Rational Suite
- IDEs (VS, Eclipse, Netbean…)
- UML CASETools
- Software testing tools
- Project management tools
- Moodle

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CS470 – Capstone Project II

❖ General information

- Course ID : **CS470**
- Knowledge block : **Elective – Graduation Projects**
- Number of credits : **5**
  - Credit hours for theory : **0**
  - Credit hours for practice : **0**
  - Credit hours for self-study : **150**
- Prior-course : **Capstone Project I, Any programming-intensive CS elective, CS350, CS320, CS333, CS300**

❖ Course description

This course emphasizes teamwork in small groups on a substantial project that will be performed for a real customer. Projects are chosen to provide interdisciplinary content with project proposals being solicited from the community at large. Projects that involve students as well as customers from other disciplines are encouraged. Lectures will be directed towards the management of software development projects such as those being carried out by the teams. It is the intent of the course to provide a capstone experience that integrates the material contained in the remainder of the CS curriculum through work on a project that applies this material in another discipline. Each team member will contribute to the design, documentation, and testing phases of the project. This course creates an obligation for participation for two consecutive quarters.

❖ Course goals

At the end of the course, students are able to

- Demonstrate a professional attitude
- Demonstrate the ability to integrate the different disciplines required
- Communicate effectively with clients and sponsors
- Communicate effectively in both written work and in group situations
- Effectively manage, monitor, and control the activities involved in a development project
- Determine an appropriate process and accompanying set of deliverables for their project
- Show the ability to document appropriately the deliverables for their project - software specifications, project plans, source code, technical reports…
- Select and justify an appropriate methodology for their project
- Demonstrate a professional attitude

❖ **Course content**

Initially, the Capstone class will have a structure like that of most other classes. Saturday morning meetings will consist of lecture and class interaction. The goal of these lectures will be to help reinforce students' knowledge of commonly accepted software engineering and project management practices. However, by the second term of the Capstone Sequence, the structure of the course will have morphed to something unlike any other course you have taken here. A major goal of the Capstone is to accustom you to a corporate team environment, where responsibility for getting things done belongs to the team and its members.
Each team will arrange a regular half hour status meeting with the Instructor each week. This will provide some visibility into team performance, dynamics, and effort invested by individual team members. In addition, the status meetings will ensure that each team makes steady, consistent progress towards completing the project.

❖ **Resources**

Textbooks

- Software Engineering (9th Edition): Ian Sommerville

Others

- All software engineering books

Tools

- Rational Suite
- IDEs (VS, Eclipse, Netbean…)
- UML CASETools
- Software testing tools
- Project management tools
- Moodle

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CS386 – Introduction to Database Systems

❖ General information

- Course ID : **CS386**
- Knowledge block : **Elective – Computer Science**
- Number of credits : **4**
  - Credit hours for theory : **40**
  - Credit hours for practice : **90**
  - Credit hours for self-study : **30**
- Prior-course : **Discrete Mathematics**

❖ Course description

The course is designed to provide students the overview of the needs for databases in enterprises, as well as other organizations. The course will provide the background knowledge of database systems on where the relational model is emphasized. Moreover, the techniques, tools and skills are provided for students to design, manipulate, and exploit the database via a relational database management system. The course also mentions future trends in database systems research.

❖ Course goals

At the end of the course, students are able to

- Explain roles and basic concepts of a database in an information system
- Apply common data models for modeling data
- Master query languages to exploit the relational database
- Design a good database schema
- Describe how main components of Database Management System (DBMS) work
- Practice skills of building databases and queries in DBMS

❖ Course content

- Overview database system
- Entity relationship model
- Relational data model
- Query languages
- Integrity constraint
- Functional dependency and normal forms
- Transaction, scheduler and locking
- Recovery methods
- Other database issues

❖ **Resources**

Textbooks

- Database Systems: The Complete Book (2nd Edition), Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, Prentice Hall, 2008.
- Fundamentals of Database Systems (7th Edition), Ramez Elmasri, Shamkant B. Navathe, Addison Wesley, 2017.

Others

- Database system concepts (7th Edition), Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill, 2020.
- Database Management System (3rd Edition), Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill, 2003.

Tools

- MS SQL Server: T-SQL
- Visual studio.NET: C#, ASP.NET Framework