PHYS 140 Digital Fundamentals 2015

Offered: Semester I
Credit: 15 points
Pre-/Co-requisites: None

Description

An advancing course in Physics for hardware-oriented Computer Science students presenting an introduction to Boolean Algebra, and its implementation into digital logic circuits. Laboratory work using IC (Integrated Circuits) is a large component of the course. A minimal background in mathematics and physics is required, but no previous electronics experience or programming knowledge is assumed.

Aims

This course provides students with an introduction to the basic principles of Boolean Algebra which are used to understand modern digital fundamentals. Digital logic instrumentation is presented as real world applications of Boolean Algebra.

Skills and knowledge to be gained

Students who pass this course should be able to:

- explain the basic Boolean logic operations of NAND, NOR and NOT
- state the laws and rules of Boolean Algebra
- explain Boolean expressions in terms of sum-of-product and product-of-sum forms
- simplify multivariable Boolean Algebra expressions using Karnaugh maps
- express decimal numbers in binary, octal and hexadecimal forms
- explain combinatorial logic and sequential logic
- describe functions of combinatorial logic such as adders, decoders and multiplexers
- explain the operation of latchs, SR, D, and JK edge-triggered flip-flops
- describe the difference between synchronous and asynchronous digital logic circuits
- explain the operation of integrated circuit counters, cascaded counters and shift registers using timing diagrams
- explain how analogue signals are converted into binary numbers, and how binary numbers are reconverted back into analogue signals
- describe the basics of computer memory, RAM/ROM, read/write, addressing
- construct digital logic circuits in the lab and present results in a clearly written Lab Report

Syllabus

- Introduction to digital logic, representation by electronic quantities; fundamental quantities (NAND, NOR, and NOT); combinational logic, truth tables, minterm and maxterm forms; minimization of Boolean expressions; NAND and NOR gate implementation; binary, octal and hexadecimal number systems; introduction to digital logic computer simulation codes: Logisim©.
- Larger combinational logic problems; Karnaugh maps and systematic methods for minimization, exclusive-OR gates; binary arithmetic, ones and twos complement, half-adders, full-adders.
- Sequential circuits, RS, D, and JK flip-flops, master-slave flip-flops; modulo-n counters and design methods using JK and D flip-flops.

- Shift registers, parallel-to-serial and serial-to-parallel conversions, BitComparators; counters with control features, cascading counters; operational Amplifier introduction, digital signal sampling, Nyquist Theorem; analogue-to-digital conversion (ADC), successive approximation; tracking and digital ramp, parallel encoders, research example from CERN.
- Digital-to-analogue conversion (DAC), current-ladder, multichannel analyzers; programmable array logic introduction; simple computer: registers and buses, memory (RAM and ROM), PICAXE microcontroller introduction and programming in lab.

Learning activities and teaching methods

Description	Study time
44 x 1-hour lectures	44 hours
4 x 1-hour In-Class Assignments	4 hours
Private Study (1.5 hours per lecture)	66 hours
Lab Work (3 hours per lab session)	30 hours

Inclusive learning

Students are urged to discuss privately any impairment-related requirements face-to-face and/or in written form with the course convenor/lecturer and/or tutor.

Assessment

Form	Weight	Time	When
assignments	20% (4 × 5%)	4 hours	weeks 2, 5, 8, 11
labs	20% (5 × 4%)	3 hours/week	weeks 1-11
exam	60%	3 hours	exam period

Academic Integrity

The University of Auckland will not tolerate cheating, or assisting others to cheat, and views cheating in coursework as a serious academic offence. The work that a student submits for grading must be the student's own work, reflecting his or her learning. Where work from other sources is used, it must be properly acknowledged and referenced. This requirement also applies to sources on the world-wide web. A student's assessed work may be reviewed against electronic source material using computerised detection mechanisms. Upon reasonable request, students may be required to provide an electronic version of their work for computerised review. Please visit the below link for further information: https://www.auckland.ac.nz/en/about/learning-and-teaching/policies-guidelines-and-procedures/academic-integrity-info-for-students.html

Resources

Prescribed text:

Thomas Floyd (2009) *Digital Fundamentals* (10th edition) (Pearson International Edition); 140 Lab Manual, Department of Physics, The University of Auckland.

LogiSim© digital simulation software from a free download.

Feedback

Marked script and model solutions to assignments; marked exam script (if requested)

Enrolment

Typical enrolment Semester I: 130