| DO NOT TYPE IN THIS BOX |
|---|
| Bulletin # : _____ |
| Academic Year : _____ |

# FLORIDA INTERNATIONAL UNIVERSITY
# UNIVERSITY CURRICULUM COMMITTEE
## *Proposal for a New Course*

1. **School/College** Engineering and Computing

   **Div./Dept. in Which Taught** School of Computing and Information Sciences

2. CDA (Alpha Prefix) | 3 (1st Digit) | _____ (Last 3 Digits) | _____ ("C"-lec-lab "L"-Lab) | 3 (Cr. Hrs.)

   **CIP Code** *(Leave this blank):* _____

3. **Grading Method (select one):** ☒ Graded ☐ Pass/Fail

4a. **Course Title** Computer Architecture

b. **Abbreviated course Title** *(for computer class schedules, transcripts)* Computer Architecture

LIMITED TO 25 Characters *(including spaces)*

5. **Statewide Course Numbering Subject Matter Area** CDA (Computer Design/Architecture)

6. **Catalog Description/Major Topics** *(not to exceed 200 characters including spaces)*

   *College of Medicine and College of Law: Attach description not exceeding 1,000 characters including spaces.*

   Covers the levels of organization in a computer: digital logic; machine and assembly language programming, design of memory, buses, ALU, CPU; virtual memory, I/O.

7. **Attach detailed syllabus course outline and course justification on separate page(s).**
8. **Prerequisite(s):** COP 3337 and (COT 3100 or MAD 2104)
9. **Corequisite(s):** None
10. **Objective(s) of Course:**

    Mastery in machine and assembly language programming; design of combinational and sequential circuits, memory, ALU, and CPU; Exposure to cache architectures, branch predictions & multiple instrn issue

11. **Does this course duplicate/overlap other courses at FIU?** ☒ No ☐ Yes
    **If yes, please explain:** _____
12. **What other closely related department(s) have been consulted about this course?**
    Electrical and Computer Engineering
13. **Is this course used for the assessment of a program or a certificate (if yes, then send a notification to assessment@fiu.edu)?** No Yes

**PROPOSAL REQUESTED BY:**

**Faculty Contact** Trevor Cickovski _____ 3 / 21 / 20 19
(Type name) (Signature)
tcickovs@fiu.edu 305-348-8043
(Email address) (Phone number)

**Chairperson (Dept./Div.)** S.S. Iyengar _____ 3 / 21 / 20 19
(Type name) (Signature)

**Chairperson (Curr. Comm.)** Cesar Levy _____ / / 20 19
(Type name) (Signature)

**College/School Dean** John Volakis _____ / / 20 19
(Type name) (Signature)

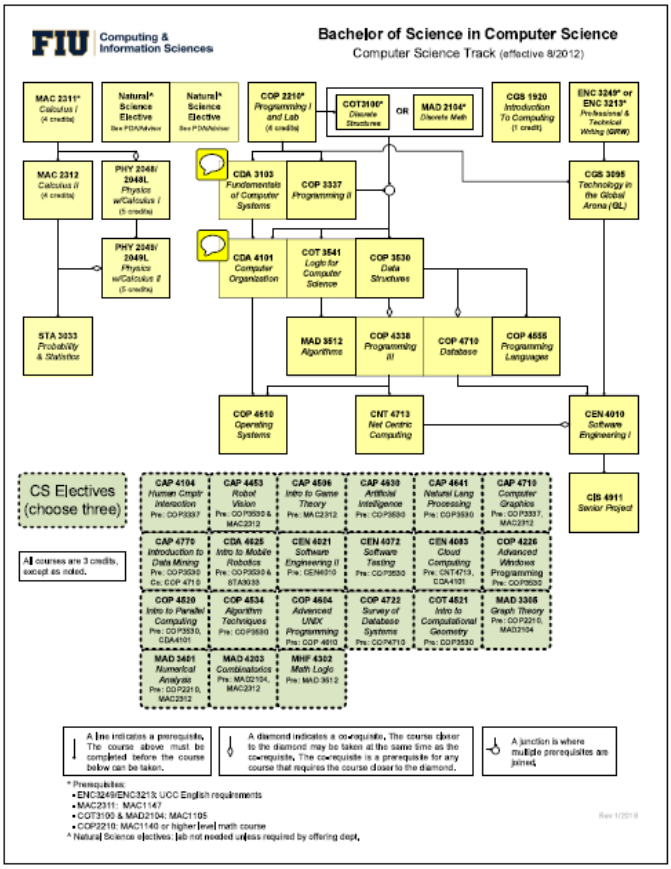
**Submit one original form. Attach one copy of the course justification and course syllabus, course description, objectives, major topics and textbooks.**

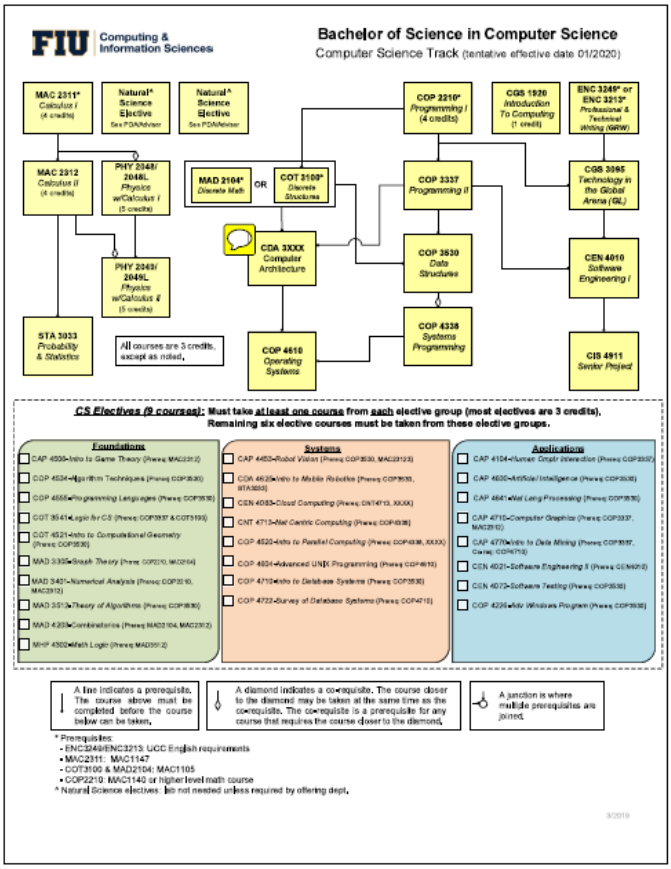
**CDA 3XXX Computer Architecture**

**New Course Justification**

During the curriculum restructuring process, two architecture specific required courses (CDA-3103 and CDA-4101) are identified with substantial overlap with other Computer Science required courses. For this reason, these two courses as in the left flowchart (present curriculum model) below, have been replaced with one new course (CDA-3XXX) as shown in the right flowchart (restructured new curriculum model) below. This enables students to take one additional elective course to widen their skills in emerging technologies that would increase their career opportunities.

This course focuses on the execution of high-level language programs through assembly language code and machine language, basics of digital logic; design of combinational and sequential circuits, memory, arithmetic logic unit, and CPU. Further, it introduces cache architecture, branch prediction and multiple instruction issue that would facilitate students to gain insight on performance improvement of program execution.



Subject: Re: New undergraduate "Computer Architecture course - proposal
From: Shekhar Bhansali <sbhansa@fiu.edu>
Date: 3/20/2019, 11:53 PM
To: Nagarajan Prabakar <prabakar@cis.fiu.edu>
CC: Herman Watson <hwatson@fiu.edu>, "S. S. Iyengar" <iyengar@cs.fiu.edu>, Shu-Ching Chen <chens@cs.fiu.edu>, Elias Alwan <ealwan@fiu.edu>, Jean Andrian <andrianj@fiu.edu>

ECE would have no objections to what you are proposing

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> On Mar 20, 2019, at 11:23 PM, Nagarajan Prabakar <prabakar@cis.fiu.edu> wrote:
>
> Dear Shekhar,
>
> SCIS is restructuring the undergraduate curriculum to reduce the length of course prerequisite chain and to accelerate the 4-year graduation rate for SCIS majors.
> In this regard, we propose to replace the following two required architecture courses in the current model
> Â Â  CDA-3103 "Fundamentals of Computer Systems"
> Â Â  CDA-4101 "Computer Organization"
> with one new course: CDA-3XXX "Computer Architecture" as in the proposed model.
>
> Please review this course syllabus of this course and let us know if there is any overlap with ECE courses.
>
> Sorry for the late notice. I would appreciate if you could inform your decision by this week.
>
> Thank you
> Regards
> --Prabakar
> 305.348.2033
>

# School of Computing and Information Sciences

**Course Title:** Computer Architecture **Date:** 3/20/19

**Course Number:** CDA-4101

**Number of Credits:** 3

| **Subject Area:** Computer Organization | **Subject Area Coordinator:**<br>Nagarajan Prabakar<br>**email:** prabakar@cis.fiu.edu |
|---|---|
| **Catalog Description:**<br>Covers the levels of organization in a computer: digital logic; machine and assembly language programming, design of memory, buses, ALU, CPU; virtual memory, I/O | |
| **Textbook:** Computer Organization and Design: The Hardware/Software Interface<br>David A. Patterson, John L. Hennessy<br>Morgan Kaufmann | |
| **References:** Digital Design and Computer Architecture<br>David Money Harris and Sarah L. Harris<br>Morgan Kaufmann | |
| **Prerequisites Courses:** COP 3337 and (COT 3100 or MAD 2104) | |
| **Corequisites Courses:** None | |

Type: Required for CS Major

Prerequisites Topics:

- High level programming language constructs
- Function call/return
- Parameters of a function(method)
- Boolean algebra
- Fundamental data structures

Course Outcomes:

1. Master the data path of a simple von Neumann architecture and its relation to the instruction execution cycle
2. Master simple machine and assembly language programming
3. Master the implementation of high-level language constructs in lower levels: selection, iteration, function call/return
4. Be familiar with interrupts and traps
5. Master the design of combinational and sequential circuits
6. Master the design of memory and the ALU.
7. Master control unit design
8. Be familiar with cache architectures, branch predictions, scheduling of multiple instruction issue and flow control

**School of Computing and Information Sciences**
**CDA-3XXX**
**Computer Architecture**

## Relationship between Course Outcomes and Program Outcomes

| BS in CS: Program Outcomes | Course Outcomes |
|---|---|
| a) Demonstrate proficiency in the foundation areas of Computer Science including mathematics, discrete structures, logic and the theory of algorithms | 1, 5 |
| b) Demonstrate proficiency in various areas of Computer Science including data structures and algorithms, concepts of programming languages and computer systems. | 1, 2, 3, 5, 6, 7, 8 |
| c) Demonstrate proficiency in problem solving and application of software engineering techniques | 5 |
| d) Demonstrate mastery of at least one modern programming language and proficiency in at least one other. | |
| e) Demonstrate understanding of the social and ethical concerns of the practicing computer scientist. | |
| f) Demonstrate the ability to work cooperatively in teams. | |
| g) Demonstrate effective communication skills. | |

## Assessment Plan for the Course & how Data in the Course are used to assess Program Outcomes

Student and Instructor Course Outcome Surveys are administered at the conclusion of each offering, and are evaluated as described in the School's Assessment Plan: http://www.cis.fiu.edu/programs/undergrad/cs/assessment/

**School of Computing and Information Sciences**
**CDA-3XXX**
**Computer Architecture**

## Outline

| Topic | Number of Lecture Hours | Outcome |
|---|---|---|
| • Digital logic: Design of<br>o Data representation<br>o Fundamental building blocks (logic gates, combinational circuits)<br>o Von Neumann model<br>o Instruction execution cycle<br>o Multiplexer, demultiplexer, encoder, decoder<br>o Arithmetic Logic Unit, Shifter<br>o Latch, flip-flop, register, memory organization<br>o Clocks, counters<br>o Bus protocols, arbitration, DMA<br>o Data path, control unit<br>o Microprogram | 14 | 1,5,6,7 |
| • Assembly level machine organization<br>o Instruction sets and types<br>o Assembly language programming<br>o Addressing modes<br>o Subroutines and system routines<br>o I/O and interrupts<br>o Bit level manipulation<br>o Assembly process and linking | 14 | 2,3,4 |
| • Performance enhancement<br>o Interpretation and translation<br>o Simple machine architecture<br>o Instruction prefetch<br>o Pipelining, pipeline hazards<br>o Cache architecture<br>o Branch prediction<br>o Dynamic scheduling of instructions<br>o Speculative execution | 11 | 8 |

**School of Computing and Information Sciences**
**CDA-3XXX**
**Computer Architecture**

## Course Outcomes Emphasized in Laboratory Projects / Assignments

| | Outcome | Number of Weeks |
|---|---|---|
| 1 | Digital circuit design<br>Outcomes: 5 | 2 |
| 2 | Machine and assembly language programming<br>Outcomes: 2,3 | 3 |
| 3 | Control unit and CPU design<br>Outcomes: 1,4,7 | 4 |
| 4 | Memory<br>Outcomes: 6,8 | 2 |
| 5 | Pipelining<br>Outcomes: 8 | 2 |

## Oral and Written Communication

No significant coverage

| Written Reports | | Oral Presentations | |
|---|---|---|---|
| Number Required | Approx. Number of pages | Number Required | Approx. Time for each |
| 0 | 0 | 0 | 0 |

## Social and Ethical Implications of Computing Topics

No significant coverage

| Topic | Class time | student performance measures |
|---|---|---|
| | | |

**School of Computing and Information Sciences**
**CDA-3XXX**
**Computer Architecture**

## Approximate number of credit hours devoted to fundamental CS topics

| Fundamental CS Area | Core Hours | Advanced Hours |
|---|---|---|
| **Algorithms:** | | |
| **Software Design:** | | |
| **Computer Organization and Architecture:** | **2.5** | |
| **Data Structures:** | | |
| **Concepts of Programming Languages** | **0.5** | |

## Theoretical Contents

| Topic | Class time |
|---|---|
| | |

## Problem Analysis Experiences

1. Instruction set analysis, Implementation of high level programming language constructs in low level languages

## Solution Design Experiences

1. Digital circuit design
2. Assembly language programming
3. Microprogram design

**School of Computing and Information Sciences**
**CDA-3XXX**
**Computer Architecture**

## The Coverage of Knowledge Units within Computer Science Body of Knowledge[1]

| Knowledge Unit | Topic | Lecture Hours |
|---|---|---|
| PL2 | Virtual machine, hierarchy of virtual machines, intermediate languages | 6 |
| AR1 | History of computer architecture, fundamental logic circuits, gate delays | 6 |
| AR2 | Bits, bytes, and words, numeric data representation, fixed- and floating-point systems, signed and twos-complement representations, nonnumeric data (character codes, graphical data), representation of records and arrays | 2 |
| AR3 | von Neumann machine, control unit; instruction fetch, decode, and execution, instruction sets and types (data manipulation, control, I/O), assembly/machine language programming, instruction formats, addressing modes, subroutine call and return mechanisms, I/O and interrupts | 12 |
| AR4 | Storage systems, coding, data integrity, memory organization, latency, cycle time, cache memories | 4 |
| AR5 | I/O fundamentals, external storage, RAID architectures, bus protocols, bus arbitration, DMA | 2 |
| AR6 | Implementation of simple datapath, control unit, pipelining, instruction level parallelism | 3 |
| AR7 | SIMD, MIMD, VLIW, interconnection networks, shared memory systems, cache coherence | 2 |
| AR8 | Superscalar, superpipelining, branch prediction, prefetching, speculative execution, multiple instruction issue | 2 |

[1]See http://www.computer.org/education/cc2001/final/chapter05.htm for a description of Computer Science Knowledge units