SIMON FRASER UNIVERSITY
Senate Committee for Undergraduate Studies
NEW COURSE PROPOSAL

Course Number: **ensc452 (4)**

Course Title: **Advanced Digital System Design**
Long - for calendar/schedule no more than 100 characters including spaces/punctuation

AND
Short - for registration/transcript no more than 30 characters including spaces/punctuation

Advanced Digital System Design

State number of hours for Lect (**2**) Sem ( ) Tut ( ) Lab (**4**)

Course Description (for Calendar).

Digital System Design Considerations including: Methodologies, Specification, SoC partitioning, Fault Tolerance, Design Reuse, Debugging and Verification

Attached is a course outline to this proposal: See Pages 4-5

Prerequisite: **ensc 350 and ensc 351**

Corequisite: **N/A**

Special Instructions: i.e. does this course replicate the content of a previously approved course to such an extent that students should not receive credit for both courses. If so, this should be noted in the pre-requisite.

Course(s) to be dropped if this course is approved: **N/A**

Rationale for Introduction of this Course:

I believe there is currently only one technical elective offered for Computer Engineers (ensc 450) and its focus is on lower level design issues (CMOS) level. The proposed course is a systems level course, which enables computer engineers to utilize all their knowledge from previous hardware and software courses to develop a System-on-Chip (SoC). Finally, this course is also useful for students in other options as many applications cannot be implemented on general purpose processors and this course will provide them with the experience of implementing an SoC on a FPGA.

Scheduling and Registration Information:

Indicate effective **semester/year** course would be first offered and planned **frequency** of offering thereafter.

One previous offering and the desire is to offer it once a year.

There is a two-semester wait for implementation of any new course.

Waiver required _____

Will this be a required or elective course in the curriculum?

Offered as an elective

What is the probable enrolment when offered?

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Which of your present CFL faculty have the expertise to offer this course?

Dr. Lesley Shannon, Mr. Lakshman One

Are there any proposed student fees associated with this course other than tuition fees? (if so, attach mandatory supplementary fee approval form)

No.

Resource Implications:
Note: Senate has approved (S.93-11) that no new course should be approved by Senate until funding has been committed for necessary library materials. Each new course proposal must be accompanied by a library report and, if appropriate, confirmation that funding arrangements have been addressed.

Campus where course will be taught: _____**Burnaby**_____

Library report status _____

Provide details on how existing instructional resources will be redistributed to accommodate this new course. For instance, will another course be eliminated or will the frequency of offering of other courses be reduced; are there changes in pedagogical style or class sizes that allow for this additional course offering?

Any outstanding resource issues to be addressed prior to implementation: space, laboratory equipment, etc.

The necessary equipment has already been purchased.

Approvals

1. **Departmental approval** indicates that the Department has approved the content of the course, and has consulted with other Departments and Faculties regarding proposed course content and overlap issues.

   _____

   Chair, Dept./School Date

   _____

   Chair, Faculty Curriculum Committee Date

2. **Faculty approval** indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds.

_____ Date: _____

Dean or Designate

List which other Departments and Faculties have been consulted regarding the proposed course content including overlap issues. *Attach documentary evidence of responses.*

_____

_____

_____

_____

Other Faculties approval indicates that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

_____ Date: _____

_____ Date: _____

3. SCUS approval indicates that the course has been approved for implementation subject, where appropriate, to financial issues being addressed.

Course approved by SCUS (Chair of SCUS)

_____ Date: _____

Approval is signified by date and appropriate signature.

Course Outline.

- -good design practices
- -Design methodologies (top-down, bottom-up, etc)
- -Design Specification
- -Design for Testability
- -Design Considerations: cost, size, area, energy and power
- -Specifying System Requirements (for example:
  - -Functional Requirements "Use Case" List, UML
  - -flexibility/adaptability (upgrading functionality)
  - -tolerance (serviceability and safety)
  - -security)
- -Specifying Application Platform
  - -SoC? Custom/ASIC/FPGA? (Pros and Cons of each)
  - -multiple types of processors available
    - -Pentium, DSP (parallel datapath/execution architecture fixed/floating point 8-bit)
    - -various size/power requirements and capabilites
    - -FPGAs have reconfigurable and customizable (soft/hard)
  - -other peripherals (on-chip/off-chip); drivers/interface
    - -eg if it's real time, do I need a timer?
  - -OS required? is the application hard-coded to the platform (benefits of each)
- -FPGA architecture
- -FPGAs have their own design flow (altera/xilinx: Hardcopy)
- -FPGA CAD tools (ISE/EDK) and algorithms
- -Implementing Designs (Tasks)
  - -choosing a software language
  - -pros and cons of data types/structures (arrays vs pointers, sequential vs object oriented, performance vs abstraction, etc)
  - -example some applications use a DSP processor, which have on-chip memories. to meet performance requirements, the entire program has to fit on-chip hand-coded assembly
  - -implementation study: design choices:
    - -fixed point vs floating point
    - -computation resolution 8 vs 12 vs 16 ..
    - -fault tolerance (give an example)
    - -must meet time to market requirements
    - -software easy, but hardware faster... =(
- -Reliability:
  - -Why do systems fail to operate properly: long time in operation, hostile environment, etc.
  - -Give an example of a system that breaks down **Note may not be computation, may be communication
  - -Give examples of how fault tolerance can be introduced into hardware (additional hardware, "voting", where it’s

used (space applications, etc)) and software (exception handling)
-choosing/computing the "right" answer in inhospitable environments (high altitudes, high heat, underwater, space, etc)
-fault tolerance affects the application's platform choice

-Intellectual Property (types soft/firm/hard, legal issues)
-IP specification
-IP design
-IP reuse
-IP standards (groups VSIA, etc)
-Design Reuse is key for minimizing design time for hardware modules (IP cores)
-Many challenges: physical interface, communication protocols, altered functionality in new system (streamed/pipelined/bursty)
-Much work on how to design IP and many IP vendors
-Organizations such as VSIA promote standardized physical interfaces to simplify integration (OCP, Wishbone). Also AMBA).

-Datapath Design
-Data Synchronization Issues
-Asynchronous design
-Meta-stability
-code review
-Debugging and Verification (hw and sw); BIST, scan chain
-design visibility- how do we see the problems
-simulation
-debugging
-emulation
-verification-BIST, Scan Chain

-Requirements: Well defined Test Cases in the system specification and good test vector choices (may be part of the specification).
-Testboards, testbeds, logic analyzers
-Future of computing system design:
-NoC, MPSoC
-DSP Architecture
-Application-Specific Computing
-Reconfigurable Computing
-Embedded Systems
-Meta-computing