

CS - 2400 - Assembly Language Programming and Introduction to High Performance Computing

04. UG Course Modification (No Special Designation)

Due Dates and Resources

If you have questions or need assistance in filling out this proposal form, you may contact the [Office of Curriculum](#).

Deadlines for curriculum can be found:

[Curriculum SharePoint Curriculum Website Procedural Calendar](#)

On your Curriculog dashboard under 'My Upcoming Events'

In order to meet the deadline, this proposal must be on the *Nonsubstantive, Substantive Colleg/School, OR Substantive University Level Review* step on or before the listed due date. Which step will depend on the changes being made.

Resources for curriculum can be found:

[Originator How-To Guide Curriculum SharePoint](#)

This form **SHOULD** be used for the following:

Modification of a course **without** a special designation (General Studies, Service Learning, Ethnic Studies & Social Justice, or Senior Experience).

This form **SHOULD NOT** be used for the following:

Modifying a course with a special designation (General Studies, Service Learning, Ethnic Studies & Social Justice, or Senior Experience).
Creating a new course with or without a special designation (General Studies, Service Learning, Ethnic Studies & Social Justice, or Senior Experience).
Creating or

modifying a
graduate course.

Directions for Form

General Instructions and Information

You may collapse individual sections of this form by clicking the arrow or "V" icon to the right of the section title.

All fields that are marked with an asterisk (*) are required.

Each section may have additional directions attached. Please follow instructions.

Note: Proposals that are incomplete or filled out incorrectly will be returned to the originator.

INSTRUCTIONS FOR MODIFYING AN EXISTING COURSE

Import the course you wish to modify.

Fill out Part I of the form.

Carefully follow the instructions on selecting the level of review your proposal requires.
Incorrect review selection will require a resubmission of the proposal.

LAUNCH the proposal.

Fill out Part II to indicate all the modifications you make to the course.

Modify any course fields in Part III as needed.

Modification Note: DO NOT MAKE CHANGES TO YOUR COURSE

INFORMATION (PART III) UNTIL AFTER YOU LAUNCH THE PROPOSAL in order to track changes. Failure to use the track changes feature may cause a delay or denial of your proposal.

If you modify additional fields not already indicated in Part II, please make sure you add them to the modification list.

Approve the proposal.

Use the checkmark icon on the right of the screen to approve the proposal.

Part I: Department and Originator Information (Fill out BEFORE launching the proposal)

If you are changing course ownership, please list both departments and if applicable, both college/schools.

College/School:*

College of Aerospace, Computing, Engineering, and Design

Department:*

Department of Computer Sciences

Name of Proposal Originator* Weiyong Zhu

Email of Proposal Originator* wzhu1@msudenver.edu

Justification and Resource Implication for Curriculum Proposal:*

1. We change the title of this course to better reflect its contents, to avoid confusions that have been caused in the recent Program Review.
2. Assembly language programming not only is a foundational topic needed as prerequisite to upper-division Computer Science core courses such as Principle of Programming Languages and Operating Systems, but also is included in two mandatory knowledge units in NSA's CAE-CO (Centers of Academic Excellence – Cyber Operations) designation requirements for certifying Cybersecurity programs. Therefore, assembly language programming is one of the core topics that need to be included in both Computer Science curricula and Cybersecurity curricula that follow national standards. Meanwhile, assembly language programming is widely included in undergraduate Computer Science curricula by programs ranging from nationally top-ranked Computer Science programs to the ones at in-state public research institutions. We have been teaching assembly language programming in CS2400. This course modification proposal intends to clearly indicate it in the title of this course.
3. The rest of the topics in this course focus on basic performance analysis of computing systems as well as various fundamental ways to pursue high performance in computing at the system level, most of which rely on the topic of assembly language programming. However, this course neither has room nor intends to give a comprehensive coverage on high performance computing, which by itself would be an 4-credit-hour upper-division Computer Science course. Instead, this course serves as an introductory to basic high performance computing approaches at the system level. This course modification proposal intends to reflect this aspect in the title of this course as well.
4. We are removing the math prerequisite because it's not directly related to the contents in CS2400. Instead, the computer arithmetic covered in CS1400 are much more relevant and are sufficient.
5. We move "Error Detecting/Correcting Codes" and "Cache Memory" from CS2400 to CS1400 such that the Assembly Language Programming part can be covered in more depth. Meanwhile, these topics are more relevant to Computer Organization than to the introductory topics on High Performance Computing at the system level.
6. There is no additional resource required for the changes proposed in this proposal.

Related Curriculum Proposals:*

CS1400 <https://msudenver.curriculog.com/proposal:12622/form>

Impact Report for CS 2400

Source: 2024-2025 Undergraduate Catalog	
Prerequisite(s):	CPE 4700 - Senior Design I
	CS 3013 - Mobile App Development
	CS 3210 - Principles of Programming Languages
	CS 3400 - Computer Architecture [ARCHIVED FALL 2023]
	CS 3410 - Embedded Systems [ARCHIVED FALL 2023]
	CS 3600 - Operating Systems
	CS 3750 - Computer and Network Security
Programs	Computer Engineering Major, B.S.
	Computer Science Major, B.S.
	Computer Science Minor
	Senior Experience Graduation Requirements

Course Modification Level Review

The modification level review question will determine the workflow of this proposal, so it is essential you select the correct one. Please consult [this tool](#) which will help you determine the review level you need. If you select a level of review that does not include the changes you make to the course, this proposal will be denied and you will have to resubmit a new proposal. If you are unsure which level of review you need to select, please contact the Curriculum Staff [here](#).

Note: Changing the level of review after launching the proposal will not change the workflow. If you discover that you have selected an incorrect review level post-launch, you must submit a new proposal. You can contact the Curriculum Office to delete the incorrect proposal.

Course Modification Level Review Selection:*

Nonsubstantive Substantive College/School Level
 Substantive University Level

According to the Undergraduate Curriculum Manual, it is the responsibility of both the originator as well as each level of review to consider potential overlap and curriculum conflict. Any potential overlap or conflict with existing curriculum should be reviewed, and the impacted department(s) should be requested to provide a letter of notification or support, depending on the circumstances. Attach documentation that supports affected Departments were notified and/or provided support of the proposed changes in the Proposal Toolbox by clicking on the paperclip icon on the right side of the form.

Please Confirm That: I, the originator of this proposal, have completed the necessary due diligence to review this proposal for any potential overlap and/or conflict with existing curriculum. Any departments identified as having potential overlap and/or conflicts have been contacted and a letter of notification and/or a letter of support has been obtained.

Part II: Course Modification Information

Reminder: This form CANNOT be used to change courses with special designations (Ethnic Studies & Social Justice, Service Learning, Senior Experience, General Studies). If you submit a course with special designation(s) with this form, it will be denied and you will need to resubmit.

Please indicate on the below list all of the course modifications you are making. **Please do not make changes to sections you do not specify are being modified and make sure to select ALL sections that you modify.**

Specify which sections have been modified (check all that apply):

- Part IIIa (prefix, course number, course title, transcript/banner course title, course type, CIP code)
- Part IIIb (credits, distribution of credits, schedule type, grade mode, contact hours, repeats, equivalencies, crosslistings, registration restrictions)
- Part IIIc (prerequisites, corequisites, or prerequisite(s)/corequisite(s), banner enforced prerequisites, corequisites, or prerequisite(s)/corequisite(s), catalog course description, catalog note, lab fees, field trips)
- Part IIId (required reading, SBLOs, outline, evaluation of student performance)

If the course modification includes changing prefixes, is it a new prefix?

- Yes
- No
- N/A

Reminder: DO NOT MAKE CHANGES TO YOUR COURSE INFORMATION (PART IIIa-III d) UNTIL AFTER YOU LAUNCH THE PROPOSAL in order to track changes. Failure to use the track changes feature may cause a delay or denial of your proposal.

If you modify additional sections not already indicated, please make sure you add them to the modification checklist.

Part IIIa: Course Information

Prefix:

Course Number: 2400

Course Title: Assembly Language Programming and Introduction to High Performance Computing

Transcript/Banner: Assembly Language Programming and Introduction to High Performance Computing

Course Type:*

Computer Science

CIP Code: 11.0701

Part IIIb: Course Information, continued

Please check all that apply from the selections below. You may select more than one option if applicable.

- Check All that Apply:*
- Required for Major
 - Required for Minor
 - Required for Concentration
 - Required for Certificate
 - Elective
 - Specified Elective

To receive Title IV financial aid funds, all institutions of higher education must comply with the federal definition of a credit hour. The Higher Learning Commission requires institutions to maintain policies and procedures for verifying compliance with this definition.

Federal Credit Hour Definition: A credit hour is an amount of work represented in intended learning outcomes and verified by evidence of student achievement that is an institutionally-established equivalency that reasonably approximates not less than:

(1) one hour of classroom or direct faculty instruction and a minimum of two hours of out-of-class student work each week for approximately fifteen weeks for one semester or trimester hour of credit, or ten to twelve weeks for one quarter hour of credit, or the equivalent amount of work over a different amount of time; or (2) at least an equivalent amount of work as required in paragraph (1) of this definition for other activities as established by an institution, including laboratory work, internships, practica, studio work, and other academic work leading toward the award of credit hours. 34CFR 600.2 (11/1/2010)

Credits:* 4

Distribution of Credits:* (4 + 0)

Schedule Type(s):*

Lecture

Grade Mode(s):*

Letter

Face-to-Face or Equivalent Hours per course

Consult Appendix B and C of the [Curriculum Manual](#) to determine the hours for the course

Lecture: 50

Lab:

Internship:

Practicum:

Other Hours:

Additional Student 120
Work Hours:

Please answer yes or no to the below questions. If you answer yes to any of the questions, please fill out the related field on the right.

A specified repeatable course is a course that allows a student to repeat the course either in its entirety or for a certain identified total number of credit hours. If you decide to make your course repeatable, please specify either how many times a student can repeat the course for credit, or for the total number of credits they can receive.

Is this course a specified repeatable course? * No Yes

If yes, indicate specified repeatable number of credits and/or repeats allowed:

Is this course a variable topics umbrella course? * No Yes

If yes, indicate variable topic number of credits and/or repeats available:

A crosslisting is when a course is made available under additional prefixes for students in other programs.

An equivalency is when two courses are coded in Banner to be equal to each other.

Generally equivalencies are used when an old, archived course is needed to be equal to a new course. Crosslistings are used for all active courses. Supporting documentation should be included to demonstrate approval for crosslistings.

Are there course equivalencies? * No Yes

If yes, list all equivalent courses in alphabetical order:

Are there course crosslistings? * No Yes

If yes, list all crosslistings in alphabetical order:

Registration Restrictions

Program:

Major:

Level:

Undergraduate

Class:

Student Attribute:

Part IIIc: Course Information, continued

The following fields will allow you to attach prerequisites, corequisites, or prerequisites or corequisites to your course. Please specify if you want and of these prerequisites, corequisites, or prerequisites or corequisites Banner enforced.

Banner enforcement means that the requirement will be enforced when the student attempts to register for a course. If you do not Banner enforce the requirement, the system will not check the student's record for the requirement to be met.

Please also indicate the minimum passing grade.

Prerequisite(s): CS 1400 and CS 1050, both with a grade of "C-" or better, or permission of instructor.

Banner Enforced Prerequisite(s): (CS 1400 or CS 190C) and CS 1050

Minimum Passing Grade for Banner Enforced Prerequisite(s): C- or T

Corequisite(s):

Banner Enforced Corequisite(s):

Prerequisite(s) or Corequisite(s):

Banner Enforced Prerequisite(s) or Corequisite(s):

Minimum Passing Grade for Banner Enforced Prerequisite(s) or Corequisite(s):

Catalog Course Description:*

In this course, students learn assembly language programming and create software in assembly language using a contemporary development environment. Additionally, students study the functional organization of high-performance computers, multicore and multithreaded processors, high-performance storage, and multiprocessor and multicomputer parallel architectures.

The note field DOES show up in the course listing in the university catalog. A note should be made in specific instances where additional information about a course needs to be conveyed to students. The most common reasons for adding a note are:

The course is crosslisted Example: *(Note: Credit will be granted for only one prefix.)*

Variable credit courses Example: *(Note: Variable Credit)*

A course is repeatable Example: *(Note: This course may be repeated up to 3 times under different topics) OR (Note: This course is repeatable for a maximum of six semester hours)*

If a student cannot take two courses and earn credit for both Example: *(Note: Students cannot earn credit for XXX1234 and XXX2345)*

Note:

Lab Fees:

Field Trips:

Part IIIId: Course Information, continued

The following section is the course content.

Required reading: Please list materials in preferred citation style (eg. MLA, APA, etc.).

List each material in this format. If there are multiple material please format them in a bullet or list style

Specific Measurable Student Behavioral Learning Objectives: Please list the SBLOs in your preferred numbering or bulleting style. Start section with: Upon completion of this course, the student should be able to:.

Detailed Outline of Course Content or Outline of Field Experience/Internship: Please list the course outline in your preferred numbering or bulleting style. It is recommended that you use a numbering format for this field.

Evaluation of Student Performance: Please list the evaluation of student performance in your preferred numbering or bulleting style.

You must use the numbering list feature within the toolbar above each field. Right click on a number in the list and select "Numbered List Properties" to change the numbering style. Please maintain consistency in the selected numbering or bulleting styles.

Reminder: DO NOT MAKE CHANGES TO YOUR COURSE INFORMATION (PART IIIa-IIIId) UNTIL AFTER YOU LAUNCH THE PROPOSAL in order to track changes. Failure to use the track changes feature may cause a delay or denial of your proposal.

If you modify additional sections not already indicated, please make sure you add them to the modification checklist.

Required reading and other materials will be equivalent to:*

Patterson, D. A. & Hennessy, J. L. (2013). *Computer Organization and Design: the Hardware/Software Interface*, 5th edition. Burlington, MA: Morgan Kaufmann

Optional/Recommended book for ARMv7 Programming:

Hohl, W. & Hinds, C. (2014). *ARM Assembly Language*, 2nd edition. Boca Raton, FL: CRC Press

Specific, Measurable Student Behavioral Learning Objectives:*

Upon completion of this course the student should be able to:

1. Discuss the various classes of instructions: data movement, arithmetic, logical, and flow control instructions.
2. Design, implement, and test stand-alone assembly-language programs.
3. Describe how a processor's control unit interprets a machine-level instruction.
4. Explain processor pipelining.
5. Compare performance of various processors and systems.
6. Describe how superscalar and vector architectures use hardware redundancy to execute more than one operation per processor cycle.
7. Explain the concept of multiprocessing.
8. Examine how special-purpose graphics processors can accelerate performance..
9. Describe high performance hard disk and networked attached storage.

**Detailed Outline of
Course Content
(Major Topics and
Subtopics) or Outline
of Field
Experience/Internship ***

1. Assembly Language Programming
 1. Instruction sets and memory addressing
 2. Assembly instructions and assembly directives
 3. Assembly language programming techniques

2. Functional Organization of High Performance Computers
 1. Microarchitectures: machine-level implementation of assembly instructions.
 2. Instruction-level parallelism and processor pipelining
 3. Overview of superscalar and vector architectures
 4. Branch prediction
 5. Processor and system performance

3. Multiprocessing
 1. Short vector processing (multimedia operations)
 2. Multicore and multithreaded processors
 3. Flynn's taxonomy: multiprocessor structures and architectures
 4. Special-purpose parallel graphics processors

4. High Performance Storage
 1. Increasing disk reliability and performance: RAID hard disks
 2. Storage area networks and network attached storage

**Evaluation of Student
Performance:***

1. Homework and Programming Assignments
2. Quizzes and Examinations
3. Final Examination

CAEPD and Registrar's Office Use Only

Notes Director selected IIIB as a section that was modified due to the changes in hours and the removal of the equivalency.

This course modification will be effective for the University 2025-2026 Undergraduate Catalog and will be reflected in Banner beginning in Fall 2025.

