Course Number	CompE-475
Course Title	Microprocessors
Schedule Number	21075
Prerequisite	CompE-375 with C- or better and CompE-470 with any grade other than F. Deep knowledge of digital logic modules and Verilog hardware description language is required. If your prerequisite is "Not Met" on the file, as per SDSU policy, you will be dropped from the class unless you provide proof to the instructor by the second class of the semester. If you have not met the prerequisite requirements for this course, your final grade will be an "F".
Course Description	The fundamentals and practice of modern processor design: Instruction set architecture, microarchitecture design, pipeline processors, data and control hazards, branch prediction, performance measurements, exception handling, out-of-order execution, multi-threading, context switching, memory hierarchy, parallelism, multi-core processors. CompE-470 is a prerequisite for CompE-475 – Microprocessors. In CompE-470 you learned how to design and test fundamental digital components using Verilog hardware description language. In CompE-475, you will use your library of digital modules developed in CompE-470 to design and implement your own microprocessor architecture on a FPGA.
Credits	Three units
Modality	The course will be offered online. For online modality, The "face-to-face" sections/tags in the syllabus won't apply.
Class Schedule	Tuesdays and Thursdays between 15:30 PM and 16:45 PM (face-to-face modality) For the online modality: Lecture videos are posted on Canvas.
Class Location	SH-119 (face-to-face modality)
Final Exam	Thursday May 13 between 13:00 and 15:00 The final exam will take place in the course classroom (face-to-face modality)
Instructor	Dr. Amir Alimohammad Email: aalimohammad@sdsu.edu Office location: 403-Engineering
Instructor Discussion Session	For the face-to-face modality, Tuesdays and Thursdays by appointment. For online modality, Tuesdays between 1:00 PM and 2:00 PM via Zoom. Any changes to this schedule will be announced. These Discussion Sessions are not the substitute for already posted lecture videos and are not intended to duplicate lecturing. The sessions are for further discussions and answering any questions that students may have regarding the covered topics in the lecture videos and assignments. Please watch the lecture videos and have your questions ready.
Teaching Assistant	Sudarshan Suresh Babu Email: ssureshbabu@sdsu.edu Office location: 218-Engineering (for the face-to-face modality)

Teaching Assistant	For the face-to-face modality, it will be announced.
Discussion Session	For online modality, the schedule for the discussion session will be announced. The assignments' schedules will be announced throughout the semester.

Email Communication

- The student email address in Canvas is their @sdsu.edu email address. Notifications will be delivered to their SDSU email address, as outlined in SDSU Senate policy. SDSU email can be accessed by going directly to gmail.sdsu.edu and signing in via SDSUid (e.g. jsmith0123@sdsu.edu).

Topics Covered

- MIPS programming
- MIPS instruction set architecture and microarchitecture design
- System-on-a-chip architectures and Zynq FPGAs
- Cache characteristics and parallel architectures

Learning Outcomes

- *Knowledge*: Describe a software program using MIPS assembly language; Identify and describe microprocessors microarchitectures; Describe Cache characteristics and architectures; Define performance evaluation and energy efficiency metrics.
- *Comprehension*: Understand the MIPS instruction set architecture; Compare single-cycle, multi-cycle, and pipelined MIPS microarchitectures; Classify superscalar and VLIW architectures; Summarize multithreading and multiprocessing; Comprehend system-on-a-chip architectures and Zynq FPGAs.
- *Application*: Apply knowledge in Verilog hardware description language to model microprocessors microarchitectures; Apply knowledge about exception handling to microprocessor architectures.
- *Analysis*: Analyze parallel processors architectures; Compare microprocessors performance.
- *Synthesis*: Design, synthesize, and implement single-cycle, multi-cycle, and pipelined MIPS microarchitectures; Partition and implement a program on a system-on-a-chip architecture of Zynq FPGAs.
- *Evaluation*: Functional testing and performance evaluation of designed microarchitectures.

Grading Policy

		Assignments	
Assignments	30%		
Exam 1	20%	Verilog	3%
Exam 2	20%	Single-cycle processor	4%
Final Exam	30%	SPIM simulator	3%
		Multi-cycle processor	5%
		Pipeline processor	6%
		Zynq 1 assignment	2%
		Zynq 2 assignment	4%
		FIR Filter (part a only)	3%

- The grading policy is subject to change.
- Assignments and exams are varied in scope, complexity, and hence, grade-weighting.
- Exams are closed book/note. The final exam covers all topics.
- Your final grade will be calculated SOLELY based on the above percentages.

- No individual extra credit options are available. Collective extra credit options might be available.
- There are no preconceptions on how many "A"s and "A-"s and "B+"s will be given. I will compute the weighted sum of your grades in assignments, tests, exams, etc. For the relative weightings, see the above. I will rank-order the weighted sums from largest to smallest. I will look for gaps in the rank-ordered sums and use them as grade boundaries. I will assign grades to each cluster of rank-ordered scores between the gaps. This ensures no one will be only a few points from getting a higher grade.

Course activities, Assignments, Tests, Midterm and Final Exams

- This 400-level course is relatively demanding and requires your dedication. Please spend as much time as possible learning the material. Since the amount of your prior knowledge on digital design and Verilog hardware description language from CompE-470 affects your learning and performance, you may have to spend more time on this course than you anticipate.
- You need to install a Verilog simulator on your personal computer. To help you with this process, a tutorial is posted under "Course Documents/Course material" folder on Canvas. Please follow the instructions in the "Vivado Guide" tutorial. Please follow the posted "Installation of the Required Software". If you are unable to download and license Vivado, as an alternative option, you can download and install the Playground simulator for Verilog HDL from https://www.edaplayground.com/. Since SDK is no longer directly supported by Vivado version 2019.2 and after, it is recommended that you download an older version of Vivado (e.g., 2018.3 and before). The Vitis IDE can be used with the latest version of Vivado.
- You must present your assignment work to the Teaching Assistant (TA). For the online modality, the assignments will be graded through one-on-one Zoom meeting demos. Please configure all Zoom settings beforehand and verify that your microphone and audio are working properly.
- For demoing your assignments, it is highly recommended that you are completely ready to present your work during your time slot as there will not be time to debug your design during your assigned time window. During the demos, you will be asked to show your simulation waveforms, explain your design and your code in detail, and answer a few conceptual questions pertaining to the topics the assignment has covered. Please be prepared for the demos by organizing your simulation waveforms with the signals specified in the assignment. The grader may ask you to synthesize and simulate your code during the presentation.
- You will be notified with your scheduled date and time of your demo. If you cannot demo at your assigned time or if you are prepared to demo your project early, you need to make an appointment with the grader for a date and time BEFORE your assigned date and time. Please note that after you present your work, no additional time will be given to re-present your work. If you decide to present your project early, make sure that you are ready. Late demos will not be accepted.
- Demos are about 10 minutes per student; however, some demos may take longer than others. So please be patient if the grader cannot see your work within your demo time window. You will be placed in a queue where you will have to wait for your turn to demo.
- Your Verilog HDLs for the design and testbenches should be clearly organized and well commented. Waveforms should be organized and labeled accordingly. Do not include unnecessary intermediate signals in your output waveform window. Points will be deducted for cluttered waveforms.
- Your assignments' grades will be based on your ability to answer questions during the presentation as well as how clearly you can explain your design/code. **A fully functional design does not guarantee a passing grade. If you have a working design yet fail to demonstrate your ability to explain how and why it operates as it does, you will receive a significant penalty.**

- The homework presentation time is not the time to ask questions or try to debug your design. You will only have time to demonstrate your work to the grader. Please have all your designs ready in well-organized directories so you can easily execute them during your allotted time. If you cannot meet the grader during the assigned time, it is your responsibility to e-mail the grader in advance and schedule another time slot that is BEFORE the original due date.
- For the Canvas submission of your Assignments, you should upload your solutions in one document under the "Assignments" folder on Canvas. Please include the source codes, testbenches, and output waveforms in a single file (either in Doc or Pdf format). Please do not upload more than one file in any other format. Make sure your code is well-commented. Please name your file "lastname_firstname". For online submission of your assignments, the submission deadline is 11:59 PM so you all have enough time to upload your work in that day. Please meet the submission deadlines.

Online Exams

To enforce academic honesty and integrity, the conditions will be applied to all tests and exams:

- The exam will be given only once at the already scheduled exam's date and time. All students must take the exam at the scheduled date and time. The exam will not re-open for taking a second time. Please note that the exam link will disappear 10 minutes after the exam's start time. This is due to the Canvas's limitation on defining an end time for the exam. Please be on time.
- For students enrolled with SASC, additional time will be given based on the SASC's recommendation.
- Only one question will be shown at a time. No backtracking or copy and paste is permitted.
- Questions will be chosen from a bank of questions. The questions, the sequence of questions, as well as the answer choices will be randomized among students' exams.
- The exam will be timed carefully such that only enough time is given for students who know the material to answer the questions.
- If your wireless Internet is not reliable, it is your responsibility to have access to reliable wireless or wired Internet to take your exams. In the unlikely event that Canvas or your Internet access disconnects you from the final exam, please call or text the Google Voice number that will be announced with your concern, last name, first name, and REDID. Please write the Google Voice number down in the event that you cannot access this announcement if you lose your Internet connection. Please note that the activity logs will be monitored for the exam to ensure that your concern is valid. If it is deemed acceptable, you will be instructed to re-enter the exam. Unfortunately, Canvas does not stop the exam timer in such events, and you will miss some time due to your Internet interruption.

Make-up Assignments, Tests, and Exams

- Deadlines are not subject to change and no late assignments are accepted: You must take the test/exam at the announced date and time. Not submitting your assignment by the given deadline or not showing up for the test results in a grade of zero. Requests regarding changing the deadlines or dates of assessments are not acceptable.
- Generally, no make-up assignment, test, or exam will be given. Requests regarding giving make up exams are not acceptable.
- Missed exams can be made up only under extenuating circumstances, such as medical emergencies. If you cannot meet the deadline for a valid reason, such as hospitalization, I require supporting documents and you should provide them to me before the date of your assignment/test/exam. If your reason is accepted, then you will be given a make-up assignment/test/exam. Note that the make-up exam can be more difficult than the scheduled exam.

Requests to Revise a Grade

- Requests for re-assessing a grade need to be submitted in writing along with the graded assignment/test/exam. Thorough re-assessment will be performed, and points may be added or deducted.
- No discussion of grades will be done prior to the re-assessment.
- You must bring your request for the re-assessment of your work to my attention within a week. You have only one week to submit a written request along with your original assignment/exam for re-grading. No changes will be made after one week.

Course Materials and Resources

- All the lecture notes are included in the required textbook: CompE 475 – Microprocessors, by Dr. Amir Alimohammad. The textbook is upload on Canvas. Other course materials will be posted under the "Course Materials" folder on Canvas.

Attendance, Announcements, and Updates (face-to-face modality)

- Attending lectures is not mandatory, however, it is your responsibility to know the announcements made in class and material covered. Generally, announcements will be given in class.
- Turn off your cell phone when entering the classroom.
- Recording devices are not permitted during lectures.

Learning Support

- In the face-to-face modality, I allocate the beginning of every lecture to your questions. Please ask your technical questions in class instead of via email. Other students may be having the same questions as you. This allows other students to engage in the discussion as well.
- Instead of communicating your questions via email, I have created an Online Discussion Forum on Canvas. I highly encourage you to subscribe to the Discussion Board and post your questions. An effective discussion board provides opportunities for participants to: (a) learn independently and collaboratively; (b) be actively, rather than passively engaged in their learning; (c) teach and learn from each other. When a question is posted, subscribers to the discussion forum, including students, teaching assistants, and myself, will receive a notification email immediately and are able to answer your questions as soon as possible. Therefore, active participation of students and collaborative learning are not limited to the lecture hours only. Based on the following three guidelines for Online Discussion Boards for Instructors, I highly encourage you to get involved in the Discussion Board activities. "1. The Immediate Response Principle: Responding immediately to students' posts can stifle the discussion. Students will likely wait for your reply instead of responding to one another; 2. Post your reply only after the first few students have posted theirs; and 3. An overly active facilitator can discourage and squelch student participation." Students who are most supportive in answering students' questions on the Discussion Board will receive extra credits.

Providing Anonymous Feedback

- If you would prefer providing comments and feedback anonymously, please bring your suggestions to my attention via https://amir.sdsu.edu/~amir/feedback.htm.

Students Requiring Special Accommodations

- If you require especial accommodations for this class, it is your responsibility to contact Student Ability Success Center at 619-594-6473. To avoid any delay in the receipt of your accommodations, you should

contact Student Ability Success Center as soon as possible. Please note that I cannot provide accommodations until I have received a letter from Student Ability Success Center.

Academic Honesty

The University adheres to a strict policy prohibiting cheating and plagiarism. Examples of academic dishonesty include but are not limited to:

- Copying, in part or in whole, from another's test or other examination;
- Obtaining copies of a test, an examination, or other course material without the permission of the instructor;
- Collaborating with another or others in work to be presented without the permission of the instructor;
- Falsifying records, laboratory work, or other course data;
- Submitting work previously presented in another course, if contrary to the rules of the course;
- Altering or interfering with grading procedures;
- Assisting another student in any of the above;
- Using sources verbatim or paraphrasing without giving proper attribution (this can include phrases, sentences, paragraphs and/or pages of work);
- Copying and pasting work from an online or offline source directly and calling it your own;
- Using information you find from an online or offline source without giving the author credit;
- Replacing words or phrases from another source and inserting your own words or phrases.

The California State University system requires instructors to report all instances of academic misconduct to the Center for Student Rights and Responsibilities. Academic dishonesty will result in disciplinary review by the University and may lead to probation, suspension, or expulsion. Instructors may also, at their discretion, penalize student grades on any assignment or assessment discovered to have been produced in an academically dishonest manner.

Changes to the Syllabus

SDSU's Academic Senate Policy File indicates under Faculty Academic Responsibilities:

- "A syllabus shall not bind the instructor to specific details, and the instructor shall retain the right to adjust the course design. Major departures from the syllabus, however, especially with regard to student learning outcomes, major assignment due dates and exam dates, and grading policies, shall be made only for compelling reasons."
- "Any major changes to the course syllabus shall be announced in class, communicated to all students electronically, and incorporated into an updated and posted version of the syllabus."

Student Privacy and Intellectual Property

The Family Educational Rights and Privacy Act (FERPA) mandates the protection of student information, including contact information, grades, and graded assignments. I will use Canvas to communicate with you, and I will not post grades or leave graded assignments in public places. Students will be notified at the time of an assignment if copies of student work will be retained beyond the end of the semester or used as examples for future students or the wider public. Students maintain intellectual property rights to work products they create as part of this course unless they are formally notified otherwise.

Religious Observances

According to the University Policy File, students should notify the instructors of affected courses of planned

absences for religious observances by the end of the second week of classes.

Student Email Addresses

Students are provided with an SDSU Gmail account for their official use. This SDSU email address will be used for all communications. Per university policy, students are responsible for checking their official university email once per day, please see Student Official Email Address Use Policy here.

Resources for students

A complete list of all academic support services--including the Writing Center and Math Learning Center--is available on the Student Affairs' Academic Success website. Counseling and Psychological Services (619-594-5220) offers confidential counseling services by licensed therapists; you can Live Chat with a counselor at http://go.sdsu.edu/student_affairs/cps/therapist-consultation.aspx between 4:00pm and 10:00pm, or call San Diego Access and Crisis 24-hour Hotline at (888) 724-7240.

Sexual violence / TItle IX mandated reporting

As an instructor, one of my responsibilities is to help create a safe learning environment on our campus. I am a mandated reporter in my role as an SDSU employee. It is my goal that you feel able to share information related to your life experiences in classroom discussions, in your written work, and in our one-on-one meetings. I will seek to keep the information you share private to the greatest extent possible. However, I am required to share information regarding sexual violence on SDSU's campus with the Title IX coordinator, Jessica Rentto 619-594-6017. She (or her designee) will contact you to let you know about accommodations and support services at SDSU and possibilities for holding accountable the person who harmed you. Know that you will not be forced to share information you do not wish to disclose and your level of involvement will be your choice. If you do not want the Title IX Officer notified, instead of disclosing this information to your instructor, you can speak confidentially with the following people on campus and in the community. They can connect you with support services and discuss options for pursuing a University or criminal investigation. Sexual Violence Victim Advocate 619-594-0210 or Counseling and Psychological Services 619-594-5220, psycserv@sdsu.edu. For more information regarding your university rights and options as a survivor of sexual misconduct or sexual violence, please visit titleix.sdsu.edu or sdsutalks.sdsu.edu.

Classroom Conduct Standards

SDSU students are expected to abide by the terms of the Student Conduct Code in classrooms and other instructional settings. Prohibited conduct includes:

- Willful, material and substantial disruption or obstruction of a University-related activity, or any on-campus activity;
- Participating in an activity that substantially and materially disrupts the normal operations of the University or infringes on the rights of members of the University community;
- Unauthorized recording, dissemination, or publication (including on websites or social media) of lectures or other course materials;
- Conduct that threatens or endangers the health or safety of any person within or related to the University community, including (i) physical abuse, threats, intimidation, or harassment; and (ii) sexual misconduct.

Violation of these standards will result in referral to appropriate campus authorities.

Medical-related Absences

Students are instructed to contact their professor/instructor/coach in the event they need to miss class, etc. due to an illness, injury or emergency. All decisions about the impact of an absence, as well as any arrangements for making up work, rest with the instructors. Student Health Services (SHS) does not provide medical excuses for short-term absences due to illness or injury. When a medical-related absence persists beyond five days, SHS will work with students to provide appropriate documentation. When a student is hospitalized or has a serious, ongoing illness or injury, SHS will, at the student's request and with the student's consent, communicate with the student's instructors via the Vice President for Student Affairs and may communicate with the student's Assistant Dean and/or the Student Ability Success Center.

SDSU Economic Crisis Response Team

If you or a friend are experiencing food or housing insecurity, technology concerns, or any unforeseen financial crisis, it is easy to get help! Visit sdsu.edu/ecrt for more information or to submit a request for assistance. SDSU's Economic Crisis Response Team (ECRT) aims to bridge the gap in resources for students experiencing immediate food, housing, or unforeseen financial crises that impacts student success. Using a holistic approach to well-being, ECRT supports students through crisis by leveraging a campus-wide collaboration that utilizes on and off-campus partnerships and provides direct referrals based on each student's unique circumstances. ECRT empowers students to identify and access long term, sustainable solutions in an effort to successfully graduate from SDSU. Within 24 to 72 hours of submitting a referral, students are contacted by the ECRT Coordinator and are quickly connected to the appropriate resources and services. For students who need assistance accessing technology for their classes, visit our ECRT website (sdsu.edu/ecrt) to be connected with the SDSU library's technology checkout program. The technology checkout program is available to both SDSU and Imperial Valley students.