

CALIFORNIA STATE UNIVERSITY, BAKERSFIELD
ACADEMIC SENATE

Proposal for Master of Science in Computer Science

RES 202108

AAC & BPC

RESOLVED: that the Academic Senate recommends the approval of the Proposal for Master of Science in Computer Science.

RATIONALE: the Academic Affairs and Budget and Planning Committees of the Academic Senate have both reviewed the proposal and agree that this self-supported program has the resources required to deliver the program and the program fulfills a need for both students and industry.

Distribution List:

President

Provost

Dean NSME

Dean EEGO

Chair of Computer & Electrical Engineering & Computer Science

General Faculty

Approved by the Academic Senate October 29, 2020

Sent to the President November 6, 2020

Approved by the President November 6, 2020

Proposal for Master of Science in Computer Science at CSU Bakersfield

Table of Contents

1. Program Type.....	1
2. Program Identification	1
3. Program Overview and Rationale	2
4. Curriculum	5
5. Societal and Public Need for the Proposed Degree Major Program	14
6. Student Demand.....	18
7. Existing Support Resources for the Proposed Degree Major Program	21
8. Additional Support Resources Required.....	25
9. Self-Support Programs.....	26
Appendix A: Catalog Copy.....	28
Appendix B: Comprehensive Program Assessment Plan	36
Appendix C: Curriculum Map Matrix	41
Appendix D: Self-Support Basic Cost Recovery Budget	45
Appendix E: Support Letters from Campus Administrators.....	50
Appendix F: Short Faculty CVs.....	52
Appendix G: Course Outlines for New Courses	77
Appendix H: Environmental Scan Report from UPCEA.....	122

1. Program Type

- b. Self Support
- c. Delivery Format: Fully face-to-face
- g. New Program

2. Program Identification

- a. Campus: CSU Bakersfield (CSUB)
- b. Full degree title: Master of Science in Computer Science (MS CS)
- c. Academic Master Plan: Renewed on the AMP at the CSU Board of Trustees meeting on March 24-25, 2015 for a Fall 2017 to Fall 2022 implementation timeline. Switched to a self-support program in the March 2015 renewal.
- d. Intended implementation: Fall 2021
- e. Total units for graduation: 30 semester units
- f. Unit with primary responsibility for program: Offered by the Department of Computer and Electrical Engineering and Computer Science (CEE/CS) as a self-support program through Extended Education and Global Outreach (EEGO).

- g. Proposal prepared by: The CEE/CS subcommittee members responsible for this proposal are:
 - 1) Melissa Danforth, Professor, Department Chair
 - 2) Alberto Cruz, Assistant Professor
 - 3) Anthony Bianchi, Assistant Professor
 - 4) Chengwei Lei, Assistant Professor
 - 5) Vincent On, Assistant Professor
 - 6) Nicholas Toothman, Assistant Professor
- h. Statement from appropriate campus authority: See letters from Dr. Vernon Harper, Interim Provost of CSUB, dated August 26, 2019, and from Dr. Kathleen Madden, Dean of Natural Sciences, Mathematics, and Engineering, dated January 23, 2020 in Appendix E.
- i. Campus approval documents: See attached CSUB New Degree Proposal routing sheet and supporting approval documents.
- j. WASC Substantive Change review: The WASC Senior College and University Commission Substantive Change Screening Form will be submitted in Spring 2020. If a full Substantive Change Review is required, that will be submitted by no later than November 2020 to provide adequate time for review.
- k. Proposed Classification of Instructional Programs and CSU Degree Program Codes:
 - 1) CIP Code: 11.0701 (Computer Science)
 - 2) CSU Degree Program Code: 07011 (Computer Science)

3. Program Overview and Rationale

- a. Descriptive overview of program:
 - 1) Purpose and strengths

As the only four-year public university in the southern San Joaquin Valley, California State University, Bakersfield (CSUB) fills a critical role in the educational attainment, economic development, and quality of life in its service region. The student body at CSUB reflects the diversity of the service region and CSUB carries designations as both a Hispanic Serving Institution (HSI) and a Minority Serving Institution (MSI). CSUB was cited by the Center for Urban Education in 2009 as a HSI with potential to be an exemplar for STEM education. The School of Natural Sciences, Mathematics, and Engineering (NSME) at CSUB was recognized by Excelencia in Education as the 2012 National Example of Excelencia at the Baccalaureate level.

The Computer and Electrical Engineering and Computer Science (CEE/CS) Department is a student-centered department that prides itself on its strong undergraduate research programs, hands-on learning, and commitment to student success. The department offers three undergraduate degrees in Computer Science, Computer Engineering, and Electrical Engineering, with a combined enrollment of over 600 undergraduate students. Faculty members engage students in cutting edge research projects and our undergraduate students have presented in national and international peer-reviewed conferences.

About 60% of CEE/CS alumni are employed in the service region. The proposed Master of Science in Computer Science (MS CS) program will further enhance the educational attainment of alumni by providing an option for obtaining an advanced computing degree in the area. Alumni who currently wish to pursue an MS CS degree must travel over 90 miles to the nearest institution which offers a similar program. While several regional employers offer financial incentives for their employees to pursue advanced degrees, the distance to other programs can be time-prohibitive for those who hold full-time jobs.

The core of the proposed program is a traditional MS CS program, with the elective areas focusing in the high-demand areas of cybersecurity, artificial intelligence and data science, and distributed and parallel computation. Employers have expressed a strong interest in these areas. These areas also align with the expertise of the CEE/CS faculty members.

2) Fit with institutional mission/learning outcomes

CSUB's Mission Statement is as follows:

CSU Bakersfield is a comprehensive public university offering excellent undergraduate and graduate programs that advance the intellectual and personal development of its students. We emphasize student learning through our commitment to scholarship, ethical behavior, diversity, service, global awareness and life-long learning. The University collaborates with partners in the community to increase the region's overall educational attainment, enhance its quality of life, and support its economic development.

The CEE/CS Department is housed in NSME. NSME's mission statement is as follows:

The School of Natural Sciences, Mathematics, and Engineering is dedicated to providing an outstanding educational experience consistent with the University's Mission, which is to be a comprehensive public university committed to offering excellent undergraduate and graduate programs that advance the intellectual and personal development of its students.

The objectives of the School of Natural Sciences, Mathematics, and Engineering are to:

- Promote science, engineering, and health education for the purpose of improving the human condition.
- Foster scientific integrity in all professional endeavors.
- Prepare students for entry into the workforce in science, technology, engineering and mathematics (STEM), and healthcare services.
- Prepare students for admission to graduate programs in science, mathematics, engineering, and nursing.
- Prepare students for leadership roles in the community.

The MS CS program educational objectives (PEOs) were designed to support the mission of CSUB and of NSME. The objectives for the MS CS program are to produce graduates who will:

1. Demonstrate expertise in advanced computing topics and an ability to maintain a high standard of professional competence.
2. Analyze and solve significant real world problems with contemporary computing knowledge.
3. Apply computing knowledge ethically, with an understanding of realistic constraints and for the overall benefit of a diverse society.

4. Enhance the economic well-being of their region through a combination of computing expertise, communication skills, social responsibility, leadership, and entrepreneurship.

Demonstrating computing expertise and an ability to maintain professional competence supports CSUB's mission to advance the intellectual and personal development of students, CSUB's commitment to life-long learning, and NSME's mission to prepare students for entry into the workforce and into higher-level graduate programs such as Ph.D. programs.

Analyzing and solving significant real world problems is in line with CSUB's commitment to scholarship and to increasing educational attainment and with NSME's mission to promote STEM education to improve the human condition.

Ethically applying computer science knowledge for the benefit of society supports CSUB's commitment to ethical behavior, diversity, and global awareness and NSME's mission to foster scientific integrity.

Enhancing the economic well-being of the region is in line with CSUB's mission to support the region's economic development and enhance its quality of life and with NSME's mission to prepare students for leadership roles in the community.

The fit of the program's educational objectives with the institutional learning outcomes are described in Section 4.a Learning Outcomes.

3) Compelling reasons for offering the program at this time

Demand for trained computer science professionals is increasing, particularly within cybersecurity, artificial intelligence, and data science. As noted in the environmental scan for the MS CS program (see Appendix H), computing jobs have strong growth projections in California and nationally, with the current pipeline being inadequate to meet those demands. There is strong industry demand for additional educational programs to improve pipelines to the workforce.

In addition to industry demands, enrollments in the CSUB undergraduate BS CS program have doubled over the last decade, from an average of about 130 students in the late 2000's to over 300 students in the past two years. Enrollments in the BS CS program have increased every single year from 2010/11. The number of BS CS graduates has also increased from an average of 16 per year to an average of 50 per year in the same time span. We now have a dynamic pool of alumni that could feed into an MS CS program. As noted in Dr. Harper's attached letter of support, this program would support CSUB's mission by providing alumni in the area a pathway to complete an advanced degree in a high-demand academic area.

In addition to local interest from alumni and regional employers, international student demand for graduate programs in computer science is high, as noted in the environmental scan from UPCEA.

- b. Proposed catalog description: See Appendix A: Catalog Copy.

4. Curriculum

a. Learning outcomes:

1) Institutional learning outcomes

CSU Bakersfield's university learning outcomes (ILOs) are:

- I. Students will show critical reasoning and problem solving skills.
- II. Students will be able to communicate orally and in writing.
- III. Students will demonstrate discipline-based knowledge and career-based-learning.
- IV. Students will possess numerical literacy.
- V. Students will become engaged citizens.
- VI. Students will develop a well-rounded skill set.

CSU Bakersfield's university learning outcomes for graduate programs (GP-ILOs) are:

- I. Students will demonstrate broad, integrative knowledge.
- II. Students will develop specialized knowledge.
- III. Students will practice intellectual skills such as analytic inquiry, use of information resources, engaging diverse perspectives, quantitative fluency, and communication fluency.
- IV. Students will conduct applied learning.

CSUB's ILOs are in the Academic Information section of the CSUB catalog. CSUB's GP-ILOs are in the Division of Graduate Programs section the CSUB catalog. The catalog is posted at <https://www.csu.edu/catalog>

2) Program learning outcomes

The program educational objectives (PEOs) reflect the vision for the skills and abilities of graduates within three to five years after graduation. The objectives for the MS CS program are to produce graduates who will:

1. Demonstrate expertise in advanced computing topics and an ability to maintain a high standard of professional competence.
2. Analyze and solve significant real world problems with contemporary computing knowledge.
3. Apply computing knowledge ethically, with an understanding of realistic constraints and for the overall benefit of a diverse society.
4. Enhance the economic well-being of their region through a combination of computing expertise, communication skills, social responsibility, leadership, and entrepreneurship.

The following table maps which MS CS MS CS program educational objectives support the institutional learning outcomes, both ILOs and GP-ILOs. A reduction of this mapping is used for the assessment plan in Appendix B:

	PEO 1: Demonstrate computing expertise	PEO 2: Solve significant real world problems	PEO 3: Apply computing knowledge ethically	PEO 4: Enhance economic well-being of region
ILO 1: Show critical reasoning & problem solving skills	X	X	X	X
ILO 2: Communicate orally & in writing				X
ILO 3: Demonstrate discipline-based knowledge & career-based learning	X	X	X	X
ILO 4: Possess numerical literacy	X	X		
ILO 5: Become engaged citizens			X	X
ILO 6: Develop well-rounded skill set	X	X	X	X
GP-ILO 1: Demonstrate broad, integrative knowledge	X	X	X	X
GP-ILO 2: Develop specialized knowledge	X			X
GP-ILO 3: Practice intellectual skills	X	X	X	X
GP-ILO 4: Conduct applied learning		X		

3) Student learning outcomes

The student learning outcomes for the MS CS program are:

1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.
2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.
3. An ability to communicate effectively in a variety of professional contexts.
4. An ability to recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

The following table maps which MS CS student learning outcome(s) support the attainment of each of the MS CS program educational objectives. A reduction of this mapping is used for the assessment plan in Appendix B:

	SLO 1: Analyze complex problems	SLO 2: Apply CS theory and fundamentals	SLO 3: Communicate effectively	SLO 4: Recognize professional, legal, and ethical responsibilities
PEO 1: Demonstrate computing expertise	X	X		X
PEO 2: Solve significant real world problems	X	X		
PEO 3: Apply knowledge ethically		X		X
PEO 4: Enhance economic well-being of region		X	X	X

- b. Assessment plan and outcome matrix: See Appendix B for the assessment plan and Appendix C for the outcome matrix.
- c. Total number of units for graduation: 30 semester units
- d. Baccalaureate unit exception: Not applicable to graduate programs.
- e. Options, concentrations, or emphases: Not applicable. There are no options, concentrations, or emphases in the proposed program.
- f. List of new courses needed during the first two years of implementation:

The following courses are part of the course rotation in the first two years of the program. See Appendix A for the course descriptions:

Course	Course Title	Units	Level	Type of Course
CMPS 5000	Colloquium in Computer Science	1	Grad	Core – Required
CMPS 5010	Current Topics in Computer Science	2	Grad	Core – Required
CMPS 5100	Research Methodologies & Professional Ethics	2	Grad	Core – Required
CMPS 5120	Grad. Algorithm Design & Analysis	3	Grad	Core – Required
CMPS 5240	Grad. Computer Architecture	3	Grad	Core – Select from List
CMPS 5350	Grad. Software Engineering	3	Grad	Core – Select from List
CMPS 5500	Grad. Programming Languages & Compilers	3	Grad	Core – Select from List
CMPS 5600	Grad. Operating Systems	3	Grad	Core – Select from List
CMPS 5640	Grad. Distributed Computation	3	Grad	Core – Select from List
CMPS 5420	Natural Language Processing	3	Grad	Elective: AI/Data Science
CMPS 5450	Grad. Data Mining	3	Grad	Elective: AI/Data Science
CMPS 5270	Hardware Security	3	Grad	Elective: Cybersecurity
CMPS 5510	Reverse Engineering	3	Grad	Elective: Cybersecurity
CMPS 5650	Operations Security	3	Grad	Elective: Cybersecurity
CMPS 5150	Parallel Algorithms	3	Grad	Elective: Parallel/Distrib.
CMPS 6910	Thesis Research	1-3	Grad	Capstone: Thesis option
CMPS 6920	Thesis Defense	1	Grad	Capstone: Thesis option
CMPS 6950	Graduate Project I	2	Grad	Capstone: Project option
CMPS 6960	Graduate Project II	1	Grad	Capstone: Project option
CMPS 7000	Continuous Enrollment	0	Grad	Continuous enrollment

The following elective courses would be part of the rotation in the third year of implementation:

Course	Course Title	Units	Level	Type of Course
CMPS 5560	Machine Learning	3	Grad	Elective: AI/Data Science
CMPS 5160	Distributed Learning & Optimization	3	Grad	Elective: Parallel/Distrib.

The following courses are listed in the catalog copy in Appendix A but are not part of the formal rotation. These courses would be scheduled on either an individual study basis or on a case-by-case basis in the future to prototype elective courses before formalizing an elective course into the rotation.

Course	Course Title	Units	Level	Type of Course
CMPS 5770	Special Topics	1-3	Grad	Elective prototype
CMPS 5800	Graduate Research	1-3	Grad	Ind. Study course

g. Course offering plan for the first three years of the program:

Year	Fall (Course – Exp. Enrollment)	Spring (Course – Exp. Enrollment)	Summer (Course – Exp. Enrollment)
1	CMPS 5000 – 20 from C1 CMPS 5010 – 20 from C1 CMPS 5120 – 20 from C1 CMPS 5240 – 20 from C1 Summary: 9 units offered Active Cohorts: C1: 20 entered in Fall Year 1 (Term 1)	CMPS 5000 – 17 from C1 CMPS 5100 – 17 from C1 CMPS 5350 – 17 from C1 CMPS 5420 – 17 from C1 Summary: 9 units offered Active Cohorts: C1: 17 retained from Fall Year 1 (Term 2)	CMPS 5000 – 15 from C2 CMPS 5010 – 15 from C2 CMPS 5120 – 15 from C2 CMPS 5500 – 20 from C1 C2 CMPS 5270 – 20 from C1 C2 CMPS 6910 – 5 from C1 CMPS 6950 – 12 from C1 Summary: 12 units regular courses, 5 units capstone Active Cohorts C1: 17 retained from Fall Year 1 (Term 3) – Assume 5 choose thesis and 12 choose project C2: 15 entered in Summer Year 1 (Term 1)
2	CMPS 5000 – 32 from C2 C3 CMPS 5100 – 32 from C2 C3 CMPS 5120 – 20 from C3 CMPS 5600 – 35 from all CMPS 5450 – 30 from all CMPS 6910 – 5 from C1 CMPS 6920 – 5 from C1 CMPS 6960 – 12 from C1 Summary: 12 units regular courses, 4 units capstone	CMPS 5000 – 17 from C3 CMPS 5010 – 17 from C3 CMPS 5640 – 20 from all CMPS 5510 – 15 from all CMPS 5150 – 15 from all CMPS 6910 – 4 from C2 CMPS 6950 – 8 from C2 CMPS 7000 – As needed Summary: 12 units regular courses, 5 units capstone	CMPS 5000 – 15 from C4 CMPS 5100 – 15 from C4 CMPS 5120 – 15 from C4 CMPS 5240 – 25 from all CMPS 5650 – 25 from all CMPS 6910 – 9 from C2 C3 CMPS 6920 – 4 from C2 CMPS 6950 – 12 from C3 CMPS 6960 – 8 from C2 CMPS 7000 – As needed Summary: 12 units regular courses, 9 units capstone

	<p>Active Cohorts: C1: 17 retained from Fall Year 1 (Term 4) C2: 12 retained from Summer Year 1 (Term 2) C3: 20 entered in Fall Year 2 (Term 1)</p>	<p>Active Cohorts: C2: 12 retained from Summer Year 1 (Term 3) – Assume 4 choose thesis and 8 choose project C3: 17 retained from Fall Year 2 (Term 2)</p>	<p>Active Cohorts: C2: 12 retained from Summer Year 1 (Term 4) C3: 17 retained from Fall Year 2 (Term 3) – Assume 5 choose thesis and 12 choose project C4: 15 entered in Summer Year 2 (Term 1)</p>
3	<p>CMPS 5000 – 32 from C4 C5 CMPS 5010 – 32 from C4 C5 CMPS 5120 – 20 from C5 CMPS 5350 – 35 from all CMPS 5560 – 30 from all CMPS 6910 – 5 from C3 CMPS 6920 – 5 from C3 CMPS 6960 – 12 from C3 CMPS 7000 – As needed</p> <p>Summary: 12 units regular courses, 4 units capstone</p> <p>Active Cohorts: C3: 17 retained from Fall Year 2 (Term 4) C4: 12 retained from Summer Year 2 (Term 2) C5: 20 entered in Fall Year 3 (Term 1)</p>	<p>CMPS 5000 – 17 from C5 CMPS 5100 – 17 from C5 CMPS 5500 – 20 from all CMPS 5420 – 15 from all CMPS 5160 – 15 from all CMPS 6910 – 4 from C4 CMPS 6950 – 8 from C4 CMPS 7000 – As needed</p> <p>Summary: 12 units regular courses, 5 units capstone</p> <p>Active Cohorts: C4: 12 retained from Summer Year 2 (Term 3) – Assume 4 choose thesis and 8 choose project C5: 17 retained from Fall Year 3 (Term 2)</p>	<p>CMPS 5000 – 15 from C6 CMPS 5010 – 15 from C6 CMPS 5120 – 15 from C6 CMPS 5600 – 25 from all CMPS 5270 – 25 from all CMPS 6910 – 9 from C4 C5 CMPS 6920 – 4 from C4 CMPS 6950 – 12 from C5 CMPS 6960 – 8 from C4 CMPS 7000 – As needed</p> <p>Summary: 12 units regular courses, 9 units capstone</p> <p>Active Cohorts: C4: 12 retained from Summer Year 2 (Term 4) C5: 17 retained from Fall Year 3 (Term 3) – Assume 5 choose thesis and 12 choose project C6: 15 entered in Summer Year 3 (Term 1)</p>

Likely faculty to teach the courses:

Course Number & Title	Faculty List
CMPS 5000 Colloquium (2)	All faculty listed in Section 7.a (List of Faculty) on page 21
CMPS 5010 Current Topics (2)	All faculty listed in Section 7.a (List of Faculty) on page 21
CMPS 5100 Research Methods (2)	All faculty listed in Section 7.a (List of Faculty) on page 21
CMPS 5120 Grad. Algorithms (3)	Chengwei Lei, Anthony Bianchi, Melissa Danforth, Kanwal Gagneja
CMPS 5150 Parallel Algorithms (3)	Alberto Cruz, Anthony Bianchi, Kanwal Gagneja, Vincent On
CMPS 5160 Distributed Learning (3)	Anthony Bianchi, Vincent On, Alberto Cruz
CMPS 5240 Grad. Architecture (3)	Mostafa Abdelrehim, Alberto Cruz, Vincent On, Melissa Danforth
CMPS 5270 Hardware Security (3)	Alberto Cruz, Melissa Danforth, Kanwal Gagneja
CMPS 5350 Grad. Software Eng. (3)	Nicholas Toothman, Melissa Danforth
CMPS 5420 Natural Lang. Proc. (3)	Anthony Bianchi, Alberto Cruz
CMPS 5450 Grad. Data Mining	Chengwei Lei, Alberto Cruz, Vincent On, Anthony Bianchi, Walter Morales

CMPS 5500 Grad. Prog. Lang. (3)	Chengwei Lei, Nicholas Toothman, Melissa Danforth
CMPS 5510 Reverse Engineer. (3)	Melissa Danforth, Kanwal Gagneja
CMPS 5560 Machine Learning (3)	Anthony Bianchi, Chengwei Lei, Alberto Cruz, Vincent On
CMPS 5600 Grad. Operating Sys. (3)	Melissa Danforth, Kanwal Gagneja
CMPS 5640 Grad. Distrib. Comp. (3)	Anthony Bianchi, Vincent On, Kanwal Gagneja
CMPS 5650 Operations Security (3)	Melissa Danforth, Kanwal Gagneja
CMPS 5770 Special Topics (1-3)	All faculty listed in Section 7.a (List of Faculty) on page 21
CMPS 5800 Grad. Research (1-3)	All faculty listed in Section 7.a (List of Faculty) on page 21
CMPS 6910 Thesis Research (1-3)	All faculty listed in Section 7.a (List of Faculty) on page 21
CMPS 6920 Thesis Defense (1)	All faculty listed in Section 7.a (List of Faculty) on page 21
CMPS 6950 Grad. Project I (2)	All faculty listed in Section 7.a (List of Faculty) on page 21
CMPS 6960 Grad. Project II (1)	All faculty listed in Section 7.a (List of Faculty) on page 21
CMPS 7000 Continuous Enroll. (0)	N/A – Special course to allow students to maintain enrollment

h. Evidence that proposed MS CS capstone experience complies with Section 40510 of Title 5:

The proposed MS CS program supports the thesis and project capstone options of Section 40510.

The Thesis requirements are: “A thesis is the written product of a systematic study of a significant problem. It identifies the problem, states the major assumptions, explains the significance of the undertaking, sets forth the sources for and methods of gathering information, analyzes the data, and offers a conclusion or recommendation. The finished product evidences originality, critical and independent thinking, appropriate organization and format, and thorough documentation. Normally, an oral defense of the thesis is required.”

The expectation for Thesis option students support all of these requirements. As noted in the catalog copy, students who select the Thesis option are expected to complete a research project on a significant problem, with broad scope and originality, within computer science, including appropriate background research on the selected topic. The student is expected to orally defend their thesis, complete all revisions required by the Thesis Committee and the Program Committee, and file their thesis with the CSUB library to satisfactorily complete CMPS 6920 (Thesis Defense).

The Project requirements are: “A project is a significant undertaking appropriate to the fine and applied arts or to professional fields. It evidences originality and independent thinking, appropriate form and organization, and a rationale. It is described and summarized in a written abstract that includes the project's significance, objectives, methodology and a conclusion or recommendation. An oral defense of the project may be required.”

The expectations for Project option students support all of these requirements. As noted in the catalog copy, students who select the Project option are expected to complete an innovative software or computing project of significant undertaking, including appropriate market research for the project. The student must complete all revisions to the project and project report required by the Project Committee and the Program Committee to satisfactorily complete CMPS 6960 (Graduate Project II).

i. Corresponding bachelor's degree program:

The corresponding degree program for the proposed MS CS program is the Bachelor of Science in Computer Science (BS CS) at CSUB. The BS CS program is not subject to any specialty or national professional accreditation, as ABET accreditation is optional for BS CS programs.

The BS CS program is accredited by WASC Senior College and University Commission (WSCUC) and has been accredited from 1987 to present.

j. Admission criteria and prerequisite coursework:

The following criteria must be met for a student to be admitted to the Master of Science in Computer Science program:

1. An earned bachelor's degree from an accredited institution.
2. Minimum coursework equivalent to CMPS 2010 (Programming I), CMPS 2020 (Programming II), CMPS 2120 (Discrete Structures), CMPS 2240 (Comp. Arch. I: Assembly), MATH 2510 (Calculus I), and MATH 2520 (Calculus II) is required to be considered for admission in the program. Additional upper-division coursework is required to be admitted at Classified Graduate Student status, as detailed in that section.
3. An undergraduate GPA of at least 3.0 in the last 60 semester units or 90 quarter units of course work is required for Classified Graduate Student status. The Program Committee may admit students with at least a 2.5 GPA, but less than a 3.0 GPA, at Conditional Graduate Student status on a case-by-case basis.
4. Submission of three letters of recommendation, including EEGO reference forms.
5. Submission of a personal statement and curriculum vitae/resume.
6. Formal decision by the Program Committee to accept the student into the graduate program. The decision will be based on a formal application procedure, which includes evaluation of coursework, GPA, letters of recommendation, personal statement, curriculum vitae, and other application materials that may be required by the Committee and/or offered by the student.

Applicants whose bachelor's degree is not yet awarded at the time of application may be admitted as a Conditionally Classified Graduate Student. Proof of degree completion must be submitted to the Program Committee prior to beginning the MS Computer Science program.

In addition to meeting the above requirements for admission, all graduate applicants, regardless of citizenship, whose preparatory education is principally in a language other than English must demonstrate competence in English, both in spoken and written forms. The minimum score on the Test of English as a Foreign Language (TOEFL) required for admissions is a score of 550 or higher (or 79 on the Internet-based TOEFL exam). Documentation must be provided in original form by the testing institution.

k. Criteria for continuation as a graduate student in the program:

Time Limits

Time limits have been set for completion of requirements at each level of status. For students admitted as Conditionally Classified Graduate Students, advancement to Classified Graduate Student status must be accomplished in the timeframe specified in the admissions letter.

Advancement to Candidate status must be accomplished within three calendar years of achieving

Classified Graduate Student status. The three-year limit may be extended upon approved petition to the Program Committee. All requirements, and graduation, must be completed within five calendar years of admission to the program. The five-year limit may be extended upon approved petition to the Program Committee.

Classified Graduate Student

Acceptance as a Classified Graduate Student indicates that space is available in the program for the student and that the student has met the minimum academic preparation requirements for the program, as follows:

1. An earned baccalaureate degree from an accredited institution.
2. Computer science coursework equivalent to: CMPS 3120 (Algorithm Analysis), CMPS 3240 (Comp. Arch. II: Organization), CMPS 3350 (Software Engineering), CMPS 3500 (Programming Languages), CMPS 3600 (Operating Systems), CMPS 3620 (Computer Networking), and MATH 3200 (Probability Theory).
3. An undergraduate GPA of at least 3.0 in the last 60 semester units or 90 quarter units of course work.

Conditionally Classified Graduate Student

Applicants who do not meet the requirements for Classified Graduate Student status may be provisionally admitted to the MS Computer Science program as a Conditionally Classified Graduate Student if, in the judgement of the Program Committee, the applicant has potential to successfully complete all remaining requirements for Classified Graduate status within a reasonable timeframe. The remaining requirements and the timeframe will be determined by the Program Committee and will be specified in the admissions letter. Upon successful completion of all requirements (or approved substitutions for remaining coursework), the student can apply for full acceptance to the program as a Classified Graduate Student. Failure to satisfactorily complete all requirements within the specified timeframe will result in dismissal from the program.

Note: Conditionally Classified Graduate Students may not enroll in more than 10 semester units of coursework for graduate credit prior to advancing to Classified Graduate Student status. Conditionally Classified Graduate Students are also not allowed to enroll in any 6000-level courses.

Advancement to Candidate Status

Advancement to Candidate status indicates that the student has completed at least 20 semester units (30 quarter units) within the student's approved Plan of Study and that there is a reasonable expectation that the student will complete all remaining degree requirements within one calendar year. Students will be advanced to Candidate status when they have met the following criteria:

1. Completion of all requirements for Classified Graduate Student status.
2. Approval of the student's Plan of Study by the Graduate Program Director.
3. Completion of at least 20 semester units (30 quarter units) towards the Master of Science in Computer Science degree with a graduate GPA of at least 3.0 and grades of "B-" or better in all graded courses on the approved Plan of Study.
4. Approval of the capstone option selected by the student:
 - a. Thesis option: Approval of the student's Thesis research topic by the student's Thesis Committee and the Graduate Program Director.

- b. Project option: Approval of the student’s Project by the student’s Project Committee and the Graduate Program Director.
- 5. Certification by the student’s Thesis or Project Advisor that the student will satisfactorily complete their capstone option within one calendar year.

l. Undergraduate articulation with community colleges: Not applicable to graduate programs.

m. Advising roadmap:

All students will be expected to develop a Plan of Study in consultation with their assigned Program Advisor. The Graduate Program Director is responsible for approving each student’s Plan of Study after it has been developed by the student and their Program Advisor. There must be an approved Plan of Study on record with the program as a condition of graduation.

The following roadmaps for Thesis and Project Options have been developed to allow students to graduate in four terms, and to also provide personal flexibility so students can tailor their Plan of Study to their desired career objectives.

Thesis Option Roadmap:

Term 1 (9 units)	Term 2 (9 units)	Term 3 (6 units)	Term 4 (6 units)
CMPS 5000 (1) CMPS 5010 or 5100 (2)* CMPS 5120 (3) Select one core course (3)	CMPS 5000 (1) CMPS 5010 or 5100 (2)* Select one core course (3) Elective (3)	CMPS 6910 (3) Elective (3)	CMPS 6910 (2) CMPS 6920 (1) Elective (3)

* Choice of CMPS 5010 or 5100 in first two terms depends on entry term.

The two selected core courses in Terms 1 and 2 can be swapped with any of the elective courses in Terms 3 and 4 if the student wishes to take a core course offered during later terms.

Thesis Option students can also choose to take two elective courses in Term 3 and no elective courses in Term 4, bringing Term 3 up to 9 units and reducing Term 4 to 3 units.

The options selected by the student, including any of the above changes to the roadmap for that particular student, will be noted on the student’s Plan of Study.

Project Option Roadmap:

Term 1 (9 units)	Term 2 (9 units)	Term 3 (8 units)	Term 4 (4 units)
CMPS 5000 (1) CMPS 5010 or 5100 (2)* CMPS 5120 (3) Select one core course (3)	CMPS 5000 (1) CMPS 5010 or 5100 (2)* Select one core course (3) Elective (3)	CMPS 6950 (2) Elective (3) Elective (3)	CMPS 6960 (1) Elective (3)

* Choice of CMPS 5010 or 5100 in first two terms depends on entry term.

The two selected core courses in Terms 1 and 2 can be swapped with any of the elective courses in Terms 3 and 4 if the student wishes to take a core course offered during later terms.

Project Option students can also choose to take two elective courses in Term 4 and one elective course in Term 3, bringing Term 4 up to 7 units and reducing Term 3 to 5 units.

The options selected by the student, including any of the above changes to the roadmap for that particular student, will be noted on the student’s Plan of Study.

- n. Accreditation process and timeline: No specialized accreditation is required for this program. The WASC Senior College and University Commission Substantive Change Screening Form will be submitted in Spring 2020. If a full Substantive Change Review is required, that will be submitted by no later than November 2020 to provide adequate time for review.

5. Societal and Public Need for the Proposed Degree Major Program

- a. List of other CSUs and any neighboring institutions offering the proposed program:

To the best of our knowledge, the following CSUs offer a Master of Science in Computer Science (their driving distance from CSUB is also noted):

1. California State University Channel Islands (118 mi)
2. California State University, Chico (371 mi)
3. California State University, Dominguez Hills (129 mi)
4. California State University, East Bay (256 mi)
5. California State University, Fresno (117 mi)
6. California State University, Fullerton (150 mi)
7. California State University Long Beach (137 mi)
8. California State University, Los Angeles (115 mi)
9. California State University, Northridge (95 mi)
10. California State Polytechnic University, Pomona (138 mi)
11. California State University, Sacramento (279 mi)
12. California State University, San Bernardino (161 mi)
13. San Diego State University (232 mi)
14. San Francisco State University (283 mi)
15. San José State University (236 mi)
16. California Polytechnic State University, San Luis Obispo (132 mi)
17. California State University San Marcos (210 mi)

There are numerous external public and private institutions in California offering a similar degree. The three nearest campuses and their driving distances from CSUB are:

18. University of California, Los Angeles, a public research institution in Los Angeles, CA (106 mi)
19. Loyola Marymount University, a private research university in Los Angeles, CA (115 mi)
20. University of Southern California, a private research institution in Los Angeles, CA (122 mi)

- b. Differences between proposed program and those listed in Section 5.a:

Due to the high number of other CSU campuses also offering a Master of Science in Computer Science, the following comparison table is with the three closest CSU campuses. Courses unique to the proposed program are highlighted in blue:

Courses	Proposed	Northridge	Los Angeles	Fresno
Colloquium	Required			Required
Current Topics	Required			
Research/Ethics	Required			Required

Algorithms	Required	Select Three	Select Three	Required
Architecture	Select Two	Select Three		Required
Software Eng.	Select Two	Select Three	Select Three	Elective
Prog. Language	Select Two	Select Three	Elective	Required
Operating Sys.	Select Two		Elective	Elective
Distrib. Comp.	Select Two			
Comp. Theory		Select Three	Elective	Elective
Comp. Network			Select Three	
Web Program.		Elective	Select Three	Elective
Functional Prog.			Select Three	
Capstone	Thesis or Project	Thesis or Project	Thesis, Project, or Exam	Thesis, Project, or Exam
Elective courses	Nat. Lang. Proc. Data Mining Machine Learn. Hardware Sec. Reverse Eng. Operations Sec. Parallel Alg. Distrib. Learn.	Data Mining Machine Learn. Comp. Graphics SE Architecture SE Requirement SE GUIs Networking	Data Science Comp./Net. Sec. Comp. Graphics SE Architecture System Analysis SE HCI Networking Artificial Intel.	Comp. Graphics SE Development Wireless Net. Artificial Intel.

Note: Courses at the three comparison campuses that are not offered in the proposed program are only listed if they are a core at one campus or an elective at two or more campuses.

Our core computing coursework is similar to the other CSUs, with modifications to fit the strengths of CSUB's faculty members and local industry needs. We have also included distributed computation in the core, as this is a new knowledge area added to the Association for Computing Machinery (ACM) Computer Science 2013 Body of Knowledge. Older CSU programs may not have adapted their curriculum to these new guidelines. CSUB was also the first BS CS program in the CSU to add this area to their undergraduate core curriculum.

Also, while not universally common across the other CSUs, the inclusion of a research methodologies and professional ethics course in the proposed program is critical to training the next generation of researchers, professionals, and academics to be fully cognizant of the impact of computing and computing solutions on individuals and society. Even students who choose the Project option need to be familiar with the societal implications of computing and how to remain current within the profession, so this course is required for all students. Similarly, the current topics course provides necessary exposure to the breadth of active research topics in computing, which is a critical foundation for all MS CS students, regardless of their capstone pathway.

The proposed program was compared to all other CSU campuses and **significantly different** than these other programs in the following areas:

1. The proposed breadth/specialization in theory of distributed and parallel computation is unique: There are two CSU campuses that share a specialization/breadth area in distributed

and parallel systems: California State University, Dominguez Hills and California State University, Fullerton. Their curriculum is summarized as follows:

California State University, Dominguez Hills	California State University, Fullerton	Proposed Program
CSC 531 Comp. Arch. CSC 541 Adv. Op. Systems CSC 551 Data Comm. and Computer Networks CSC 552 Distrib. Computing and Parallel Processing CSC 555 Info. Assurance and Network Security	CPSC 531 Advanced Database Management CPSC 551 Operating Systems Design CPSC 558 Advanced Computer Networks	CMPS 5150 Parallel Algorithms CMPS 5160 Distributed Learning & Optimization CMPS 5640 Graduate Distributed Computation

Dominguez Hills has a concentration in Distributed Systems Networking (DSN). CSC 551 and CSC 555 are courses on computer networks and network security. Our program focuses its breadth area strictly on distributed and parallel computing. CSC 531 would cover parallel hardware considerations (such as shared memory) as part of a greater survey in computer architecture. Our course CMPS 5150 goes into parallel algorithms/theory in depth. CSC 541 may cover message passing and system management over multiple nodes but not to the depth it will be discussed in the proposed programs CMPS 5640. We will cover distributed and parallel processing in much greater depth. Indeed, only one course (CSC 552) overlaps with the proposed curriculum.

Fullerton also offers a specialization/breadth area in Distributed Systems. CPSC 531, CPSC 551 and CPSC 558 may cover some distributed topics and does not cover the same topics as our proposed CMPS 5640. California State University, Fullerton does not have a course strictly on parallel and distributed computing.

Thus, we will be the first CSU campus to offer a rigorous, theoretical specialization/breadth area in distributed and parallel computation/algorithms. We will offer CMPS 5150 Parallel Algorithms, CMPS 5160 Distributed Learning and Optimization, and CMPS 5640 Graduate Distributed Computation. The proposed program intends to offer greater depth given its growing importance to the field of computer science. There is a growing trend for businesses to outsource its data centers to companies such as Amazon (Amazon Web Services) and Microsoft (Azure). A central theme of this drive is the scalability of applications across multiple servers, which must use distributed and parallel algorithms.

2. No other campus currently offers a course in distributed machine learning: Following the previous motivation that businesses are increasingly using the cloud and remote data centers, most of these applications rely on machine learning algorithms to provide their services (also mentioned as deep learning, artificial intelligence, big data and data science in the media). The course CMPS 5160 Distributed Learning and Optimization is the intersection of data science and distributed computation. **It will be the first of its kind in the CSU.**
3. Existing programs do not cover computer and network security in depth: Ten campuses offer an elective in computer and network security, or cryptography. However, at most campuses, only a single class is offered in cybersecurity or cybersecurity concepts are bundled into a more general course on computer networks. Cybersecurity is a growing concern in society

and California has a need for trained cybersecurity professionals. The proposed program offers several specialized graduate-level electives that focus on current topics in cybersecurity. CMPS 5270 Hardware Security provides a foundation in a growing area of concern: hardware-level vulnerabilities such as Spectre and Meltdown, which cannot fully be handled by patching code and microcode. CMPS 5510 Reverse Engineering will provide critical skills for understanding and mitigating exploit code “in the wild”, which is a highly prized skill in both industry and security research. CMPS 5650 Operations Security focuses on protecting critical infrastructure and data.

c. Other curricula offered by the campus that are closely related to proposed program:

None. There is no graduate-level computer science curriculum currently offered at CSUB.

d. Community participation in planning process:

An environmental scan for the MS CS program was conducted by UPCEA Center for Research and Marketing Strategy in 2016. To prepare this report, job postings and projections in Kern County, the primary county in CSUB’s service region, and in California were analyzed. See Appendix H for the complete environmental scan report.

Informal discussions were held with employers in the area. In addition to their general computing professional needs, they expressed a need for specialized training for data analysts and cybersecurity professionals, which aligns to the proposed elective areas.

Alumni from the program were also asked to participate in an interest survey. Those results are presented in Section 6.a.

e. Applicable workforce demand projections and other relevant data:

An environmental scan for the MS CS program was conducted by UPCEA Center for Research and Marketing Strategy in 2016. According to that report, the top three industries employing computing professionals in Kern County are school districts (elementary and secondary), the federal government, and corporate/subsidiary/regional offices, with a combined projected growth of 2.6k jobs by 2025 (7%). The top three industries in California are custom computer programming services, computer system design services, and software publishers, with a combined projected growth of 90k jobs by 2025 (27%).

The report also analyzed growth in specific computer occupation fields, based on data from the Department of Labor, Bureau of Labor Statistics. In Kern County, the three fields with the highest projected growth are information security/cybersecurity analysts (38%), application software developers (28%), and computer network architects (28%). In California, the top three fields are information security/cybersecurity analysts (36%), application software developers (24%), and computer systems analysts (22%).

In addition to growth in these specific occupation fields, the report also noted research and technology trends in big data, data analytics, machine learning, cloud computing (distributed computation), and cybersecurity, which aligns with the proposed elective areas.

See Appendix H for the complete environmental scan report.

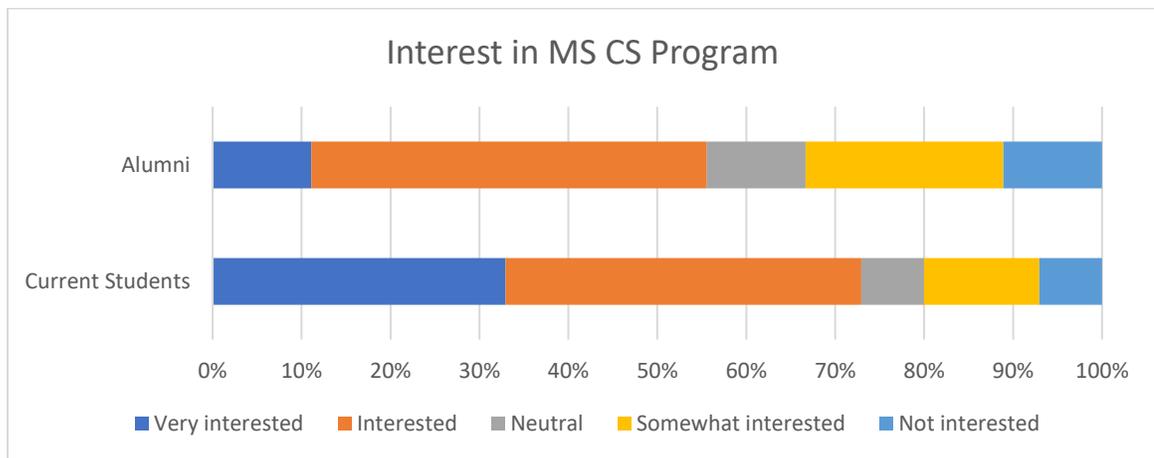
6. Student Demand

a. Compelling evidence of student interest in program:

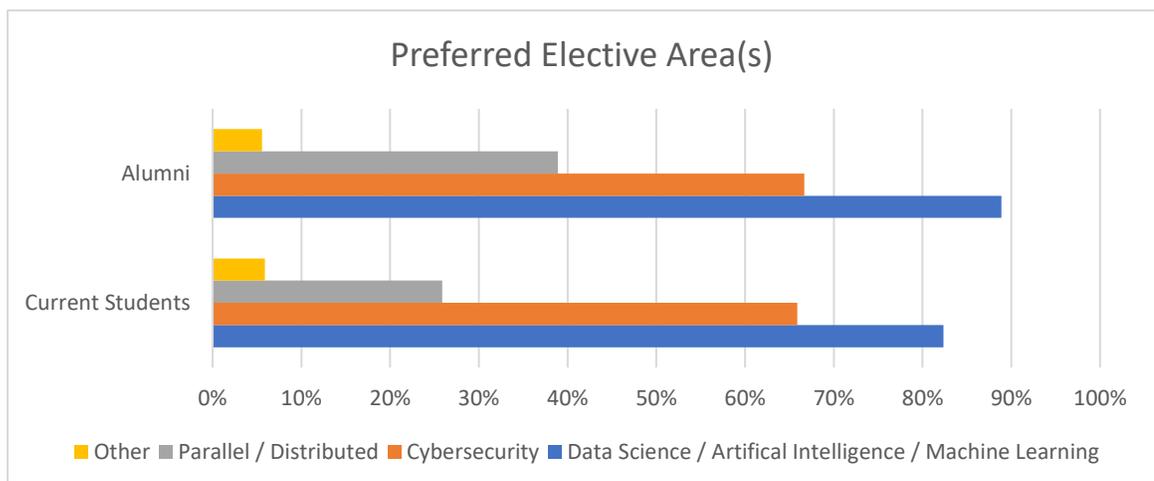
In addition to the environmental scan from UPCEA, the CEE/CS Department conducted a survey of current students and alumni in Fall 2019. The survey was posted on the department website and sent out to the department student email list (which includes alumni who have graduated within the past two years). Some faculty members also announced the survey to their courses.

Overall, 85 current students and 18 alumni completed the survey. Slightly under 80% of the respondents were from calculus-based programs that would meet the criteria for admissions to the MS CS program.

Student interest in the program is high, with 55% of the alumni and 72% of the current students expressing that they are interested or very interested in the MS CS program, as shown in the following figure:



For both alumni and current students, data science / artificial intelligence / machine learning was the most popular elective area, with cybersecurity and parallel / distributed computation also having strong interest, as shown in the following figure:

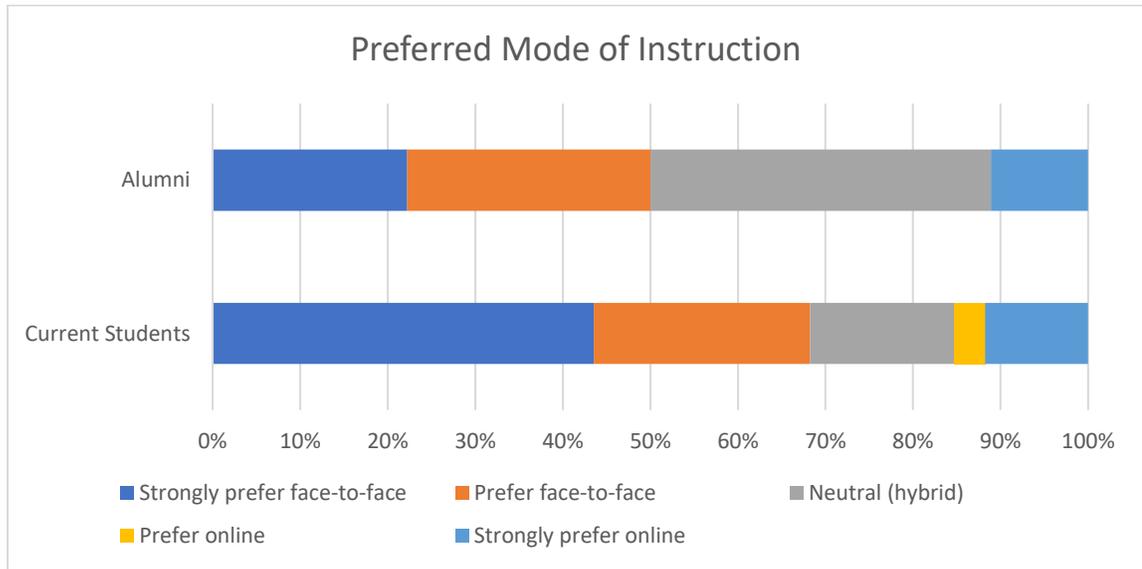


Primary factors affecting students' decisions to enroll in the MS CS program would be the cost of the program and when the courses are scheduled, for both alumni and current students. Slightly

more than 80% of the respondents said that they would be willing to pay \$20,000 or more to complete the MS CS program.

Capstone preferences were similar between the alumni and current students, with about 70% preferring the Project option, 25% preferring the Thesis option, and 5% undecided. This input was used to determine the expected sizes for the capstone courses in Section 4.g above.

The survey also asked students about their preferred mode of instruction. Only 11% of the alumni and 15% of the current students prefer online instruction. Over 68% of the current students and 50% of the alumni prefer face-to-face mode, with the remainder preferring hybrid instruction, as shown in the following figure:



Overall, the student interest survey shows that there is strong interest in the MS CS program, and the student responses to the elective preferences, mode of instruction, and cost of the program are in line with what we have proposed for the MS CS program.

b. Diversity and access to the university:

Advertising and recruitment for the program will be primarily managed by EEGO. Program marketing will feature a two-pronged approach, targeting known or likely candidates already on the CSUB campus as well as external candidates statewide. In both scenarios, tactics may include the following (not an exhaustive list):

- Digital advertising (Facebook, Instagram, Google, LinkedIn, etc.)
- Email marketing
- Digital music / radio (Spotify)
- On-campus and / or webinar information sessions
- Industry-specific publications (professional orgs, etc.)
- Tabling events

Program overview, outcomes, course descriptions, tuition and fees, and additional information will be added to the Extended Education website. Additionally, various printed collateral

featuring program information may be developed to support specific audiences as marketing progresses.

Candidates who meet the minimum criteria for admission, as outlined in Appendix A: Catalog Copy, will be evaluated by a committee of at least three faculty members from the CEE/CS Department. The decision will be based on a formal application procedure, which includes evaluation of coursework, GPA, letters of recommendation, personal statement, curriculum vitae, and other application materials that may be required by the committee and/or offered by the student. The application procedure is designed to insure equitable access and consideration of all qualified candidates.

c. Number of undergraduate majors and degree production:

	2016/17	2017/18	2018/19	2019/20
BS CS Majors (Headcount)	273	287	302	309 (preliminary)
BS CS Degrees Awarded	26	49	51	Fall: 12 awarded Spring: 56 applications

d. Professional uses of proposed degree program:

Graduates from the proposed program will be well-suited for a variety of computing jobs in academia, government, and industry, as well as to continue on to Ph.D. programs in Computer Science. All graduates would be suited to jobs in computing research, software development, computer programming, computer systems analysis, and generalized computing jobs, given the skills they will obtain from the program.

Graduates who choose electives in the data science / artificial intelligence / machine learning area will be suited for jobs such as data scientist, data analyst, data architect, big data engineer, artificial intelligence engineer, machine learning engineer, and other jobs in this fast-growing field. Graduates who choose electives in the cybersecurity area will be suited for jobs such as information security analyst, security engineer, security architect, SecOps engineer, DevSecOps engineer, database/network/system administrator, and other jobs in cybersecurity. Graduates who choose electives in the parallel / distributed computation area will be suited for jobs such as cloud architect, cloud engineer, high performance computing data scientist, high performance computing engineer, parallel computing engineer, and other jobs within the field.

Within CSUB's service region, there is employer demand specifically for cybersecurity professionals and data analysts. Additionally, the community colleges within the region need people with MS degrees to teach the lower-division CS courses required for the associate degree for transfer in computer science (ADT CS). The CEE/CS Department also needs more people with MS CS degrees for its own lecturer pool for the BS CS program.

And as noted in the environmental scan, California has a strong unmet need for trained computing professionals in a variety of fields. All areas listed above have job openings within California. Graduates could go on to a variety of careers ranging from designing next-generation technology for Silicon Valley companies to supporting industry needs for computing expertise.

e. Expected number of majors and graduates:

The program has been designed around a cohort model where 20 students are admitted in the Fall semester (17 are retained in future semesters) and 15 students are admitted in the Summer

semester (12 retained in future semesters). The program has also been designed to be completed in four semesters by someone attending full-time, as noted in the advising roadmaps in Section 4.m. The expected active cohorts for each semester in the first three years are detailed above in Section 4.g. A summary of the expected enrollments in the first, third, and fifth year follows:

Enrollments	Year 1	Year 3	Year 5
Continuing Students from Previous Year	---	29	29
Students Entering in Fall	20	20	20
Total Students Enrolled in Fall	20	49	49
Total Students Enrolled in Spring	17	29	29
Students Entering in Summer	15	15	15
Total Students Enrolled in Summer	32	44	44
Graduates	Year 1	Year 3	Year 5
Expected Graduates in Fall	--	17	17
Expected Graduates in Summer	--	12	12
Total Expected Graduates for Year	--	29	29

7. Existing Support Resources for the Proposed Degree Major Program

a. List of faculty members who would teach in the program:

1) CEE/CS faculty with primary Computer Science responsibilities:

- Anthony Bianchi, Assistant Professor, Ph.D. Electrical Engineering 2014, CSUB faculty since 2016, specializes in parallel / distributed computing and machine learning.
- Alberto Cruz, Assistant Professor, Ph.D. Electrical Engineering 2014, CSUB faculty since 2014, specializes in artificial intelligence and computer architecture.
- Melissa Danforth, Professor, Ph.D. Computer Science 2006, CSUB faculty since 2006, specializes in cybersecurity and computer science theory.
- Kanwal Gagneja, Assistant Professor, Ph.D. Computer Science 2013, CSUB faculty since 2020, specializes in cybersecurity, cloud computing, digital forensics, and Internet of Things (IoTs).
- Chengwei Lei, Assistant Professor, Ph.D. Computer Science 2014, CSUB faculty since 2016, specializes in data science and computer science theory.
- Walter Morales, Part-time Lecturer, M.S. Engineering 2015, CSUB faculty since 2013, also affiliated with Mathematics Department, specializes in data science.
- Vincent On, Assistant Professor, Ph.D. Electrical Engineering 2018, CSUB faculty since 2018, specializes in parallel / distributed computing and machine learning.
- Nicholas Toothman, Assistant Professor, Ph.D. Computer Science June 2020, CSUB faculty since 2019, specializes in animation, virtual reality, and software engineering.

2) CEE/CS faculty with primary Electrical and Computer Engineering responsibilities who could teach some proposed courses and/or serve on capstone committees:

- Mostafa Abdelrehim, Assistant Professor, Ph.D. Electronics and Communications Engineering 2015, CSUB faculty since 2020, specializes in network-on-chips and thermal and power modeling of many-core computer architectures.

- Marcia Golmohamadi, Assistant Professor, Ph.D. Electrical Engineering 2019, CSUB faculty since 2020, specializes in communication systems, antenna design, signal processing, and machine learning.
- Saeed Jafarzadeh, Associate Professor, Ph.D. Electrical Engineering 2012, CSUB faculty since 2012, specializes in machine learning for power grid control algorithms.
- Wei Li, Professor, Ph.D. Electrical and Computer Engineering 1991, CSUB faculty since 2001, specializes in robotics and control systems.
- Weiguo Luo, Part-time Lecturer, Ph.D. Civil Engineering 2005, CSUB faculty since 2016, specializes in sensor networks and automation.
- Amin Malek Mohammadi, Assistant Professor, Ph.D. Electronics and Computer Systems Engineering – Optical Fiber Communication Systems focus 2009, CSUB faculty since 2020, specializes in optical communication, signal processing, and photonic chip-scale integrated circuits and systems.
- Ehsan Reihani, Assistant Professor, Ph.D. Mechanical Engineering – Electrical Engineering focus 2015, CSUB faculty since 2016, specializes in power grid control.

b. Facilities used in support of the program:

The Science III building at the CSUB main campus is the primary home of the CEE/CS Department. All faculty and staff member offices, most department teaching classrooms, and the department research laboratories are located in the Science III building. The CEE/CS Department also shares one teaching room with the Physics and Engineering Department in the Engineering Modular Complex, primarily for engineering courses.

The following rooms are department-controlled spaces in Science III that will be used for both the existing undergraduate BS CS program and the proposed MS CS program:

Room	Type	Description
Sci. III 324 794 sq. ft.	Student Support	CEE/CS Tutoring Center Weekday tutoring services for lower-division courses. Computers are also available for students to use in any CEE/CS course and have all the teaching lab software.
Sci. III 341 303 sq. ft.	Student Support	CEE/CS Major Study Room This room contains a library of technology books, three computers, whiteboards, and multiple study tables. It is open for study groups, projects, and other student activities.
Sci. III 314 301 sq. ft.	Research Lab / Infrastructure Support	Isolated Network and ITS Network Rack Used for cybersecurity research projects and coursework. Half of the room is blocked off via a wire partition for ITS use and is not available for student use.
Sci. III 328 612 sq. ft.	Research Lab	Computer Perception Lab Shared research space for multiple faculty members on both the CS and engineering sides of the department. Primarily used for software-based/simulation research.
Sci. III 240 972 sq. ft.	Teaching Lab	General teaching computer lab with 35 Linux/Windows dual-boot computers. Primarily used by the CS side of the department.

Sci. III 311 1020 sq. ft.	Teaching Lab	General teaching computer lab with 35 Linux computers, primarily used by the CS side of the department.
Sci. III 313 1051 sq. ft.	Teaching Lab	Specialized teaching lab with 17 Linux/Windows dual-boot computers. Primarily used by engineering. Occasionally used for CS lecture courses.
Sci. III 315 1011 sq. ft.	Teaching Lab	State Farm Advanced Workstation Laboratory 35 Linux computers with high-end video cards and large monitors for advanced graphics, visualization, AI, and other high-level CS courses.

The department has additional research and teaching laboratories for the engineering side of the department, but we do not anticipate using that space for the MS CS program.

The undergraduate programs would have priority use of all department-controlled space, since they are stateside programs. The MS CS courses would only be scheduled in the teaching labs after all need for the undergraduate programs is met, or at times when the undergraduate courses are not scheduled (e.g. weekends). MS CS students using the research labs and student support spaces would share that space with undergraduate students.

c. Electronic and physical library resources:

The following statement was provided by Ying Zhong, the CSUB librarian for NSME departments, including the CEE/CS Department:

At CSUB, the Walter W. Stiern Library opened in 1994 and is the largest building on the California State University, Bakersfield campus. The 150,000 square-foot building houses nearly half a million volumes and provides electronic access to more than 30,000 periodical titles via its hundreds of computer terminals. The Library is managed and operated by 23 staff members and faculty librarians. The Library also maintains a branch library at the CSUB Antelope Valley campus in Lancaster.

On the main floor, students can check out books, laptop computers and iPads, obtain research help from a librarian at the reference desk, borrow reserve materials, or use the reference computers to access resources. The Library's users check out more than 70,000 items per year on average. The Resource Sharing Department, which performs more than 15,000 borrowing and lending transactions per year, is located on the first floor, as are the reference, California History, Multicultural, First Year Experience and law collections.

The 2nd floor contains the library's extensive collection of print periodicals. The newest addition to the Walter W. Stiern Library on this floor is Fab Lab Annex, a digital fabrication lab. Students will be able to use 3D printers and vinyl cutters, with trained staff to help them as needed. The 3rd and 4th floors house the main book collection. Computer Science books are located on the 4th floor. Texts related to general Computer Science number 2818 in-print books and 941 in-print journals. Texts related to Computer Science number 25972 eBooks and 865 Electronic journals. This circulation collection is the largest academic book collection in the southern San Joaquin Valley. Group and individual study rooms are also found on these floors.

Eight full time Librarians, all of whom hold advanced degrees in library science, on average, answer more than 500 reference questions per week at the reference desk. They also provide online reference assistance through the 24-hour Question Point service and offer in-depth help to

students through the Individual Research Assistance Program. There is a tenured Associate Librarian assigned to the Computer Science subject area. Services provided by the Librarian include consultation to students and faculty, both in-person and online, and orientation programs.

The Stiern Library homepage serves as the information portal for most library research. From the homepage, CSUB users can connect to eBooks, research databases and reference resources. All these resources can be accessed off campus by CSUB students and faculty. Users may access a huge electronic collection of computer books via Safari, Ebrary, and EBSCOhost eBook collection. Periodical Databases, such as EBSCOhost, ScienceDirect, IEEE Xplore Digital Library, ACM Digital Library, are a few of the periodical databases CSUB students have access to. These databases cover a wide spectrum of computer science areas and provide citations up to full text articles.

In June 2017, The Walter W. Stiern Library is implementing a shared library system known as CSU+ that will allow all 23 CSU libraries to manage hundreds of millions of books and articles and easily share resources with one another.

d. Academic technology, equipment, and other specialized materials:

The CEE/CS Department operates its own server room with multiple server racks. CSUB's Information Technology Services (ITS) maintains the networking equipment up to the server room switch and provides two gigabit fiber connections to the server room switch. CEE/CS maintains all the server rack equipment. Each server rack is equipped with UPSs and PDUs for power reliability and distribution. There is also a tape library for backup services. The server racks currently house three teaching servers, two research servers, three legacy servers, and three research servers for other departments. There is sufficient infrastructure to add more research and teaching servers in the future.

The CEE/CS Department also maintains an isolated network, which is not connected to the Internet or campus network, for cybersecurity teaching and research. The isolated network has UPSs and PDUs for power reliability and distribution, as well as a tape library for backups. There is a VMware server, backup server, management server, GPU workstation, and seven Dell PC workstations in the isolated network.

For software resources, the CEE/CS Department is part of the VMware Academic Program (VMAP) and Microsoft Azure for Education program, which provides educational-use software licenses to faculty members and students. The department also has a MATLAB and Simulink license with toolboxes for bioinformatics, communications, computer vision, control system, curve fitting, data acquisition, digital signal processing, embedded coder, fixed-point, fuzzy logic, global optimization, HDL coder, HDL verifier, image acquisition, image processing, instrument control, MATLAB coder, MATLAB compiler, MATLAB compiler SDK, neural network, optimization, partial differential equation, signal processing, Simscape, Simscape power, Simulink coder, statistics and machine learning, symbolic math, and wavelet.

Through school-level and campus-level software license agreements, there is also access to National Instruments LabVIEW and Multisim, Autodesk products, SOLIDWORKS, Microsoft Office365, Minitab, and SPSS. Some of these programs may have a small educational fee required for use on personal devices.

8. Additional Support Resources Required

a. Additional faculty or staff:

No additional faculty or staff are needed. The CEE/CS Department already has sufficient staff for maintaining the department equipment and facilities. EEGO has sufficient support staff for managing the self-support program. The CEE/CS Department also has sufficient faculty to offer all courses and mentor the capstone students in the MS CS program.

As noted in Section 7.a on page 21, the CEE/CS Department has eight CS faculty members and seven ECE faculty members who are qualified to teach in the program. This includes seven tenured/tenure-track CS faculty members and six tenured/tenure-track ECE faculty members.

To minimize burn-out of faculty members, CEE/CS has negotiated a time replacement option for full-time faculty members with EEGO, where faculty members teaching graduate courses can opt to buy out their stateside time using the standard CSUB replacement rate rather than teaching for overload pay. This option has been accounted for in the self-support budget in Appendix D. This would not negatively impact stateside teaching for undergraduate students, as the graduate students could be hired as laboratory teaching assistants during their MS CS program to reduce the stateside teaching load for current faculty members. Additionally, alumni of the MS CS program who stay in the region would be qualified to teach as part-time instructors for the undergraduate program.

If every CS faculty member teaches 3 WTUs of regular graduate courses per year and slightly more than half of the ECE faculty members also agree to teach 3 WTUs of graduate courses (either for overload pay or using the time replacement option), we could offer up to 36 WTUs with our current faculty members. Our planned course offerings, as described in Section 4.g on page 8, has 30 WTUs of regular courses in the first year and 36 WTUs of regular courses per year after the initial year, so we have sufficient faculty to offer the regular courses for the MS CS program.

Capstone courses will primarily operate through individual study (either for overload pay or using the time replacement option). As noted in the planned course offerings, after the initial two years, each year we have an enrollment expectation of 14 unique thesis students (5 continuing work began in the prior year) and 32 unique project students (12 continuing work began in the prior year). If only the tenure-track CS faculty members supervised the capstone students, this would translate to an expectation of each faculty member supervising 2 thesis students and 4 project students per year. However, the tenure-track ECE faculty members and the lecturers with terminal degrees would also be eligible to be capstone instructors. If each ECE faculty member and lecturer supervised 1-2 students, this would reduce the number of capstone students each CS faculty member is expected to supervise each year to around 4 students.

For the above reasons, we will not need additional faculty members to offer the program.

b. Additional lecture or laboratory space:

No additional lecture or laboratory space is needed. Our planned course offerings, as described in Section 4.g on page 8, have up to 12 lecture units of regular courses per term which would need classrooms. This translates to 10 hours per week of meeting time for the graduate courses. We do not offer undergraduate classes on weekends, so any of the classrooms described in Section 7.b on page 22 would be available on weekends for the graduate courses. There are also sufficient

unused time blocks in those classrooms during weekdays, particularly in the late evenings, to offer the graduate courses. Weekends and evenings would also work best for any graduate students who have full-time jobs. The capstone courses will operate as individual study courses and will use the 25Live event reservation system at CSUB to find a room when it is needed for presenting the final project or for oral defense of the thesis.

c. Additional library resources:

No additional library resources are needed. As noted in Librarian Ying Zhong's report in Section 7.c on page 23, CSUB already has access to the ACM Digital Library, IEEE Xplore Digital Library, EBSCOhost, SpringerLink, and Elsevier Science Direct. These resources, along with the other physical and electronic resources already provided at CSUB and CSUB's existing interlibrary loan agreements, cover the vast majority of the publication venues in Computer Science. These existing resources will be sufficient to support the MS CS program.

d. Additional academic technology, equipment, or specialized materials:

Given the size of our undergraduate program, sharing our existing server resources between the undergraduate and graduate students would place an undue strain upon the existing servers, particularly the servers with GPU computing functionality which are already heavily used by the current undergraduate students. CSUB has received a U.S. Department of Education Title V, Part B HSI grant, award number P031M190029, to support multiple graduate programs at CSUB, including the MS CS program. This grant includes slightly over \$66k in funding to purchase a dedicated GPU compute server and a dedicated cybersecurity server for the MS CS program, as well as workstations to connect to the servers. The self-support budget in Appendix D also contains a line item ("CEE/CS Equipment Fund") to fund replacing this equipment every five years out of the fees paid by the MS CS students.

9. Self-Support Programs

a. Confirm that the proposed program will not be offered at places or times likely to supplant or limit existing state-support programs:

As noted in Section 8.b above, we do not currently offer any stateside undergraduate courses on the weekends and we have time blocks in department classrooms in the late weekday evenings that are not being used for stateside undergraduate courses. These would be the time blocks used for the MS CS courses.

b. Explain how state-support funding is either unavailable or inappropriate:

In order to support the proposed program at the outlined enrollment levels in the stateside budget, we would need to offer 36 WTUs of regular graduate courses and to supervise of 32 graduate students in capstone courses each year. This would require at least two additional tenure-track lines, as well as another full-time lecturer position during the initial years of the tenure-track appointments to cover the collective bargaining agreement release time for new faculty members (assuming this continues in the next contract). The entire CSUB campus only had 6 growth tenure-track hires authorized in 2018/19 and 13 growth tenure-track lines authorized in 2019/20. Given the low number of growth tenure-track lines available for the entire campus, it would not be feasible to support this program on the stateside budget at this time, or in the near future.

- c. Explain how at least one of the following additional criteria shall be met:
- iv. For new programs, the client group for the course or program receives educational or other services at a cost beyond what could be reasonably provided within CSU Operating Funds:
- As noted in Section 9.b above, the cost to staff the program would exceed the funding that could be provided by the stateside budget.
- d. For self-support programs, please provide information on the per-unit cost to students and the total cost to complete the program: The per-unit cost is \$650 and the total cost to complete the program is \$19,500. See Appendix D for the complete self-support cost recovery budget for the first five years of the program.

Appendix A: Catalog Copy

Department of Computer and Electrical Engineering and Computer Science School of Natural Sciences, Mathematics, and Engineering

Department Chair: Melissa Danforth

Program Office: Science Building III, 317

Telephone: (661) 654-3082

email: ceecs@cs.csubak.edu

Website: www.cs.csubak.edu

Faculty: M. Abdelrehim, A. Bianchi, A. Cruz, M. Danforth, K. Gagneja, M. Golmohamadi, S. Jafarzadeh, C. Lei, W. Li, A. Malek Mohammadi, V. On, E. Reihani, N. Toothman, H. Wang (emeritus)

Program Description

The Department of Computer and Electrical Engineering and Computer Science (CEE/CS) offers a graduate program leading to a Master of Science in Computer Science degree. The program is intended to prepare students for high-tech careers in the computing industry, government agencies, academic research, or graduate studies at the doctoral level. Thesis and project options are both available in the program and the electives are designed in response to regional, state, and national needs in computing. A broad range of faculty research interests, access to modern facilities, and a strong student-faculty interaction permit the student to choose from a broad spectrum of research or project topics.

Program Objectives

The program educational objectives are to prepare graduates who:

1. Demonstrate expertise in advanced computing topics and an ability to maintain a high standard of professional competence.
2. Analyze and solve significant real world problems with contemporary computing knowledge.
3. Apply computing knowledge ethically, with an understanding of realistic constraints and for the overall benefit of a diverse society.
4. Enhance the economic well-being of their region through a combination of computing expertise, communication skills, social responsibility, leadership, and entrepreneurship.

All graduates are also expected to adhere to the Association for Computing Machinery (ACM) Code of Ethics, <https://www.acm.org/code-of-ethics>.

PROGRAM ADMINISTRATION

Program Committee and Graduate Program Director

The Program Committee consists of at least three faculty members from the CEE/CS Department. The Graduate Program Director is the chair of the committee. The committee is appointed following the procedures outlined in the CSUB University Handbook, in consultation with the faculty of the CEE/CS Department, the Dean of Natural Sciences, Mathematics, and Engineering (NSME) and the Dean of Extended Education and Global Outreach (EEGO).

The Program Committee makes decisions regarding student admission and classification, petitions from students in the program, curriculum development and revision, and course offerings. The Graduate Program Director is responsible for approving each student's Plan of Study, approving changes in student status such as advancement to Candidate status, overseeing advising for students in the program, and coordinating other program administrative tasks (in consultation with the CEE/CS Department Chair). The Graduate Program Director also serves as the faculty liaison between the program and EEGO.

Advising

The Graduate Program Director is responsible for assigning a Program Advisor to each student. The Program Advisor is a member of the program faculty who can best serve the student's needs. The Program Advisor mentors the student through the graduate program, helps the student select elective and capstone options for their Plan of Study, assists the student in identifying an appropriate Thesis or Project Advisor, and responds to concerns raised by the student. Students should meet with their Program Advisor early on in the program to develop their Plans of Study in order to facilitate timely completion of the degree.

Capstone Options

Students in the program have two options for their capstone experience: (1) a Thesis or (2) a Project. Each student will choose a capstone option in consultation with their Program Advisor, as part of their approved Plan of Study.

Students who select the Thesis option are expected to complete a research project on a significant problem, with broad scope and originality, within computer science, including appropriate background research on the selected topic. Thesis option students should identify their Thesis Advisor by the end of their second term. The Thesis Advisor will supervise the student's research and chair the student's Thesis Committee. Each student will have a Thesis Committee with at least three members, including the Thesis Advisor. At least two of the committee members must be faculty members within the program. The third committee member should preferably be a faculty member from outside the program, a faculty member from another institution, or a community member. Committee members from other institutions or from the community must follow campus policies for participation in the committee, as listed in the Division of Graduate Programs section of CSUB's catalog. The Thesis Advisor will serve as the instructor of record for the CMPS 6910 and 6920 Thesis course sequence. The student's selected research topic must be approved by the student's Thesis Committee and the Graduate Program Director to advance to Candidate status. The student is expected to orally defend their thesis, complete all revisions required by the Thesis Committee and the Program Committee, and file their thesis with the CSUB library to satisfactorily complete CMPS 6920.

Students who select the Project option are expected to complete an innovative software or computing project of significant undertaking, including appropriate market research for the project. Project options students will have a Project Committee with at least three members, with one Project Committee member designated as the Project Advisor. The majority of the Project Committee members must be faculty members from within the program. The Project Advisor will serve as the instructor of record for the CMPS 6950 and 6960 Graduate Project course sequence. The student's project must be approved by the student's Project Committee and the Graduate Program Director to advance to Candidate status. The student must complete all revisions to the project and project report required by the Project Committee and the Program Committee to satisfactorily complete CMPS 6960.

For both capstone options, the Program Advisor will assist the student in identifying an appropriate Thesis or Project Advisor prior to enrollment in CMPS 6910 (Thesis) or CMPS 6950 (Project), depending on the capstone option selected. The student's Thesis or Project Advisor will assist the student in identifying the other members of the Thesis or Project Committee.

Any thesis or project involving human subjects research, either through direct measurement or from secondary sources, must have a human subjects protocol reviewed and approved by the CSUB Institutional Review Board (IRB). Any thesis or project involving non-human animals must have their research or educational protocol reviewed and approved by the CSUB Institutional Animal Care and Use Committee (IACUC).

APPLICATION AND ADMISSIONS PROCESS

Application for the Master of Science in Computer Science

Persons seeking a Master of Science in Computer Science must apply to both the university and the MS Computer Science graduate program for admission to this specific graduate program. Students will be admitted into the program with either conditionally classified status or classified status, depending on their prior academic preparation in computer science. In order to apply to the program, students must submit their application packet to CSUB Extended Education.

Admissions Requirements for the Master of Science in Computer Science

The following criteria must be met for a student to be admitted to the Master of Science in Computer Science program:

1. An earned bachelor's degree from an accredited institution.
2. Minimum coursework equivalent to CMPS 2010 (Programming I), CMPS 2020 (Programming II), CMPS 2120 (Discrete Structures), CMPS 2240 (Comp. Arch. I: Assembly), MATH 2510 (Calculus I), and MATH 2520 (Calculus II) is required to be considered for admission in the program. Additional upper-division coursework is required to be admitted at Classified Graduate Student status, as detailed in that section.

3. An undergraduate GPA of at least 3.0 in the last 60 semester units or 90 quarter units of course work is required for Classified Graduate Student status. The Program Committee may admit students with at least a 2.5 GPA, but less than a 3.0 GPA, at Conditional Graduate Student status on a case-by-case basis.
4. Submission of three letters of recommendation, including EEGO reference forms.
5. Submission of a personal statement and curriculum vitae/resume.
6. Formal decision by the Program Committee to accept the student into the graduate program. The decision will be based on a formal application procedure, which includes evaluation of coursework, GPA, letters of recommendation, personal statement, curriculum vitae, and other application materials that may be required by the Committee and/or offered by the student.

Applicants whose bachelor's degree is not yet awarded at the time of application may be admitted as a Conditionally Classified Graduate Student. Proof of degree completion must be submitted to the Program Committee prior to beginning the MS Computer Science program.

In addition to meeting the above requirements for admission, all graduate applicants, regardless of citizenship, whose preparatory education is principally in a language other than English must demonstrate competence in English, both in spoken and written forms. The minimum score on the Test of English as a Foreign Language (TOEFL) required for admissions is a score of 550 or higher (or 79 on the Internet-based TOEFL exam). Documentation must be provided in original form by the testing institution.

GRADUATE STUDENT CLASSIFICATION

Classified Graduate Student

Acceptance as a Classified Graduate Student indicates that space is available in the program for the student and that the student has met the minimum academic preparation requirements for the program, as follows:

1. An earned baccalaureate degree from an accredited institution.
2. Computer science coursework equivalent to: CMPS 3120 (Algorithm Analysis), CMPS 3240 (Comp. Arch. II: Organization), CMPS 3350 (Software Engineering), CMPS 3500 (Programming Languages), CMPS 3600 (Operating Systems), CMPS 3620 (Computer Networking), and MATH 3200 (Probability Theory).
3. An undergraduate GPA of at least 3.0 in the last 60 semester units or 90 quarter units of course work.

Conditionally Classified Graduate Student

Applicants who do not meet the requirements for Classified Graduate Student status may be provisionally admitted to the MS Computer Science program as a Conditionally Classified Graduate Student if, in the judgement of the Program Committee, the applicant has potential to successfully complete all remaining requirements for Classified Graduate status within a reasonable timeframe. The remaining requirements and the timeframe will be determined by the Program Committee and will be specified in the admissions letter. Upon successful completion of all requirements (or approved substitutions for remaining coursework), the student can apply for full acceptance to the program as a Classified Graduate Student. Failure to satisfactorily complete all requirements within the specified timeframe will result in dismissal from the program.

Note: Conditionally Classified Graduate Students may not enroll in more than 10 semester units of coursework for graduate credit prior to advancing to Classified Graduate Student status. Conditionally Classified Graduate Students are also not allowed to enroll in any 6000-level courses.

Advancement to Candidate Status

Advancement to Candidate status indicates that the student has completed at least 20 semester units (30 quarter units) within the student's approved Plan of Study and that there is a reasonable expectation that the student will complete all remaining degree requirements within one calendar year. Students will be advanced to Candidate status when they have met the following criteria:

1. Completion of all requirements for Classified Graduate Student status.
2. Approval of the student's Plan of Study by the Graduate Program Director.
3. Completion of at least 20 semester units (30 quarter units) towards the Master of Science in Computer Science degree with a graduate GPA of at least 3.0 and grades of "B-" or better in all graded courses on the approved Plan of Study.

4. Approval of the capstone option selected by the student:
 - a. Thesis option: Approval of the student's Thesis research topic by the student's Thesis Committee and the Graduate Program Director.
 - b. Project option: Approval of the student's Project by the student's Project Committee and the Graduate Program Director.
5. Certification by the student's Thesis or Project Advisor that the student will satisfactorily complete their capstone option within one calendar year.

PROGRAM REQUIREMENTS

Graduation Writing Assessment Requirement (GWAR)

The California State University system requires all degree candidates to demonstrate upper division writing competency before the degree can be conferred. Students who do not meet the GWAR Waivers for Graduate Students guidelines as specified in the Academic Information and Division of Graduate Programs sections of the CSUB Catalog are required to satisfy GWAR prior to the end of the first semester of the program.

Time Limits

Time limits have been set for completion of requirements at each level of status. For students admitted as Conditionally Classified Graduate Students, advancement to Classified Graduate Student status must be accomplished in the timeframe specified in the admissions letter. Advancement to Candidate status must be accomplished within three calendar years of achieving Classified Graduate Student status. The three-year limit may be extended upon approved petition to the Program Committee. All requirements, and graduation, must be completed within five calendar years of admission to the program. The five-year limit may be extended upon approved petition to the Program Committee.

Requirements for the Master of Science in Computer Science (30 total units)

1. Core Courses (15 units)

- a. CMPS 5000 Colloquium in Computer Science (2 terms at 1 unit each term)
- b. CMPS 5010 Current Topics in Computer Science (2)
- c. CMPS 5100 Research Methodologies and Professional Ethics (2)
- d. CMPS 5120 Graduate Algorithm Design and Analysis (3)
- e. A minimum of 6 units selected from the following:
 - i. CMPS 5240 Graduate Computer Architecture (3)
 - ii. CMPS 5350 Graduate Software Engineering (3)
 - iii. CMPS 5500 Graduate Programming Languages and Compilers (3)
 - iv. CMPS 5600 Graduate Operating Systems (3)
 - v. CMPS 5640 Graduate Distributed Computation (3)

2. Capstone Option (3-6 units)

- a. **Thesis Option (6 units)**
 - i. CMPS 6910 Thesis Research (5)
 - ii. CMPS 6920 Thesis Defense (1)
- b. **Project Option (3 units)**
 - i. CMPS 6950 Graduate Project I (2)
 - ii. CMPS 6960 Graduate Project II (1)

3. Elective Courses (9-12 units)

Thesis Option students need 9 elective units. Project Option students need 12 elective units.

Electives should be chosen in consultation with the student's Program Advisor and submitted to the Graduate Program Director for approval. Approved electives will be recorded on the student's Plan of Study.

Electives are available in the following areas:

- a. **Data Science / Artificial Intelligence / Machine Learning Courses**
 - i. CMPS 5420 Natural Language Processing (3)
 - ii. CMPS 5450 Graduate Data Mining (3)
 - iii. CMPS 5560 Machine Learning (3)
- b. **Cybersecurity Courses**
 - i. CMPS 5270 Hardware Security (3)
 - ii. CMPS 5510 Reverse Engineering (3)

- iii. CMPS 5650 Operations Security (3)
- c. **Parallel / Distributed Computation Courses**
 - i. CMPS 5150 Parallel Algorithms (3)
 - ii. CMPS 5160 Distributed Learning and Optimization (3)
- d. **Individual Study / Special Topics**
 - i. CMPS 5770 Special Topics in Computer Science (1-3)
 - ii. CMPS 5800 Graduate Research (1-3)

Note: Only up to 3 units of Individual Study / Special Topics may be used for elective credit.

Units from CMPS 5240, 5350, 5500, 5600, and 5640 in excess of the 6 units needed to satisfy the Core Course requirements may also be used as elective units, with approval of the Graduate Program Director.

Up to 6 semester units of CMPS 4000-level coursework not previously used to meet baccalaureate degree requirements may be used as elective units, with approval of the Graduate Program Director.

Graduation Requirements

The university will confer the degree upon the fulfillment of the following requirements:

1. Completion of all required courses according to an approved Plan of Study with a GPA of 3.0 or better.
2. Completion of all graded courses on the approved Plan of Study with a grade of “B-” or better.
3. Satisfactory completion of the student’s chosen capstone option (Thesis or Project):
 - a. Thesis option: Satisfactory completion of the thesis, including oral examination, any revisions required by the student’s Thesis Committee or the Program Committee, and filing the thesis with the library.
 - b. Project option: Satisfactory completion of the project and project documentation, including any revisions required by the student’s Project Committee or the Program Committee.

Graduate Course Descriptions

CMPS 5000 Colloquium in Computer Science (1)

This colloquium is intended to be a speaker series on current research in computer science and related fields. The colloquium provides a forum to share research, practice methods, distribute tools/software, and discuss current topics. Speakers will include scholars from academia and practitioners from the public and private sectors. Early sessions allow incoming students to familiarize themselves with the program, to other students, staff, and faculty. Offered on a credit, no-credit basis only. Course is repeatable, but only a combined total of 2 units can be used towards the Master’s degree. Each week the colloquium will meet for 50 minutes. Prerequisite: Graduate standing.

CMPS 5010 Current Topics in Computer Science (2)

This course focuses on discussions of current peer-reviewed literature in computer science and related topics. The course is in the format of a journal club and emphasis will be on research articles published in the last two years. Each week students will present and lead a discussion of one or more approved peer-reviewed articles. Students will be encouraged to discuss, analyze, critique, and implement the topics in each article. Students must submit reports on their related articles. Each week lecture meets for 100 minutes. Prerequisite: Graduate standing.

CMPS 5100 Research Methodologies and Professional Ethics (2)

This course is designed to develop research and communication skills for graduate students. The topics covered in this course will include research processes, research methods, literature searches, literature analysis, scientific manuscripts and software licensing. The course will also focus on professional ethics related to computer science and various forms of data. There will be an emphasis on requirements and regulations for human/animal-subject testing, Institutional Review Board (IRB) approval, consent, conflicts of interest, misconduct, and authorship. Each week the course will meet for 100 minutes. Prerequisite: Graduate standing.

CMPS 5120 Graduate Algorithm Design and Analysis (3)

This is an advanced graduate course in the analysis of algorithms, in terms of time and space complexity for best/average/worst case execution using asymptotic notation; the application of standard algorithmic approaches,

including divide-and-conquer, greedy algorithms, dynamic programming, and graph algorithms, to algorithm design. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5150 Parallel Algorithms (3)

This is an advanced graduate course in the design and analysis of algorithms for parallel systems. Theoretical topics include modeling the cost of parallel algorithms, and parallel algorithms for sorting, trees, graphs, and computational geometry. Practical topics will include data-parallelism, threads, futures, scheduling, synchronization, transactional memory and message passing. Students will design and present a project on parallel algorithms. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5160 Distributed Learning and Optimization (3)

Distributed computing architectures have led to adaptation of sequential algorithms to a distributed computation domain. Computer science subfields such as machine learning and optimization benefit greatly from these distributed architectures, thus have been adapted. Topics for this class include distributed learning and optimization, graph analysis, scaling, complexity analysis and evaluation of current platforms. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5240 Graduate Computer Architecture (3)

This is a graduate survey course in computer architecture for graduate students who have some experience in computer organization and design. It covers early systems, microprocessor design, instruction set architecture, control, buses, ALU, memory and multiprocessor systems. The class focuses on memory hierarchies, caching, virtual memory, ISA design considerations (RISC, CISC, VLSI RISCs), branch speculation, advanced datapaths, multithreading, coherence and consistency, and processor heterogeneity. Students will present current work in architecture. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5270 Hardware Security (3)

This course will study the principles of computer systems security from the hardware perspective, especially as it crosses layers of abstraction. Students will learn about the vulnerabilities in current digital system design flow and the challenges of building secure hardware for each layer of abstraction. Cutting edge research on these challenges will be discussed and hands-on experiences with performing attacks, developing countermeasures, and implementing secure hardware building blocks will be required. By the end of the course, students will be able to reason about security in terms of adversarial models, hardware vulnerabilities, and attacks. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5350 Graduate Software Engineering (3)

A study of concepts and research in the area of software engineering, with attention on modeling, design patterns, software architecture, deployment, quality assurance, and communication. Discussions will include presentations on historical and current research papers in the field with a special interest in ethical dilemmas in modern software development. A term project lets students apply and develop practical skills from the course material. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5420 Natural Language Processing (3)

This is a foundational course in natural language processing (NLP) for graduate students who have some experience in artificial intelligence or machine learning. The focus of the class is end-to-end systems for classification, understanding and organization of language, and generative models for communication. Topics include machine learning for text classification, bag-of-words representation, context-free parsing, semantics and machine translation. Students will present current work in NLP. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5450 Graduate Data Mining (3)

This course introduces concepts, principles, algorithms, techniques, performance, and applications of data mining and knowledge discovery. Topics may include data preprocessing, data visualization, data dissemination, the statistical foundations for data modeling, classification and prediction, clustering analysis, association and pattern analysis, and outlier detection. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5500 Graduate Programming Languages and Compilers (3)

This is an advanced graduate course where students will study programming languages with an emphasis on their implementation. Topics include lexical analysis, language syntax, control structures, the binding of names, procedures, and their implementation in compilers. Students will design and present a project on related topics. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5510 Reverse Engineering (3)

Investigation into reverse engineering techniques for both normal executables and malware. Topics include behavioral analysis of executables, static binary analysis, dynamic binary analysis, anti-analysis and evasion techniques, obfuscation, shellcode, and code injection. Hands-on activities will reinforce the theoretical concepts being discussed. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5560 Machine Learning (3)

This course introduces concepts of machine learning with a focus of supervised learning methods. Foundational modeling of classification and regression problems will be covered. Topics include linear discriminate analysis (LDA), logistic regression, support vector machines (SVM), maximum likelihood estimation (MLE), nearest neighbor, neural networks (NN), decision trees, decision forest, AdaBoost, convolutional NN, recurrent NN. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5600 Graduate Operating Systems (3)

This course exposes students to recent developments in operating systems research and design. Course lectures and reading assignments will be on classic and recent papers that shaped the field on a range of topics, including OS design, virtual memory management, file systems, virtualization, concurrency and synchronization, cloud systems, heterogeneity, and security. The course also exposes students to basic system-building and evaluation methodologies through programming assignments and a final project. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5640 Graduate Distributed Computation (3)

With the growth of large-scale systems, there is an increasing need for distributed systems that can cover the load. This class will cover MapReduce, cloud computing networks, timing, fault tolerance, consistency, transaction, dataflow and peer to peer systems. This course emphasizes the evaluation of real-world systems from multiple contexts. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5650 Operations Security (3)

This course covers the theoretical and applied aspects of operations security (OPSEC) in cyber systems to protect sensitive and/or confidential data. Topics include threat and adversarial modeling, vulnerability analysis, penetration testing, risk assessment, countermeasures, systems hardening, and other defensive operations. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5770 Special Topics in Computer Science (1-3)

Contemporary topics at a graduate level in computer science, as announced in Schedule of Classes. May be repeated to maximum of 9 units in different topics. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 5800 Graduate Research (1-3)

Independent investigation and study of an advanced topic in computer science under direct supervision of an instructor. The graduate research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 units. Prerequisite: Classified graduate student status or permission of the instructor.

CMPS 6910 Thesis Research (1-3)

The systematic study of a research problem of significant scope and novelty as determined by the Thesis Committee. Student will identify a problem, articulate the significance of the work, determine sources and methods for gathering data (laboratory, simulation and/or field work), experiment and analyze the data, and offer a conclusion or recommendation to the research question. Students receive training and preparation for the Thesis Defense. This is required for Master's students who select the Thesis option for their capstone. Course is repeatable, but only a combined total of 5 units can be used towards the Master's degree. Prerequisite: CMPS 5100, Classified graduate student status, and Approval of the instructor (Thesis Advisor).

CMPS 6920 Thesis Defense (1)

Final preparation for the Thesis Defense. This should only be taken after the Thesis demonstrates originality, critical and independent thinking, appropriate organization and format, and thorough documentation, and readiness for oral defense. Activities vary depending on topic, though all Thesis Defense classes include review and revision of the presentation by the Thesis Advisor, an oral defense and an acceptance/pass or rejection/failure decision by the Thesis Committee. This is required for Master's students who select the Thesis option for their capstone. Offered on a credit, no-credit basis only. Students who receive the no-credit grade may repeat the course, although a subsequent rejection of Thesis Defense may result in dismissal from the program. Prerequisite: CMPS 6910, Advancement to candidacy, and Approval of the instructor (Thesis Advisor).

CMPS 6950 Graduate Project I (2)

Students will undertake a significant project within the scope of Computer Science under the supervision of a faculty member serving as Project Advisor. The project must be original, demonstrate independent thought, possess appropriate form and organization, and include a market analysis. Students must demonstrate progress with written reports and oral presentations, to be reviewed by the Project Advisor. Prerequisite: Classified graduate student status and Approval of the instructor (Project Advisor).

CMPS 6960 Graduate Project II (1)

This is a culminating experience for the Project tract students. Students will complete their project and present it to the satisfaction of the Project Committee. A written technical document (Master Project Report) that describes the project's significance, objectives, methodology and conclusion in abstract, will be reviewed by the Project Advisor and approved by the Project Committee. At the end of the course the student may publicly present the results of their project. Offered on a credit, no-credit basis only. Prerequisite: CMPS 6950, Advancement to candidacy, and Approval of the instructor (Project Advisor).

CMPS 7000 Continuous Enrollment (0)

Graduate students who have completed all of the coursework for the program except their chosen capstone option (Thesis or Project) may enroll in this special course for the purpose of maintaining continuous enrollment at CSUB while completing their capstone experience. Course is repeatable. Prerequisite: Advancement to candidacy and Approval of the Graduate Program Director.

Appendix B: Comprehensive Program Assessment Plan

The Comprehensive Program Assessment Plan begins on the next page in landscape orientation for ease of reading.

<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>g</i>	<i>h</i>	<i>i</i>	<i>j</i>	<i>k</i>
<i>ILOs</i>	<i>PLOs</i>	<i>SLOs</i>	<i>Course where each SLO is assessed</i>	<i>Assessment activity/ assignment used to measure each SLO</i>	<i>Assessment tool used to measure outcome success</i>	<i>Assessment schedule – how often SLOs will be assessed</i>	<i>How data/ findings will be quantitatively or qualitatively reported</i>	<i>Designated personnel to collect, analyze, and interpret student learning outcome data</i>	<i>Program data/ findings dissemination schedule</i>	<i>Closing the loop strategies</i>
GP-ILO 1: Students will demonstrate broad, integrative knowledge.	PEO 2: Graduates who analyze and solve significant real world problems with contemporary computing knowledge.	SLO 1: An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.	Core: CMPS 5120	Embedded exam question(s) to assess all dimensions of SLO 1	Direct score: Target at least 70% score 80% or higher	Every two years on staggered basis (half of the outcomes are assessed each year)	Department assessment report – Report will also be recorded on Taskstream	Instructor and program faculty	Annual department assessment meeting & regular department meetings	Strategies to address any noted deficiencies will be determined at assessment meetings based on instructor reflection and program faculty discussions.
			Capstone: CMPS 6920 (Thesis) or 6960 (Project)	Required section of Thesis or Project Report to analyze work using broad, integrative knowledge from other relevant disciplines	Rubric: Target at least 70% Proficient (Score of 3 on 4-pt rubric)	Every two years on staggered basis (half of the outcomes are assessed each year)	Department assessment report – Report will also be recorded on Taskstream	Instructor and program faculty	Annual department assessment meeting & regular department meetings	Strategies to address any noted deficiencies will be determined at assessment meetings based on instructor reflection and program faculty discussions.

GP-ILO II: Students will develop specialized knowledge.	PEO 1: Graduates who demonstrate expertise in advanced computing topics and an ability to maintain a high standard of professional competence.	SLO 2: An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.	Selected Core: CMPS 5240, 5350, 5550, 5600, 5640 (Each student takes two courses from list)	Embedded exam question(s) to assess all dimensions of SLO 2 (Each course will have exam question(s) to assess SLO 2 that are appropriate for the specialized knowledge in the course)	Direct score: Target at least 70% score 80% or higher	Every two years on staggered basis (half of the outcomes are assessed each year)	Department assessment report – Report will also be recorded on Taskstream	Instructor and program faculty	Annual department assessment meeting & regular department meetings	Strategies to address any noted deficiencies will be determined at assessment meetings based on instructor reflection and program faculty discussions.
		SLO 4: An ability to recognize professional responsibilities and make informed judgements in computing practice based on legal and ethical principles.	Core: CMPS 5100	Required assignment to assess ability to maintain professional competency as part of one's professional responsibilities	Rubric: Target at least 70% Proficient (Score of 3 on 4-pt rubric)	Every two years on staggered basis (half of the outcomes are assessed each year)	Department assessment report – Report will also be recorded on Taskstream	Instructor and program faculty	Annual department assessment meeting & regular department meetings	Strategies to address any noted deficiencies will be determined at assessment meetings based on instructor reflection and program faculty discussions.

GP-ILO III: Students will practice intellectual skills such as analytic inquiry, use of information resources, engaging diverse perspectives, quantitative fluency, and communication fluency	PEO 3: Graduates who apply computing knowledge ethically, with an understanding of realistic constraints and for the overall benefit of a diverse society.	SLO 4: An ability to recognize professional responsibilities and make informed judgements in computing practice based on legal and ethical principles.	Core: CMPS 5100	Required assignment(s) to assess ability to recognize professional responsibilities and make informed judgements based on legal/ethical principles	Rubric: Target at least 70% Proficient (Score of 3 on 4-pt rubric)	Every two years on staggered basis (half of the outcomes are assessed each year)	Department assessment report – Report will also be recorded on Taskstream	Instructor and program faculty	Annual department assessment meeting & regular department meetings	Strategies to address any noted deficiencies will be determined at assessment meetings based on instructor reflection and program faculty discussions.
	PEO 4: Graduates who enhance the economic well-being of their region through a combination of computing expertise, communication skills, social responsibility, leadership, and entrepreneurship.	SLO 2: An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.	Core: CMPS 5120	Embedded exam question(s) to assess SLO 2 in the context of analytic inquiry and quantitative reasoning skills	Direct score: Target at least 70% score 80% or higher	Every two years on staggered basis (half of the outcomes are assessed each year)	Department assessment report – Report will also be recorded on Taskstream	Instructor and program faculty	Annual department assessment meeting & regular department meetings	Strategies to address any noted deficiencies will be determined at assessment meetings based on instructor reflection and program faculty discussions.
		SLO 3: An ability to communicate effectively in a variety of professional contexts.	Core: CMPS 5010	Required presentation to assess oral communication fluency	Rubric: Target at least 70% Proficient (Score of 3 on 4-pt rubric)	Every two years on staggered basis (half of the outcomes are assessed each year)	Department assessment report – Report will also be recorded on Taskstream	Instructor and program faculty	Annual department assessment meeting & regular department meetings	Strategies to address any noted deficiencies will be determined at assessment meetings based on instructor reflection

						assessed each year)				and program faculty discussions.
			Capstone: CMPS 6920 (Thesis) or 6960 (Project)	Thesis or Project Report to assess written communication fluency	Rubric: Target at least 70% Proficient (Score of 3 on 4-pt rubric)	Every two years on staggered basis (half of the outcomes are assessed each year)	Department assessment report – Report will also be recorded on Taskstream	Instructor and program faculty	Annual department assessment meeting & regular department meetings	Strategies to address any noted deficiencies will be determined at assessment meetings based on instructor reflection and program faculty discussions.
GP-ILO IV: Students will conduct applied learning.	PEO 2: Graduates who analyze and solve significant real world problems with contemporary computing knowledge.	SLO 2: An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.	Capstone: CMPS 6920 (Thesis) or 6960 (Project)	Required section of Thesis or Project Report to assess SLO 2 in the context of applied learning and solving significant real world problems	Rubric: Target at least 70% Proficient (Score of 3 on 4-pt rubric)	Every two years on staggered basis (half of the outcomes are assessed each year)	Department assessment report – Report will also be recorded on Taskstream	Instructor and program faculty	Annual department assessment meeting & regular department meetings	Strategies to address any noted deficiencies will be determined at assessment meetings based on instructor reflection and program faculty discussions.

Appendix C: Curriculum Map Matrix

The Curriculum Map Matrix begins on the next page in landscape format for ease of reading.

	<i>Lower-Division Courses Needed for Admissions</i>	<i>Upper-Division Courses Needed for Classified Student Status</i>	<i>CMPS 5000 Colloquium (Core)</i>	<i>CMPS 5010 Current Topics (Core)</i>	<i>CMPS 5100 Research Methodologies (Core)</i>	<i>CMPS 5120 Graduate Algorithms (Core)</i>	<i>CMPS 5240 Graduate Architecture (Selected Core)</i>
<i>SLO 1: Analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.</i>	I / D	D / C				M	M
<i>SLO 2: Apply computer science theory and fundamentals to evaluate and produce computing-based solutions.</i>	I / D	D / C				M	M
<i>SLO 3: Communicate effectively in a variety of professional contexts.</i>	I	D / C	C	M	M		
<i>SLO 4: Recognize professional responsibilities and make informed judgements in computing practice based on legal and ethical principles.</i>	I	D / C		M	M		

I = Introduced

D=Developed

C=Competency at Undergraduate Level

M=Mastery at Graduate Level (at end of course)

	<i>CMPS 5350 Graduate Software Engineering (Selected Core)</i>	<i>CMPS 5500 Graduate Programming Languages (Selected Core)</i>	<i>CMPS 5600 Graduate Operating Systems (Selected Core)</i>	<i>CMPS 5640 Graduate Distributed Comp. (Selected Core)</i>	<i>CMPS 6910 + 6920 Thesis Courses (Core)</i>	<i>CMPS 6950 + 6960 Project Courses (Core)</i>	<i>CMPS 5420 Natural Language Processing (Elective)</i>
<i>SLO 1: Analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.</i>	M	M	M	M	M	M	M
<i>SLO 2: Apply computer science theory and fundamentals to evaluate and produce computing-based solutions.</i>	M	M	M	M	M	M	M
<i>SLO 3: Communicate effectively in a variety of professional contexts.</i>					M	M	
<i>SLO 4: Recognize professional responsibilities and make informed judgements in computing practice based on legal and ethical principles.</i>					M	M	

I = Introduced

D=Developed

C=Competency at Undergraduate Level

M=Mastery at Graduate Level (at end of course)

	<i>CMPS 5450 Graduate Data Mining (Elective)</i>	<i>CMPS 5560 Machine Learning (Elective)</i>	<i>CMPS 5270 Hardware Security (Elective)</i>	<i>CMPS 5510 Reverse Engineering (Elective)</i>	<i>CMPS 5650 Operations Security (Elective)</i>	<i>CMPS 5150 Parallel Algorithms (Elective)</i>	<i>CMPS 5160 Distributed Learning (Elective)</i>
<i>SLO 1: Analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.</i>	M	M	M	M	M	M	M
<i>SLO 2: Apply computer science theory and fundamentals to evaluate and produce computing-based solutions.</i>	M	M	M	M	M	M	M
<i>SLO 3: Communicate effectively in a variety of professional contexts.</i>							
<i>SLO 4: Recognize professional responsibilities and make informed judgements in computing practice based on legal and ethical principles.</i>			M	M	M		

I = Introduced

D=Developed

C=Competency at Undergraduate Level

M=Mastery at Graduate Level (at end of course)

Appendix D: Self-Support Basic Cost Recovery Budget

MS Computer Science - Year 1 Program Budget Division of Extended Education and Global Outreach 4-Term \$19,500 Program - \$650 per unit			
Assumptions:	Fall Term: 20 students admitted		
	Spring Term: 15% attrition from fall new admits; no new admits		
	All students enrolled in maximum advised courses		
Revenue - based on the number of enrollments multiplied by the number of units			
	Number of Enrollments - Fall (cycle 1; term 1)		20
	Number of Units - (cycle 1; term 1)		9
	Fall Unit Total		180
	Number of Enrollments - Spring (cycle 1; term 2)		17
	Number of Units - Spring (cycle 1; term 2)		9
	Spring Unit Total		153
	Academic Year Total		342
	Registration Fee Per Unit		\$650
	TOTAL Revenue - Year 1		\$222,300
Expenditures			
System/EEGO/Program Expenses			
	2.5%	Chancellor Office	5,558
	2.5%	State Controller's Office	5,558
	15%	EO1000 General Fund	33,345
	35%	EEGO Division Overhead	77,805
	2.5%	Marketing	5,558
	2.0%	Disability Services	4,446
	2.0%	CEE/CS Equipment Fund	4,446
	<i>System/EEGO/Program Expense Total</i>		<i>136,715</i>
Faculty Salaries and Benefits			
Cal	Units		
2705	9	Faculty Salaries and Benefits (2322)	24,345
	1.5%	Faculty Benefits (2322)	365
1993	9	Faculty Salaries (Time Replacement: 1,993/WTU)	17,937
	48%	Faculty Benefits (Time Replacement - 48%)	8,610
		Academic Coordinator	3,000
	<i>Faculty Salaries and Benefits Total</i>		<i>54,257</i>
School Revenue Reimbursement			
	8%	NSM&E Revenue Share Reimbursement	17,784
TOTAL Expenditures			\$208,755
NET Income			\$13,545
<i>Note:</i>	<i>For budgeting purposes, the following is assumed:</i>		
	<i>1) All students will take a project and elective for 3 units, respectively</i>		
	<i>2) All 2322 salaries have been calculated based on 20-student enrollments</i>		
	<i>3) Time-Replacement cost is \$1993 per wtu and 48% benefit calculation</i>		

MS Computer Science - Year 2				
Program Budget				
Division of Extended Education and Global Outreach				
4-Term \$19,500 Program - \$650 per unit				
Assumptions:	Summer Term: 15 new admits			
	Fall Term: 20% attrition from summer new admits; 20 new admits			
	Spring Term: 15% attrition from fall new admits; no new admits			
Revenue - based on the number of enrollments multiplied by the number of units				
	Number of enrollments - Summer (cycle 1; term 3)		17	
	Number of units - Summer (cycle 1; term 3)		6	
			<i>subtotal summer</i>	102
	Number of enrollments Summer - (cycle 2; term 1)		15	
	Number of units Summer - (cycle 2; term 1)		9	
			<i>subtotal summer</i>	135
			Summer Unit Total	237
	Number of enrollments - Fall (cycle 1; term 4)		17	
	Number of units - Fall (cycle 1; term 4)		6	
			<i>subtotal fall</i>	102
	Number of enrollments - Fall (cycle 2; term 2)		12	
	Number of units - Fall (cycle 2; term 2)		9	
			<i>subtotal fall</i>	108
	Number of enrollments - Fall (cycle 3; term 1)		20	
	Number of units - Fall (cycle 3; term 1)		9	
			<i>subtotal fall</i>	180
			Fall Unit Total	390
	Number of enrollments spring - (cycle 2; term 3)		12	
	Number of units spring - (cycle 2; term 3)		6	
			<i>subtotal spring</i>	72
	Number of enrollments - Spring (cycle 3; term 2)		17	
	Number of units - Spring (cycle 3; term 2)		9	
			<i>subtotal spring</i>	153
			Spring Unit Total	225
			Academic Year Total	852
			Registration Fee Per Unit	\$650
			TOTAL Revenue - Year 2	\$553,800
Expenditures				
System/EEGO/Program Expenses				
	2.5%	Chancellor Office		13,845
	2.5%	State Controller's Office		13,845
	15%	EO1000 General Fund		83,070
	35%	EEGO Division Overhead		193,830
	2.5%	Reserve for Market Downturns		13,845
	2.0%	Disability Services		11,076
	2.5%	Marketing		13,845
	2.0%	CEE/CS Equipment Fund		11,076
			<i>Subtotal</i>	354,432
Faculty Salaries and Benefits - based on WTU or 2322 calculation multiplied by number of units				
Calc	Units			
2705	27	Faculty Salaries and Benefits (2322)		73,035
	1.5%	Faculty Benefits (2322)		1,096
1993	27	Faculty Salaries (Time Replacement: 1,993/WTU)		53,811
	48%	Faculty Benefits (Time Replacement - 48%)		25,829
		Academic Coordinator		4,500
			<i>Subtotal</i>	158,271
School Revenue Reimbursement				
	8%	NSM&E Revenue Share Reimbursement	<i>Subtotal</i>	44,304
		TOTAL Expenditures		\$557,007
		NET Income		(\$3,207)

MS Computer Science - Year 3

Program Budget

Division of Extended Education and Global Outreach

4-Term \$19,500 Program - \$650 per unit

Assumptions:		Summer Term: 15 new admits		
		Fall Term: 20% attrition from summer new admits; 20 new admits		
		Spring Term: 15% attrition from fall new admits; no new admits		
Revenue - based on the number of enrollments multiplied by the number of units				
		Number of enrollments - Summer (cycle 2; term 4)	12	
		Number of units - Summer (cycle 2; term 4)	6	
		<i>subtotal summer</i>		72
		Number of enrollments - Summer (cycle 3; term 3)	17	
		Number of units - Summer (cycle 3; term 3)	6	
		<i>subtotal summer</i>		102
		Number of enrollments - Summer (cycle 4; term 1)	15	
		Number of units - Summer (cycle 4; term 1)	9	
		<i>subtotal summer</i>		135
		Summer Unit Total		309
		Number of enrollments - Fall (cycle 3; term 4)	17	
		Number of units - Fall (cycle 3; term 4)	6	
		<i>subtotal fall</i>		102
		Number of enrollments - Fall (cycle 4; term 2)	12	
		Number of units - Fall (cycle 4; term 2)	9	
		<i>subtotal fall</i>		108
		Number of enrollments - Fall (cycle 5; term 1)	20	
		Number of units - Fall (cycle 5; term 1)	9	
		<i>subtotal fall</i>		180
		Fall Unit Total		390
		Number of enrollments - Spring (cycle 4; term 3)	12	
		Number of units - Spring (cycle 4; term 3)	6	
		<i>subtotal spring</i>		72
		Number of enrollments - Spring (cycle 5; term 2)	17	
		Number of units - Spring (cycle 5; term 2)	9	
		<i>subtotal spring</i>		153
		Spring Unit Total		225
		Academic Year Total		924
		Registration Fee Per Unit		\$650
		TOTAL Revenue - Year 3		\$600,600
Expenditures				
System/EEGO/Program Expenses				
	2.5%	Chancellor Office		15,015
	2.5%	State Controller's Office		15,015
	15%	EO1000 General Fund		90,090
	35%	EEGO Division Overhead		210,210
	2.5%	Reserve for Market Downturns		15,015
	2.0%	Disability Services		12,012
	2.5%	Marketing		15,015
	2.0%	CEE/CS Equipment Fund		12,012
		<i>Subtotal</i>		384,384
Faculty Salaries and Benefits - based on WTU or 2322 calculation multiplied by number of units				
Calc	Units			
2705	30	Faculty Salaries and Benefits (2322)		81,150
	1.5%	Faculty Benefits (2322)		1,217
1993	30	Faculty Salaries (Time Replacement: 1,993/WTU)		59,790
	48%	Faculty Benefits (Time Replacement - 48%)		28,699
		Academic Coordinator		4,500
		<i>Subtotal</i>		175,356
School Revenue Reimbursement				
	8%	NSM&E Revenue Share Reimbursement		48,048
		<i>Subtotal</i>		48,048
		TOTAL Expenditures		\$607,788
		NET Income		(\$7,188)

MS Computer Science - Year 4 Program Budget Division of Extended Education and Global Outreach 4-Term \$19,500 Program - \$650 per unit			
Assumptions: Summer Term: 15 new admits			
Fall Term: 20% attrition from summer new admits; 20 new admits			
Spring Term: 15% attrition from fall new admits; no new admits			
Revenue - based on the number of enrollments multiplied by the number of units			
		Number of enrollments - Summer (cycle 4; term 4)	12
		Number of units - Summer (cycle 4; term 4)	6
		<i>subtotal summer</i>	72
		Number of enrollments - Summer (cycle 5; term 3)	17
		Number of units - Summer (cycle 5; term 3)	6
		<i>subtotal summer</i>	102
		Number of enrollments - Summer (cycle 6; term 1)	15
		Number of units - Summer (cycle 6; term 1)	9
		<i>subtotal summer</i>	135
		Summer Unit Total	309
		Number of enrollments - Fall (cycle 5; term 4)	17
		Number of units - Fall (cycle 5; term 4)	6
		<i>subtotal fall</i>	102
		Number of enrollments - Fall (cycle 6; term 2)	12
		Number of units - Fall (cycle 6; term 2)	9
		<i>subtotal fall</i>	108
		Number of enrollments - Fall (cycle 7; term 1)	20
		Number of units - Fall (cycle 7; term 1)	9
		<i>subtotal fall</i>	180
		Fall Unit Total	390
		Number of enrollments - Spring (cycle 6; term 3)	12
		Number of units - Spring (cycle 6; term 3)	6
		<i>subtotal spring</i>	72
		Number of enrollments - Spring (cycle 7; term 2)	17
		Number of units - Spring (cycle 7; term 2)	9
		<i>subtotal spring</i>	153
		Spring Unit Total	225
		Academic Year Total	924
		Registration Fee Per Unit	\$650
		TOTAL Revenue - Year 3	\$600,600
Expenditures			
System/EEGO/Program Expenses			
	2.5%	Chancellor Office	15,015
	2.5%	State Controller's Office	15,015
	15%	EO1000 General Fund	90,090
	35%	EEGO Division Overhead	210,210
	2.5%	Reserve for Market Downturns	15,015
	2.0%	Disability Services	12,012
	2.5%	Marketing	15,015
	2.0%	CEE/CS Equipment Fund	12,012
		<i>Subtotal</i>	384,384
Faculty Salaries and Benefits - based on WTU or 2322 calculation multiplied by number of units			
Calc	Units		
2705	30	Faculty Salaries and Benefits (2322)	81,150
	1.5%	Faculty Benefits (2322)	1,217
1993	30	Faculty Salaries (Time Replacement: 1,993/WTU)	59,790
	48%	Faculty Benefits (Time Replacement - 48%)	28,699
		Academic Coordinator	4,500
		<i>Subtotal</i>	175,356
School Revenue Reimbursement			
	8%	NSM&E Revenue Share Reimbursement	48,048
		<i>Subtotal</i>	48,048
		TOTAL Expenditures	\$607,788
		NET Income	(\$7,188)

MS Computer Science - Year 5 Program Budget Division of Extended Education and Global Outreach 4-Term \$19,500 Program - \$650 per unit				
Assumptions:		Summer Term: 15 new admits		
		Fall Term: 20% attrition from summer new admits; 20 new admits		
		Spring Term: 15% attrition from fall new admits; no new admits		
Revenue - based on the number of enrollments multiplied by the number of units				
		Number of enrollments - Summer (cycle 6; term 4)		12
		Number of units - Summer (cycle 6; term 4)		6
			subtotal summer	72
		Number of enrollments - Summer (cycle 7; term 3)		17
		Number of units - Summer (cycle 7; term 3)		6
			subtotal summer	102
		Number of enrollments - Summer (cycle 8; term 1)		15
		Number of units - Summer (cycle 8; term 1)		9
			subtotal summer	135
		Summer Unit Total	Summer Unit Total	309
		Number of enrollments - Fall (cycle 7; term 4)		17
		Number of units - Fall (cycle 7; term 4)		6
			subtotal fall	102
		Number of enrollments - Fall (cycle 8; term 2)		12
		Number of units - Fall (cycle 8; term 2)		9
			subtotal fall	108
		Number of enrollments - Fall (cycle 9; term 1)		20
		Number of units - Fall (cycle 9; term 1)		9
			subtotal fall	180
		Fall Unit Total	Fall Unit Total	390
		Number of enrollments - Spring (cycle 8; term 3)		12
		Number of units - Spring (cycle 8; term 3)		6
			subtotal spring	72
		Number of enrollments - Spring (cycle 9; term 2)		17
		Number of units - Spring (cycle 9; term 2)		9
			subtotal spring	153
		Spring Unit Total	Spring Unit Total	225
		Academic Year Total		924
		Registration Fee Per Unit		\$650
		TOTAL Revenue - Year 3		\$600,600
Expenditures				
System/EEGO/Program Expenses				
	2.5%	Chancellor Office		15,015
	2.5%	State Controller's Office		15,015
	15%	EO1000 General Fund		90,090
	35%	EEGO Division Overhead		210,210
	2.5%	Reserve for Market Downturns		15,015
	2.0%	Disability Services		12,012
	2.5%	Marketing		15,015
	2.0%	CEE/CS Equipment Fund		12,012
			Subtotal	384,384
Faculty Salaries and Benefits - based on WTU or 2322 calculation multiplied by number of units				
Calc	Units			
2705	30	Faculty Salaries and Benefits (2322)		81,150
	1.5%	Faculty Benefits (2322)		1,217
1993	30	Faculty Salaries (Time Replacement: 1,993/WTU)		59,790
	48%	Faculty Benefits (Time Replacement - 48%)		28,699
		Academic Coordinator		4,500
			Subtotal	175,356
School Revenue Reimbursement				
	8%	NSM&E Revenue Share Reimbursement	Subtotal	48,048
		TOTAL Expenditures		\$607,788
		NET Income		(\$7,188)

Appendix E: Support Letters from Campus Administrators



CSU Bakersfield

Academic Affairs

Office of the Associate Vice President for Academic Affairs and
Dean of Academic Programs

Mail Stop: 22 EDUC
9001 Stockdale Highway
Bakersfield, California 93311-1022
(661) 654-3420 OFFICE
(661) 654-6911 FAX
www.csub.edu/academicprograms

MEMORANDUM

Date: August 26, 2019

To: Melissa Danforth, Chair for the Department of Computer Science

Cc: Lynette Zelezny, President
Kathleen Madden, Dean for the School of Natural Sciences, Mathematics, and Engineering

From: Vernon Harper, Associate Vice President for Academic Affairs and Dean of Academic Programs

Subject: Administrative Support for the MS in Computer Science

The addition of a Master of Science degree in Computer Science supports the mission of CSU Bakersfield and will not impeded the successful operation and growth of existing academic programs.

California State University, Bakersfield is defined in its mission statement as “a comprehensive public university committed to offering excellent undergraduate and graduate programs that advance the intellectual and personal development of its students.” The mission statement also notes that “the University collaborates with partners in the community to increase the region's overall educational attainment, enhance its quality of life, and support its economic development.” The proposal for a Master of Science degree in Computer Science advances the university mission by providing an avenue for students in the region to complete a sought-after degree. Moreover, graduates from the program will be well positioned to support Kern County’s economic development. One of the goals of our new strategic plan is to “develop and sustain high-quality and innovative academic programs and support services” and this program will do just that. A Master of Science degree in Computer Science complements our existing Bachelor of Science degree in Computer Science, offering students an opportunity to advance their academic credentials without leaving the region.



CSU Bakersfield

School of Natural Sciences, Mathematics, and Engineering
Office of the Dean

Mail Stop: 13 SCI
9001 Stockdale Highway
Bakersfield, California 93311-1022
(661) 654-3450
(661) 654-6959 FAX
www.csub.edu/nsme

Memorandum

Date: January 23, 2020

To: Dr. Melissa Danforth, Chair
Department of Computer & Electrical Engineering & Computer Science

CC: Vernon Harper, Interim Provost & VP for Academic Affairs

From: Kathleen Madden, Dean
School of Natural Science, Mathematics, and Engineering

Re: Proposed Computer Science MS Consultation and Support

I am the administrator in charge of faculty staffing and facilities allocation in the School of Natural Sciences, Mathematics, and Engineering where the proposed MS degree in computer science will be housed, and I am writing this memo to confirm that the Department of Computer and Electrical Engineering and Computer Science has consulted with me regarding the staffing and facilities needs of the proposed MS program. I am confident that the school and department has the resources needed to enact the proposed MS program without negatively impacting other programs.

In addition, I would like to offer my strong support the proposed MS program. Kern County is a fast growing region of California, and the proportion of STEM-related jobs here is higher than in the rest of the state. There is a real community need for the skills and expertise of masters-prepared computer scientists. Furthermore, the proposed MS program will strengthen our undergraduate program; we often struggle to staff our computer science courses, and the proposed MS program will make available masters students capable of teaching lower level labs thereby freeing our faculty for lectures and upper division course work.

I appreciate the efforts that you and your colleagues have put into developing your program proposal. The proposed MS program is high-quality, aligns well with our mission, and meets area educational and workforce needs.

Appendix F: Short Faculty CVs

The following brief CVs are provided for CEE/CS Department faculty members who would be eligible to teach in the program. The primary instructors would be the faculty members with CS responsibilities, but the ECE faculty members may also be qualified to teach specific courses or to serve on Thesis and Project committees. The CVs are in the 2-page ABET format.

Tenured/Tenure-Track Faculty with Primary CS Responsibilities:

- Anthony Bianchi, Assistant Professor, Ph.D. Electrical Engineering 2014, CSUB faculty since 2016.
- Alberto Cruz, Assistant Professor, Ph.D. Electrical Engineering 2014, CSUB faculty since 2014.
- Melissa Danforth, Professor, Ph.D. Computer Science 2006, CSUB faculty since 2006.
- Kanwalinderjit (Kanwal) Gagneja, Assistant Professor, Ph.D. Computer Science 2013, CSUB faculty since 2020.
- Chengwei Lei, Assistant Professor, Ph.D. Computer Science 2014, CSUB faculty since 2016.
- Vincent On, Assistant Professor, Ph.D. Electrical Engineering 2018, CSUB faculty since 2018.
- Nicholas Toothman, Assistant Professor, Ph.D. Computer Science June 2020, CSUB faculty since 2019.

CS Lecturers with MS or Higher Degrees in CS or Engineering:

- Walter Morales, Part-time Lecturer, M.S. Engineering 2015, CSUB faculty since 2013.

Tenured/Tenure-Track Faculty with Primary ECE Responsibilities:

- Saeed Jafarzadeh, Associate Professor, Ph.D. Electrical Engineering 2012, CSUB faculty since 2012.
- Wei Li, Professor, Ph.D. Electrical and Computer Engineering 1991, CSUB faculty since 2001.
- Ehsan Reihani, Assistant Professor, Ph.D. Mechanical Engineering – Electrical Engineering focus 2015, CSUB faculty since 2016.

ECE Lecturers with MS or Higher Degrees in Engineering:

- Weiguo Luo, Part-time Lecturer, Ph.D. Civil Engineering 2005, CSUB faculty since 2016.

Dr. Anthony Christopher Bianchi

Education

Ph.D. September 2014	Electrical Engineering	University of California, Riverside
M.S. December 2010	Electrical Engineering	University of California, Riverside
B.S. June 2008	Electrical Engineering	California State University, Pomona

Academic Experience

- California State University, Bakersfield, Assistant Professor, August 2016 to present, Full Time
- University of California, Riverside, Teaching Assistant, September 2012 to March 2014

Non-academic Experience

- Albert Einstein College of Medicine, Post-Doctoral Research Fellow, Carried out experimental design and In vivo acquisition of mice for study of TMEM in mice. Design of perfusion MRI protocol. Software/algorithm development including GUI design. February 2015 to August 2016. Full Time
- General Electric Global Research, Graduate Research & Development Intern in the Biomedical Image Analysis Lab, Development of state of the art tumor segmentation algorithms, implemented in efficiently programmed multi-threaded C++. Participated in interdepartmental presentations and demonstrations. A portion of the work was published in IEEE ISBI 2013 and selected as a lecture presentation. June 2012 to September 2012. Full Time
- Fire Sentry Corporation, Electronic Engineer, Tasks included: Repaired prototype high technology electro-optical flame/fire detectors and associated control panels and accessories. Created technical documentation for internal engineering records and third party approval agencies. Conducted comprehensive experimental testing and research for new products. Provided technical business representation at trade shows and customer meetings. January 2004 to January 2012, Full and Part Time

Certifications or Professional Registrations

- IEEE Member, IEEE Computer Society, IEEE Signal Processing Society
- Tae Beta Pi – National Engineering Honors Society
- Eta Kappa Nu (HKN) – National Electrical Engineering Honors Society

Honors and Awards

- Fellowship, NSF Integrative Graduate Education and Research Traineeship (IGERT) in Video Bioinformatics, inaugural class
- East Asia and Pacific Summer Institutes (EAPSI), Taiwan Grant (Principle Investigator)
- University of California, Riverside Fellowship under NSF grant “Learning Concepts in Morphological Image Databases”

Service Activities

- Conference Staff for IEEE Conference on Distributed Smart Cameras 2013
- Reviewer for: IEEE Sensors Journal, Elsevier Pattern Recognition

- Unofficial Reviewer for: CVPR, ICIP, ICPR

Selected Publications

- A. Bianchi, B. Bhanu, A. Obenaus, "Dynamic Low-Level Context for the Detection of Mild Traumatic Brain Injury," IEEE Transactions on Biomedical Engineering, 2014.
- A. Bianchi, B. Bhanu, V. Donovan, and A. Obenaus, "Visual and contextual modeling for the detection of repeated mild traumatic brain injury," IEEE Transactions on Medical Imaging. Vol. 33, No. 1, January 2014.
- V. Donovan, A. Bianchi, R. Hartman, B. Bhanu, M.J. Carson, A. Obenaus, "Computational analysis reveals increased blood deposition following repeated mild traumatic brain injury," NeuroImage Clinical, Vol. 1, No. 1, September 2012.
- A. Bianchi, B. Bhanu, A. Obenaus, "Multi-Modal Specific Features for Detection of Mild Traumatic Brain Injury," Medical Image Analysis, *In Review 2014*.
- A. Bianchi, B. Bhanu, A. Obenaus, "High and Low Level Contextual Modeling for the Detection of Mild Traumatic Brain Injury" in Video Bioinformatics, B. Bhanu and P. Talbot, Eds. New York, NY. 2014. Accepted, in editing.
- A. Bianchi, B. Bhanu, V. Donovan and A. Obenaus, "Detecting mild traumatic brain injury using dynamic low level context," IEEE International Conference on Image Processing, Melbourne, Australia, Sept. 15-18, 2013.
- A. Bianchi, J. V. Miller, E. T. Tan, A. Montillo, "Brain tumor segmentation with symmetric texture and symmetric intensity-based decision forests" IEEE International Symposium on Biomedical Imaging, San Francisco, CA, April 2013. (selected for Oral Presentation 18.9% acceptance rate.)
- A. Bianchi, B. Bhanu, V. Donovan, A. Obenaus, "Contextual and Visual Modeling for Detection of Mild Traumatic Brain Injury in MRI," IEEE International Conference on Image Processing, Orlando, FL, October 2012.
- G. Harlow, A. Cruz, L. Shuo, N. Thakoor, A. Bianchi, J. Chen, B. Bhanu, Z. Yang, "Automated spatial analysis of ARK2: Putative link between ROP signaling and microtubules," IEEE International Symposium on Biomedical Imaging, San Francisco, CA, April 2013.
- A. Bianchi, B. Bhanu and Y. Sun, "Image retrieval of highly similar objects," ICPR Workshop on Analysis and Evaluation of Large Scale Multimedia Collection, August 22, 2010, held in conjunction with International Conference on Pattern Recognition, Istanbul, Turkey, August 23-26, 2010. **Peer Reviewed**
- S. Ashwal, J.S. Coats, A. Bianchi, B. Bhanu and A. Obenaus, "Semi-automated segmentation of ADC maps reliably defines ischemic perinatal stroke injury," Sixth Hershey Conference on Developmental Brain Injury. June 4-7, 2008, Ecquevilly, France.

Professional Development Activities

- Ethics Across the Curriculum Workshop

Dr. Albert C. Cruz

Education

Ph.D. December 2014	Electrical Engineering	University of California, Riverside
M.S. December 2010	Electrical Engineering	University of California, Riverside
B.S. June 2008	Electrical Engineering	California State University, Riverside

Academic Experience

- 2015 – Current, Assistant Professor of Computer Science, California State University, Bakersfield, Department of Computer & Electrical Engineering & Computer Science
- 2014 – 2015, Full-time Lecturer, California State University, Bakersfield Department of Computer & Electrical Engineering & Computer Science

Non-academic Experience

- None

Certifications or Professional Registrations

- None

Membership in Professional Organizations

- Member, Association for Computing Machinery (ACM)
- Member, Institute of Electrical and Electronics Engineers (IEEE)

Honors and Awards

- Media coverage in 2015 Motor Trend's Best Driver's Car
- Media coverage in 2016 Motor Trend's Best Driver's Car
- Project Director/Co-PI, Consolidated Central Valley Table Grape Pest and Disease Control District grant, 2018, \$19,660.
- PI, CSU Program for Education and Research in Biotechnology (CSUPERB) New Investigator grant, 2018 – 2019, \$15,000
- PI, Consolidated Central Valley Table Grape Pest and Disease Control District grants 2019, \$36,362.
- PI, CSU Chancellor's AWS Credit Allocation grant, 2019 – 2020, \$10,370

Selected Service Activities

- 2018 IEEE International Conference on Automatic Face and Gesture Recognition (FG 2018), Xi'An, China. Finance Chair, Registration Chair, Session Chair.
- 2020 IEEE International Conference on Automatic Face and Gesture Recognition (FG 2020), Buenos Aires, Argentina. Finance Chair, Registration Chair.

Selected Publications

- A. Cruz, Y. Ampatzidis, R. Pierro, A. Materazzi, A. Panattoni, L. De Bellis, A. Luvisi, "Detection of grapevine yellows symptoms in *Vitis vinifera* L. with artificial intelligence," *Computers and Electronics in Agriculture*, vol. 157, pp. 63-76, 2019.

- M. Cardinale, A. Luvisi, J. B. Meyer, E. Sabella, L. De Bellis, A. Cruz, Y. Ampatzidis and P. Cherubini, “Specific fluorescence in situ hybridization (FISH) test to highlight colonization of xylem vessels by *Xylella fastidiosa* in naturally infected olive trees (*Olea europaea* L.),” *Frontiers in Plant Science*, 2018.
- A. Cruz, A. Luvisi, L. D. Bellis, Y. Ampatzidis, “X-FIDO: An Effective Application for Detecting Olive Quick Decline Syndrome with Deep Learning and Data Fusion,” *Frontiers in Plant Science*, 2017.
- Cruz, B. Bhanu and N. S. Thakoor, “Background suppressing Gabor energy filtering,” *Pattern Recognition Letters*, vol. 52, pp. 40-47, 2015. doi: 10.1016/j.patrec.2014.10.001.
- A. Cruz, B. Bhanu and N. S. Thakoor, “Vision and attention theory based sampling for continuous facial emotion recognition,” *IEEE Trans. Affective Computing*, vol. 5, no. 4, pp. 418-431, 2014. doi: 10.1109/TAFFC.2014.231615.
- Cruz, B. Bhanu and B. Le, “Human Automotive Interaction: Affect Recognition for Motor Trend Magazine’s Best Driver Car of the Year,” in *Emotion and Attention Recognition Based on Biological Signals and Images*, S. A. Hosseini, Ed. InTech, 2016.
- A. Cruz, B. Bhanu and N. S. Thakoor, “Understanding of the biological process of non-verbal communication: facial emotion and expression recognition,” in *Video Bioinformatics: From Live Imaging to Knowledge (Springer Series on Computational Biology, vol. 22)*, B. Bhanu and P. Talbot, Eds. Springer, 2015. doi: 10.1007/978-3-319-23724-4.
- I. E. Cabrera, A. L. Tambo, A. Cruz, B. X. Guan, B. Bhanu and K. A. Borkovich, “Quantitative analyses during growth and development in the filamentous fungus *Neurospora Crassa*,” in *Video Bioinformatics: From Live Imaging to Knowledge (Springer Series on Computational Biology, vol. 22)*, B. Bhanu and P. Talbot, Eds. Springer, 2015. doi: 10.1007/978-3-319-23724-4.
- N. S. Thakoor, A. Cruz and B. Bhanu, “Video bioinformatics databases and software,” in *Video Bioinformatics: From Live Imaging to Knowledge (Springer Series on Computational Biology, vol. 22)*, B. Bhanu and P. Talbot, Eds. Springer, 2015. doi: 10.1007/978-3-319-23724-4.
- A. Rinaldi and A. Cruz, “Facial Emotion Recognition for Motor Vehicle Operators,” *The 20th International Conference on Image Processing, Computer Vision, and Pattern Recognition*, 2016.
- Christian T. Michael and A. Cruz, “Approximating Neuron Activity via Lifetime Charge in Artificial Neural Networks,” *28th Annual CSU Biotechnology Symposium*, 2016.
- G. Hasta and A. Cruz, “Deep Context Injection for Super-resolution,” *The 20th International Conference on Image Processing, Computer Vision, and Pattern Recognition*, 2016.
- A. Cruz, “Quantification of Cinematography Semiotics for Video-based Facial Emotion Recognition in the EmotiW 2015 Grand Challenge,” in *Proceedings of the 2015 ACM on International Conference on Multimodal Interaction*, 2015. doi: 0.1145/2818346.2830592.

Professional Development Activities

- None

Dr. Melissa Danforth

Education:

Ph.D. September 2006	Computer Science	University of California, Davis
M.S. March 2002	Computer Science	University of California, Davis
B.S. June 1999	Computer Science and Biology	California State Univ., Bakersfield

Academic Experience

- California State University, Bakersfield. Chair (Jul. 2014 – present), Interim Chair (Dec. 2013 – Jun. 2014), Professor (Sep. 2017 – present), Associate Professor (Sep. 2012 – Aug. 2017), Assistant Professor (Sep. 2006 – Aug. 2012), Lecturer (Jan. 2006 – Aug. 2006). Full-time in all positions.
- University of California, Davis. Graduate Student Researcher (Jul. 2003 – Dec. 2005); Research Assistant (Jun. 2001 – Jun. 2002); Teaching Assistant (Sep. 2000 – Jun. 2001).

Non-Academic Experience

- NetSquared Inc., Researcher (Jun. 2002 – Jun. 2003). Researched machine learning algorithms and artificial immune systems for cyber security as part of an IRPA research project for the company. Part-time while working on Ph.D. dissertation at UC, Davis.
- Customsoft Inc., Network and Applications Specialist (Nov. 1998 – Aug. 2000). Programming and maintenance of predictive dialer application and system administration of corporate network. Part-time Nov. 1998 – Jun. 1999. Full-time Jun. 1999 – Aug. 2000.

Certifications or Professional Registrations

- None

Memberships in Professional Organizations

- Association for Computing Machinery (ACM).
- USENIX: The Advanced Computing Systems Association.
- American Society of Engineering Education (ASEE) general member and member of ASEE Women in Engineering Division (WIED).
- Association for Practical and Professional Ethics (APPE).

Honors and Awards

- CS Expert, U.S. Department of Education TQP grant, 2018 – 2021. PD: Brittney Beck.
- Engineering Coordinator, U.S. Dept. of Ed. Title V grant (P031S150037), 2015 – 2020, \$3.2 million. PD: Jorge Talamantes (2015-19) and Luis Cabrales (2019-20).
- Co-PI, NSF IUSE grant for mathematics enhancements and summer program for at-risk first and second year students (DUE 1430398), 2014 – 2018 (NCE), \$1 million.
- PD/PI, U.S. Dept. of Ed. Title V grant to start the ECE programs (P031S100081), 2010 – 2016 (NCE), \$3.8 million. Took over as Project Director in Feb. 2014.
- Co-PD, U.S. Dept. of Ed. MSEIP grant (P120A140051), 2014 – 2017, \$734,735.
- PI, NSF Cyber Service SFS grant (DUE 1241636), 2012 – 2015. \$267,351.
- Co-PD, U.S. Dept. of Ed. MSEIP grant (P120A110050), 2011 – 2014, \$725,641.

Selected Service Activities

- Vice Chair (elect) of CSUB Academic Senate (Elected for Summer 2020 – Spring 2021)
- Academic Affairs Committee of the CSUB Academic Senate (Member: Fall 2016 – Spring 2020; Chair of committee: Fall 2018 – Spring 2020).

- Faculty Co-Chair of Goal 3 “Develop and Sustain High-Quality and Innovative Academic Programs and Support Services” for the CSUB Strategic Plan Task Force (Spring 2019).
- CSUB’s Information Technology Advisory Committee (Fall 2015 – present).
- Member of the CSUB Ethics Across the Campus (EAC) initiative (Fall 2013 – present).
- NSME Curriculum Committee and GE Area B/Theme 1 Committee (member: Fall 2009 – Spring 2015, chair of committee: Fall 2013 – Spring 2015).
- Faculty Juror or Moderator for CSUB Student Research Competitions (multiple years).
- Program Committee for 2016 USENIX Summit for Educators in System Administration.
- Faculty Representative to advisory committee for CSUB President Search (2017/18).
- Search committees: AVP of Enrollment Management (Spring 2019), Chief Information Security Officer of ITS (2017/2018), Dean of NSME (2016/17), Associate Dean of NSME (2014/15), AVP of ITS (2014/15), NSME Fab Lab Coordinator (2014/15), Director of Infrastructure and User Support for ITS (2013/14), and department searches.

Selected Publications

- M. Danforth, C. Lam, R. Hughes, and S. Salomon. “Enhancing Research Pipelines for Underserved Students through a Lower-Division Research Experience at a Minority-Serving Institution (Experience)”. ASEE Annual Conference, June 2019.
- M. Danforth, C. Lam, and R. Hughes. “Technology Enhanced Pre-Calculus Classrooms (Work in Progress)”. Poster session and extended abstract. ASEE Annual Conference, June 2018. – Woody Everett Best Poster Award in the Computers in Education Division.
- M. Danforth, C. Lam. “Improving Student Success and Retention through a Summer Research Program for First and Second Year Students at a Minority-Serving Institution”. ASEE Annual Conference, June 2017.
- M. Danforth, C. Lam. “Effects of a Four-Week Cyber Security Summer Program on the Attitudes and College Interests of High School Students”. Colloquium for Information Systems Security Education (CISSE) Journal, Edition 4, Issue 2, February 2017.
- M. Danforth, C. Lam, H. Mehrpouyan, R. Hughes. “Impact of a Hands-On, Exploratory Engineering Outreach Program on Knowledge and Attitudes of High School Students”. ASEE Annual Conference, June 2016.
- M. Danforth, C. Lam. “Implementation of Multidisciplinary Cyber Security Curriculum at a Medium Sized Campus”. Roundtable presentation at CISSE, June 2016.
- C. Lam, M. Danforth, R. Hughes. “A Comprehensive Approach on Delivering Calculus to Engineering Students”. ASEE Annual Conference, June 2014.
- M. Danforth. “WCIS: A Prototype for Detecting Zero-Day Attacks in Web Server Requests.” Proceedings of the USENIX LISA Conference, December 2011.

Professional Development Activities

- NSF SFS grant Dissemination Workshops at CSUB. July 2015 and July 2014. Led workshops on cyber security education/outreach for K-12 teachers and university faculty.
- Faculty Fellows Program at CSUB. 2015/16 AY. Participated in leadership workshop series for all levels of faculty interested in furthering their leadership skills.
- Mid-Career Fellows Program at CSUB. Winter 2013. Participated in leadership development via pairing associate professors with mentors in academic administration.

Dr. Kanwalinderjit Gagneja

Education:

Ph.D. May 2013	Computer Science & Engineering	North Dakota State University, Fargo
M.Tech May 1997	Computer Engineering	Punjabi University Patiala, India
MCA May 1995	Computer Science	Punjabi University Patiala, India

Academic Experience

- Assistant Professor, California State University, Bakersfield (Aug 2020 -present)
- Assistant Professor, Florida Polytechnic University, Lakeland, FL, USA (Aug. 2016-Aug 2020)
- Assistant Professor, Southern Oregon University, Ashland, OR, USA (September 2013 to Aug. 2016).
- Graduate Research Assistant & Teaching Assistant, North Dakota State University, Fargo, ND, USA (Jan. 2008 to May 2013)
- Assistant Professor, Bemidji State University, Bemidji, MN, USA (Aug. 2010 to May 2011)

Non-Academic Experience

- Programmer Analyst, North Dakota Center for Distance Education, Fargo, ND, USA (Sept. 2007 to Jan. 2008)

Certifications or Professional Registrations

None

Memberships in Professional Organizations

- Association for Computing Machinery (ACM).
- Institute of Electrical and Electronics Engineers (IEEE).
- Upsilon Pi Epsilon, Life member.

Honors and Awards

- Received Grant \$20K for further research, CSUB, 08/2020-08/2022
- Received Grant \$45K from Florida Center for Cybersecurity to build Digital Forensics program at FPU 07/2017-06/2019
- Received grant \$25K for further research at FPU 08/2016-07/2018.
- One Copyright approved
- President's Choice Award Winner 2017
- Panelist in WICT-Women in Cable Telecommunications 2016
- Panelist in Lady Ada Lovelace convention 2014
- Received NSF Student Travel Grant (\$1000) for IEEE SECON 2013 conference
- Received ACM Student Travel Grant for ACM MobiHoc 2013 conference
- Academic Achievement Award winner, NDSU, 2013.
- Global Outreach Ambassador, NDSU, 2013-2014.
- Received Green and Golden Globe Award, NDSU, 2013.
- Received NSF Student Travel Grant (\$1000) for IEEE WoWMoM 2012 conference.
- Honored with life membership of Upsilon Pi Epsilon, 2010. Honor society of the computing and information disciplines
- Student member of Faculty Search Committee, NDSU 2009-11.

- University Medalist in MTech, Computer Science & Engineering.

Selected Service Activities

- Served as Chair of search committee
- Conference session chair
- Reviewer for various conferences
- Member of Technical Program Committees and Reviewer: Elsevier Journals, InderScience Journals, MIR Labs, Journal of Bioinfo Sensor Networks, AIJ-Journal, International Journal of Sensor and Related Networks
- Graduate Advisors and Postdoctoral Sponsors: Andhra University, Visakhapatnam, India Punjab Technical University, Jalandhar, India, Punjabi University, Patiala, India.
- Member of SUS Advisory Council committee of CyberFlorida
- Program chair –SSIC-2018 conference
- TPC –MobiSecServ-2018, MobiSecServ-2019, MobiSecServ-2020

Selected Publications

- Javier Campos, Slater Colteryahn, Gagneja Kanwal, “IPv6 transmission over BLE Using Raspberry PI 3”, International Conference on Computing, Networking and Communications, Wireless Networks (ICNC'18 WN), Maui, USA, 5, Mar. 2018.
- Gagneja K.K., “Secure Communication Scheme for Wireless Sensor Networks to maintain Anonymity”, IEEE ICNC, Anaheim, California, USA, Feb. 16-19, 2015.
- Gagneja K.K., "Pairwise Key Distribution Scheme for Two-Tier Sensor Networks", IEEE ICNC, Honolulu, Hawaii, USA, pages 1081-1086, Feb. 3-6, 2014.
- Gagneja K.K. and Nygard K., "Energy Efficient Approach with Integrated Key Management Scheme for Wireless Sensor Networks", ACM MOBIHOC, Bangalore, India, pages 13-18, July 29, 2013.
- Gagneja K.K. and Nygard K., "Heuristic Clustering with Secured Routing in Heterogeneous Sensor Networks", IEEE SECON, New Orleans, USA, pages 9-16, June 24-26, 2013.
- K. K. Gagneja and K. E. Nygard, "A QoS based heuristics for clustering in two-tier sensor networks," 2012 Federated Conference on Computer Science and Information Systems (FedCSIS), Wroclaw, 2012, pp. 779-784.
- K. K. Gagneja, K. E. Nygard and N. Singh, "Using Tabu-Voronoi clustering heuristics with key management scheme for heterogeneous sensor networks," 2012 Fourth International Conference on Ubiquitous and Future Networks (ICUFN), Phuket, 2012, pp. 46-51.
- Gagneja K.K. and Nygard K., "Pairwise Post Deployment Key Management Scheme for Heterogeneous Sensor Networks", 13th IEEE WoWMoM 2012, San Francisco, California, USA, pages 1-2, June 25-28, 2012.
- K. K. Gagneja and K. E. Nygard, "Key Management Scheme for Routing in Clustered Heterogeneous Sensor Networks," 2012 5th International Conference on New Technologies, Mobility and Security (NTMS), Istanbul, 2012, pp. 1-5.

Professional Development Activities

- Attended GE Summer institute Aug 4-5, 2020 to prepare for online instruction delivery
- Attended CSUB new faculty orientation Aug 17 – 21, 2020.

Dr. Chengwei Lei

Education:

Ph.D. August 2014	Computer Science	Univ. of Texas at San Antonio
M.S. August 2008	Computer Science	Univ. of Texas at San Antonio
B.E. June 2005	Computer Sci. & Eng.	Beihang University

Academic Experience

- California State University, Bakersfield. Assistant Professor (Aug. 2016 – present). Full-time.
- McNeese State University. Assistant Professor (Aug. 2014 – July. 2016). Full-time.
- University of Texas at San Antonio. Research Scientist (Aug. 2010 – July. 2014). Part-time.
- University of Texas at San Antonio. Research Assistant (Aug. 2008 – July. 2009). Part-time.

Non-Academic Experience

- N/A

Certifications or Professional Registrations

- N/A

Memberships in Professional Organizations

- N/A

Honors and Awards

- Principal Investigator: "Topology-based Approaches to Integrated Analysis of Cancer Prognosis" from CSUB RCU Mini-grant, Granted \$2,660, 12/2016-8/2017
- Student Research Advisor (Mabelle Cruz & Andy Koumane): "Observation of Pollution in Skies above Seawater and Costal Areas using Dynamic Self-Guided UAV" from CSU COAST Undergraduate Student Research Program, Granted \$833, 12/2016-8/2017
- Principal Investigator: "Improve the Breast Cancer Prediction Accuracy by Enhancing Biological Network" from McNeese Foundation Endowed Professorships, Granted \$5,000, 12/2014-12/2015
- Presidential Dissertation Fellowship, University of Texas at San Antonio, 04/2014
- Graduate Student Research Award, University of Texas at San Antonio, 03/2013

Selected Service Activities

- Reviewer for PLOS ONE, Bioinformatics, IEEE Transactions on Signal Processing, BioMedical Engineering Online

Selected Publications and Presentations

- C Lei, W Tian, Y Zhang, R Fu, R Jia and R Winter, Probability-Based Circuit Breaker Modeling for Power System Fault Analysis, IEEE Applied Power Electronics Conference and Exposition, Tampa, FL, USA, March 26-30, 2017

- C Lei and R Jia, State Estimation in Computer Virus Epidemic Dynamical Systems using Hybrid Extended Kalman Filter, IEEE International Conference on Systems, Man, and Cybernetics, Budapest, Hungary, October 9-12, 2016
- W Tian, C Lei (Co-corresponding author), Y Zhang, D Li and R Winter, Data Analysis and Optimal Specification of Fuse Model for Fault Study in Power Systems, IEEE Power & Energy Society General Meeting, Boston, MA, USA, July 17-21 2016
- H Asere, C Lei, R Jia. Cruise Control Design Using Fuzzy Logic Controller, IEEE International Conference on Systems, Man and Cybernetics, Hong Kong, China, October 09-12, 2015
- C. Lei and J. Ruan, Fully automated protein complex prediction based on topological similarity and community structure, Proteome Science, 11(Suppl 1):S9, 2013.
- C. Lei and J. Ruan, A novel link prediction algorithm for reconstructing protein-protein interaction networks by topological similarity, Bioinformatics, 29(3): 355-364, 2013

Professional Development Activities

- Introduction to writing research grants workshop, 12/2016

Dr. Vincent Wong On

Education:

Ph.D. September 2018	Electrical Engineering	University of California, Riverside
M.S. March 2014	Electrical Engineering	University of California, Riverside
B.S. June 2009	Physics, Minor in Mathematics	University of California, Riverside

Academic Experience

- California State University, Bakersfield, Assistant Professor of Computer Science, 2019 – Current, Full-time
- California State University, Bakersfield, Full-time Lecturer, 2018 – 2019, Full-time
- University of California, Riverside, Graduate Teaching Assistant, 2014 – 2018, Part-time
- University of California, Riverside, Teaching Assistant, 2009, Part-time

Non-Academic Experience

- None

Certifications or Professional Registrations

- None

Memberships in Professional Organizations

- Member, Institute of Electrical and Electronics Engineers (IEEE)
- Member, Association for Computing Machinery (ACM)

Honors and Awards

- Fellowship, NSF Integrative Graduate Education and Research Traineeship (IGERT) in Video Bioinformatics

Selected Service Activities

- CSU Bakersfield CS Masters Program Proposal Committee
- Department of Education GPS Grant Cohort
- Reviewer for ai4i and ICTAI

Selected Publications and Presentations

- On, V.*, Zahedi, A.*, Bhanu, B. (2018), “PhaseR4D: Time-Lapse 3D Phase Contrast Imaging Using Supervised Regression,” PLoS ONE (in review)
 - *Co-first author
- Zahedi, A., On, V., Phandthong, R., Chaili, A., Remark, G., Bhanu, B., Talbot, P. (2018), “Deep Analysis of Mitochondria and Cell Health Using Machine Learning,” Scientific Reports. doi: 10.1038/s41598-018-34455-y
- On, V., Zahedi, A., and Bhanu, B. (2018), “3D Reconstruction of Phase Contrast Images Using Focus Measures”, 2018 IEEE International Conference on Image Processing (ICIP). doi: 10.1109/ICIP.2018.8451163

- On, V., Zahedi, A., Ethell, IM., Bhanu, B. (2017) “Automated Spatio-Temporal Analysis of Dendritic Spines and Related Protein Dynamics”, PLoS ONE 12(8): e0182958. doi:10.1371/journal.pone.0182958.
- On, V., Zahedi, A., Ethell, IM., Bhanu, B. (2016) “Spatio-temporal pattern recognition of dendritic spines and protein dynamics using live multichannel fluorescence microscopy”, 23rd International Conference on Pattern Recognition (ICPR). doi:10.1109/ICPR.2016.7899936.
- Zahedi, A*, On, V*, Lin, S., Bays, BC., Omaiye, E., Bhanu, B., Talbot, P. (2016). “Evaluating Cell Processes, Quality, and Biomarkers in Pluripotent Stem Cells Using Video Bioinformatics”, PLoS ONE 11(2): e0148642. doi:10.1371/journal.pone.0148642.
 - *Co-first author
- Zahedi, A., On, V., Defea, K., and Ethell, IM. (2015) “A method to regulate cofilin transport using optogenetics and live video analysis”, Springer Book Chapter.
- Zahedi, A., On, V., Defea, K., and Ethell, IM. (2013), “Optogenetics to target actin-mediated synaptic loss in Alzheimer’s”, Proc. Of International Society of Photonics and Optics (SPIE) Vol. 8586: 85860S-1-6, San Francisco, California. (Proceedings paper)

Professional Development Activities

- Tenure-Track Search Committee Training

Dr. Nicholas Joseph Toothman

Education:

Ph.D. March 2020	Computer Science	University of California, Davis
B.S. June 2010	Computer Science	California State University, Bakersfield

Academic Experience

- California State University, Bakersfield. Tenure-track lecturer (August 2019 – present). Full-time.
- University of California, Davis. Associate Instructor (Spring 2017 and Winter 2019); Graduate Student Researcher and Teaching Assistant (September 2010 – August 2019). Full and part-time.

Non-Academic Experience

- Facebook Reality Labs (formerly Oculus Research), Research Intern. Designed, implemented, and executed experiments in motion capture. Handled full-body animation and tangible interfaces in virtual reality using Unity, data collection using sqlite, and analysis using R. July – December 2017. Full-time.
- Microsoft Office 365 Team, Software Development Engineer Intern. Developed test suites for Microsoft Exchange and integrated them with deployment. June – August 2014. Full-time.
- Amazon Music Team, Software Developer Intern. Refactored a flat, file-based device configuration server with a hierarchical, dynamic system to reduce storage cost, improve retrieval times, and make scalable when adding new devices. Python and sqlite for data analysis, AWS for deployment and web service hosting. June – August 2012. Full-time.
- State Farm Insurance, End-User Computing Developer. Developed .NET applications and plugins to serve insurance underwriting and internal operations. Built a standardized framework for the team's web applications. C#, VBA, Microsoft T-SQL. June 2009 – August 2010. Full and part-time.

Certifications or Professional Registrations

- Alpha Chi – National College Honors Society

Memberships in Professional Organizations

- None

Honors and Awards

- Outstanding Graduating Senior in Computer Science, California State University, Bakersfield

Selected Service Activities

- CSUB Masters in Computer Science subcommittee member and course developer
- Volunteer for ACM Conference in Motion, Interaction, and Games 2016
- Reviewer for ACM CASA 2016
- Volunteer for ACM Conference in Intelligent Virtual Agents, 2012

Selected Publications and Presentations

- N. Toothman and M. Neff. “Spring Rigs for Skinning.” ACM SIGGRAPH Conference on Motion, Interaction and Games. Newcastle upon Tyne, United Kingdom, October 2019.
- N. Toothman and M. Neff. “The Impact of Avatar Tracking Errors on User Experience in VR.” IEEE VR, Osaka, Japan, 2019.
- N. Toothman, M. Neff. “Attachment-based character deformation” Poster proceedings of the ACM SIGGRAPH / Eurographics Symposium on Computer Animation, Los Angeles, CA, July, 2017.
- G. Bloom, S. Kemp, N. Toothman, and E. Buswell. “A Whole Theater of Others: Amateur Acting and Immersive Spectatorship in the Digital Shakespeare Game Play the Knave.” *Shakespeare Quarterly* 67.4 (2016): 408-430.
- N. Toothman, T. Martin and M. Neff. “Embodying Digital Creativity: Designing Computer Tools to Support Spontaneity and Creative Work in the Arts.” Chapter in “Digital Movement: Essays in Motion Technology and Performance”, ed. Sita Popat and Nick Salazar, Palgrave MacMillan, 2014: 221-235.
- M. Neff, N. Toothman, R. Bowmani, J.E. Fox Tree, and M. Walker. “Don't Scratch! Self-adaptors Reflect Emotional Stability.” Proceedings of ACM Intelligent Virtual Agents Conference, Springer LNAI, Reykjavík, Iceland, September, 2011.

Professional Development Activities

- None

Walter Morales

Education

M.S. December 2015	Petroleum Engineering	University of Southern California
B.S. June 2012	Computer Science	California State University, Bakersfield
B.S. December 2011	Mathematics	California State University, Bakersfield

Academic Experience

- California State University Bakersfield, Bakersfield, CA, 01/2015 to Present (5 Years 1 month) Part Time Computer Science Lecturer.
Duties: Teaching Data Mining, Programming Languages, and Discrete mathematics to CSUB junior and senior students.
- California State University Bakersfield, Bakersfield, CA 07/2013 to Present (7 Years) Part Time Math Lecturer.
Duties: teaching pre-calculus and Calculus at CSUB to entry level students

Non-Academic Experience

- Chevron North America Exploration and Production Company Bakersfield, CA, 01/2018 to Present (2 Years), Technologist – Full Time
Built several custom applications using ArcGIS, FME, Python Scripts, batch files to automatize several tasks that were before performed manually increasing efficiency and accuracy while performing these tasks therefore attaining time savings.
- Chevron North America Exploration and Production Company Bakersfield, CA, 06/2012 to 12/2017 (5 Years 6 months), Data Manager Technical Assistant – Full Time
Working giving support to Earth scientist and Engineers by supporting a 3D model of oil reservoirs and making sure that all relevant data (Directional data, well header data, logs, RSTs, etc.) are correctly loaded in the correct databases in order to be used in the model.

Certifications or Professional Registrations

- Machine Learning for engineers and Characterization – University of Oklahoma (2019)
- Advanced Geographic Information Systems (GIS) Certification (Working with Rasters, Queries and Tables, 3D Analyst, and Python for GIS) (2016)

Memberships in Professional Organizations

- Society of Petroleum Engineers (SPE) – 06/2016 to Present

Honors and Awards

- CSUB Outstanding Computer Science Graduate Award (2012)
- "Outstanding Presentation Award" winner "On Constructible Sets" for the JMM poster session. Joint Mathematics Meetings. 2012.
(<http://www.maa.org/students/undergrad/PosterWinnersJMM12.pdf>)
- Chair Award - Mathematics Department at CSUB (2011)

- Louis Stokes Alliances for Minority Participation Scholarship recipient (2008 -2011)
- National Science Foundation Scholarship recipient (2008 -2011)

Selected Service Activities

- None

Selected Publications

- None

Professional Development Activities

- None

Dr. Saeed Jafarzadeh

Education

Ph.D. 2009-2012	Electrical Engineering	University of Nevada Reno
M.S. 2005-2008	Electrical Engineering	Iran University of Science & Technology
B.S. 2000-2005	Electrical Engineering	University of Tehran

Academic Experience

- California State University Bakersfield, Aug. 2012-present, Computer & Electrical Engineering & Computer Science, *Associate Professor/Director of Power Systems Laboratory*

Non-Academic Experience

- None

Certifications or Professional Registrations

- None

Memberships in Professional Organizations

- Director of Power Systems Laboratory at CSUB
- Associate Editor
- IEEE Transactions on Fuzzy Systems
- Asian Journal of Control
- Reviewer
- IEEE Transactions on Power Electronics
- IEEE Transactions on Industrial Electronics
- IEEE Transaction on Neural Networks and Learning Systems
- IEEE Control Systems Magazine
- Journal of Circuits, Systems & Signal Processing
- Advances in Engineering Education
- Artificial Intelligence for Engineering Design, Analysis and Manufacturing
- Membership
- Institute of Electrical & Electronics Engineers (IEEE)
- IEEE Industrial Electronics Society

Honors and Awards

- “Quantitative Forecasting for Grid-Connected Renewable Power Generation: Fuzzy Logic Approach,” funded by Department of Defense, \$440,342, (2015-18). **PI**
- “Acquisition of a Multi-Domain Advanced Real-Time Simulator to Support DoD-focused Interdisciplinary Research at CSUB,” funded by Department of Defense, \$480,210. **PI**
- “Research, Experiential and Learning Opportunities for underrepresented students in biological and agricultural engineering,” submitted to USDA, \$274,728. **co-PI**

- “Increasing the Productivity of the Engineering Degree Pipeline in the High Needs Southern San Joaquin Valley: A Sound Cooperative Arrangement Project with Bakersfield College.,” funded by Dept. of Ed., \$3,249,688, 2015-2020. **Project Coordinator.**
- “STEM Retention & Graduation: An Integrated Approach,” funded by NSF DUE: IUSE, \$1,083,336, 2014-2016. **Senior Personnel**

Select Service Activities

- None listed

Select Publications

- E Reihani, A Eshraghi, M Motalleb, S Jafarzadeh. “Frequency regulation of microgrid with battery droop control”. IEEE/PES Transmission and Distribution Conference and Exposition (T&D), 2018.
- S. Sadiqbatcha, S. Jafarzadeh, Y Ampatzidis. “Particle Swarm Optimization for Solving a Class of Type-1 and Type-2 Fuzzy Nonlinear Equations”. Journal of Artificial Intelligence and Soft Computing Research 8 (2), pp. 103-110, 2018.
- S Sadiqbatcha, S Jafarzadeh. “Fuzzified DC power flow analysis”. North American Power Symposium (NAPS), 2016.
- S Jafarzadeh, J Berk. “Enhancing wind power forecasting: A bootstrap resampling interpolated Markov model”. North American Power Symposium (NAPS), 2016.
- S Jafarzadeh, MS Fadali. “Instability conditions for type-1 and type-2 TSK fuzzy systems”. IEEE International Conference on Fuzzy Systems (FUZZ-IEEE), 2016.
- C Lascu, S Jafarzadeh, MS Fadali, F Blaabjerg. “Direct torque control with feedback linearization for induction motor drives”. IEEE Transactions on Power Electronics 32 (3), pp. 2072-2080, 2016.
- H Livani, S Jafarzadeh, CY Evrenosoğlu, MS Fadali. “A unified approach for power system predictive operations using viterbi algorithm”. IEEE Transactions on Sustainable Energy 5 (3), pp. 757-766, 2014.
- S Jafarzadeh, C Lascu, MS Fadali. “Square root unscented Kalman filters for state estimation of induction motor drives”. IEEE Transactions on Industry applications 49 (1), pp. 92-99, 2012.
- S Jafarzadeh, C Lascu, MS Fadali. “State estimation of induction motor drives using the unscented Kalman filter”. IEEE Transactions on Industrial Electronics 59 (11), pp. 4207-4216, 2011.

Professional Development Activities

- None

Dr. Wei Li

Education

Ph.D. July 1991	Robotics / Computer Engineering	University of Saarland, Germany
M.S. December 1984	Electrical Engineering	Beijing Jiaotong University, China
B.S. February 1982	Mechanical Engineering	Beijing Jiaotong University, China

Academic Experience

- California State University, Bakersfield. Full Professor (July 2005 – present), Associate Professor (October. 2001 – July 2005).
- University of California, Riverside. Research Scientists (July 1999 – July 2001).
- Technical University of Braunschweig, Germany. Alexander von Humboldt Research Fellow (July 1997 – March 1999).
- Tsinghua University, China. Full Professor, (July 1996 – Oct. 2001), Associate Professor (December 1993 – July 1996), Postdoctoral Research Fellow (Oct. 1992 – Dec. 1993).
- University of Saarland, Germany. Research Associate, (July 1991 – Oct. 1992).
- Beijing Jiaotong University, China. Lecturer (Dec. 1984 – April 1988)

Non-Academic Experience

- University of Saarland, Germany. Researcher Assistant (March 1988 – July 1991), and part-time while working on doctor dissertation.

Certifications or Professional Registrations

- None

Memberships in Professional Organizations

- Member of The American Society of Mechanical Engineers (ASME)
- Member of The Institute of Electrical and Electronics Engineers (IEEE)

Honors and Awards

- The 1995 National Award for Outstanding Postdoctoral Researchers in China
- The 1995 Chinese Education Award Foundation for Outstanding Young Teachers
- The 1996 Award for Outstanding Young Professors at Tsinghua University.
- The 1997 Alexander von Humboldt Foundation Research Fellow in Germany

Selected Service Activities

- Referee for ASME Journal of Dynamic System, Measurement and Control
- Referee for IEEE Transactions on Industrial Electronics
- Referee for IEEE Transactions on Neural Networks
- Referee for IEEE Transactions on Fuzzy Systems
- Referee for IEEE Transactions on Systems, Man, and Cybernetics
- Referee for IEEE Transactions on Robotics
- Referee for IEE Proceedings C, Control Theory and Applications
- Referee for International Journal of Engineering Application of Artificial Intelligence

- Referee for Mechatronics
- Referee for Fuzzy Sets and Systems
- Referee for Pattern Recognition Letters
- Referee for International Journal of System Science
- Referee for Automatica, an IFAC Journal

Selected Publications

- X. Q. Mao, M. F. Li, W. Li*, L. W. Niu, B. Xian, M. Zeng, G. S. Chen. “Progress in EEG-Based Brain Robot Interaction Systems”. Computational Intelligence and Neuroscience. Vol. 2017, Article ID 1742862, 25 pages.
- X. Q. Mao, X. Wen, Y. Song, W. Li*, G.S. Chen. “Eliminating drift of the head gesture reference to enhance Google Glass-based control of an NAO humanoid robot”. International Journal of Advanced Robotic Systems. March-April 2017: 1–10.
- L. W. Niu, W. Li. “Reliability-conscious energy management for fixed-priority real-time embedded systems with weakly hard QoS-constraint”. Microprocessors and Microsystems. October 2016, Vol.46, 107 – 121.
- Q. Chen, W. Li*, G. S. Chen. “A FUZZY P+ID Controller for a Constant Tension Winch in a Cable Laying System”. IEEE Transactions on Industrial Electronics, Nov. 2016.
- J. Zhang, W. Li*, J. C. Yu, X. Q. Mao, M.F. Li, G. S. Chen. “Operating an underwater manipulator via P300 brainwaves”. 23rd International Conference on Mechatronics and Machine Vision in Practice (M2VIP), Nov. 2016.
- Z. Y. Qiu, B. Z. Allison, J. Jing, Y. Zhang, X. Y. Wang, W. Li, A. Cichocki. “Optimized motor imagery paradigm based on imagining Chinese characters writing movement”. IEEE Transactions on Neural Systems and Rehabilitation Engineering, September 2016.
- W. X. Li, M. F. Li, W. Li* “Improving Accuracy of Event-Related Potentials Classification by Channel Selection Using Independent Component Analysis and Least Square Methods”. International Journal of Software Science and Computational Intelligence, 8(3), 2016.
- X.Q. Mao, H. D. He, W. Li* “Path finding for a NAO humanoid robot by fusing visual and proximity sensors”. 12th World Congress on Intelligent Control and Automation (WCICA), pp. 2574-2579, 2016
- X. Wen, Y. Song, W. Li*, G. S. Chen, B. Xian “Rotation Vector Sensor-based Remote Control of a Humanoid Robot through a Google Glass”. 2016 IEEE 14th International Workshop on Advanced Motion Control (AMC), 2016.

Professional Development Activities

- None

Dr. Ehsan Reihani

Education

Ph.D. December 2015	Mechanical Engineering – Electrical Engineering focus	University of Hawaii, Manoa
M.S. September 2008	Electrical Engineering	University of Shahrood
B.S. February 2005	Electrical Engineering	University of Sadjad

Academic Experience

- Assistant Professor, Department of Computer and Electrical Engineering and Computer Science, California State University, Bakersfield (Aug. 2018 – present) Full-time.
- Lecturer, Department of Computer and Electrical Engineering and Computer Science, California State University, Bakersfield (Aug. 2016 – July 2018) Full-time.
- Hawaii Natural Energy Institute, Postdoctoral Fellow (Jan. 2016-Aug. 2016).
- University of Hawaii, Manoa. Research and Teaching Assistant (Sep. 2013 – Dec. 2015).

Non-Academic Experience

- Pouyagam Co., Embedded System Engineer (Jun. 2005 – Jun. 2006).

Certifications or Professional Registrations

- None

Memberships in Professional Organizations

- None

Honors and Awards

- None

Selected Service Activities

- None

Selected Publications

- A Novel Approach Using Flexible Scheduling and Aggregation to Optimize Demand Response in the Developing Interactive Grid Market Architecture, Applied Energy, 2016.
- Scheduling of Price-Sensitive Residential Storage Devices and Loads with Thermal Inertia in Distribution Grid, Applied Energy, 2016.
- Energy Management at the Distribution Grid Using a Battery Energy Storage System (BESS), International Journal of Electrical Power and Energy Systems, 2016.
- Optimal Placement and Sizing of the Storage Supporting Transmission and Distribution Net-works, Renewable Energy, 2016.
- Providing Frequency Regulation Reserve Services Using Demand Response Scheduling, Energy Conversion and Management, 2016.
- A Nascent Market for Contingency Reserve Services Using Demand Response, Applied Energy, 2016.

- Load Commitment of Distribution Grid with High Penetration of PV Using Hybrid Series-Parallel Prediction Algorithm and Storages, Electric Power Systems Research, 2016.
- Load Peak Shaving and Power Smoothing of a Distribution Grid with High Renewable Energy Penetration, Renewable Energy, 2016.
- Reliability Based Maintenance Scheduling of Generating Units Using Hybrid Evolutionary Algorithm, International Journal of Electrical Power and Energy Systems, 2012.

Professional Development Activities

- None

Dr. Weiguo Luo

Education

Ph.D. 2005	Civil Engineering	Southeast University, China
M.S. 2012	Petroleum Engineering	University of Regina, Canada
B.S. 2002	Petroleum Engineering	Xian Petroleum Institute, China

Academic Experience

- California State University, Bakersfield, lecturer, 03/2016-present, part time
Teach the course Analog and Digital Circuits, Signals and Systems, Digital Design with VHDL, Power System, Introduction to Engineering I and II, instruct students to do lab projects.
- Yangzhou University, China, Associate Professor, Vice Chair of Department of Civil Engineering, 2005-2009, full time
Gave lectures to undergraduates, taught engineering lab course and developed the research projects.

Non-Academic Experience

- Saskatchewan Research Council (SRC), Regina, Canada, Research Engineer, 2012-2014, full time. Duties: Designed and supervised PVT & analytical tests, conducted petroleum and chemical engineering experiments.

Certifications or Professional Registrations

- P.Eng., the registered Professional Engineer of Canada

Memberships in Professional Organizations

- SPE member, the Society of Petroleum Engineers

Honors and Awards

- SPE 2012 University Award for Excellent Academic Performance

Selected Service Activities

- None

Selected Publications

- Luo, P., Luo, W. and Li, S. Effectiveness of Miscible and Immiscible Gas Flooding in Recovering Tight Oil from Bakken Reservoirs in Saskatchewan, Canada, Fuel, Volume 208, 15 November 2017, pp 626-636.
- Luo, W. and Torabi, F. 2013. Coupling of Solvent and Hot Water to Improve Heavy Oil Recovery: Experimental and Simulation Studies. Paper SPE 165444 presented at SPE Heavy Oil Conference-Canada in Calgary, Alberta, June 11–13.
- Luo, W. Xu, S. and Torabi, F. 2013. Study on the Chemical Degradation and Biochemical Removal of HPAM in Produced Water. Paper SPE 163751 presented at Americas E&P Health, Safety, Security & Environmental Conference in Galveston, Texas, 18–20 March.

- Gu, Y, Hou, P. and Luo, W. 2013. Effects of Four Important Factors on the Measured Minimum Miscibility Pressure and First-Contact Miscibility Pressure. *Journal of Chemical and Engineering Data*, 58(5), pp 1361–1370.
- Luo, W., Xu, S. and Torabi, F. 2012. Laboratory Study of Sand Production in Unconsolidated Reservoir. Paper SPE 158619 presented at SPE Annual Technical Conference and Exhibition in San Antonio, Texas, 8–10 October.
- Xu, S., Luo, W., Zeng, F. and Gu, Y. 2011. Application of Deep Hydraulic Jet Perforating to Enhance Oil Production in Thin Reservoir with Bottom Water. Paper SPE 145978 presented at SPE Asia Pacific Oil and Gas Conference and Exhibition in Jakarta, Indonesia, 20–22 September.

Professional Development Activities

- None

Department and Campus Policies Applicable to All Graduate Computer Science Courses

CEE/CS Tutoring Center Usage

Computers in the CEE/CS Tutoring Center in Sci III 324 may be available for use by graduate students. Tutoring is NOT provided for any graduate courses, but graduate students can use the computers in the room, if one is available.

Priority in the room is given to undergraduate students who are seeking tutoring or who are completing assignments for undergraduate courses. If a tutor asks a graduate student to give up a computer for undergraduate student use, the graduate student is expected to finish their work and give up the computer.

The CEE/CS Tutoring Center is open from Monday in the second week of Fall and Spring semesters until the last day of classes. See the schedule on the door for hours the tutoring center is open.

CEE/CS Major Study Room Usage

There are a few computers and multiple study tables available in the CEE/CS Major Study Room in Sci III 341. This room is only open when faculty members are on campus, e.g. approximately 8am to 5pm on weekdays. If the door is locked during normal business hours, ask a CEE/CS staff or faculty member to unlock it.

CEE/CS Undergraduate and Graduate Research Laboratory Usage

The COMPLab, Science III 328, is available for undergraduate and graduate student research usage. This is a shared research space for all research students in the department. There are no individual storage spaces or workstations available. Students are expected to keep the space clean and be respectful of other students' use of the space.

The room is occasionally scheduled for other purposes, when it will not be available for use by research students. This usage will be noted on the door.

CEE/CS Cybersecurity Isolated Network Laboratory Usage

Students in cybersecurity undergraduate/graduate courses and/or conducting cybersecurity research may be granted access to the Isolated Network Lab in Science III 314. This is a shared project space for all authorized cybersecurity students. There are no individual storage spaces or workstations available. Students are expected to receive authorization for all projects from the cybersecurity faculty members prior to using the lab. Due to the sensitive nature of many cybersecurity projects, students may also be asked to sign a code of conduct/ethical research agreement as part of being granted access to this lab.

Walter Stiern Library Usage

Policies regarding use of the resources at CSUB's Walter Stiern Library can be found at the library website: <https://library.csub.edu/>

Academic Integrity

Students are expected to do all the work assigned to them without unauthorized assistance and without giving unauthorized assistance. For the complete policy, see the Academic Integrity policy in the Policies and Regulations section of the university catalog.

Academic Accommodations for Students

To request academic accommodations due to a disability, please contact the Office of Services for Students with Disabilities (SSD) as soon as possible. Students must have an accommodations letter from the SSD Office documenting their authorized academic accommodations in order to receive those accommodations. Present the SSD letter to the course instructor during their office hours as soon as possible at the start of the term or after the first class meeting.

Other CSUB Policies

Other applicable CSUB policies can be found in the CSU/CSUB General Information and Division of Graduate Programs sections of the CSUB catalog, posted at <https://www.csub.edu/catalog/>

CMPS 5000 Colloquium in Computer Science

Catalog Description

CMPS 5000 Colloquium in Computer Science (1)

This colloquium is intended to be a speaker series on current research in computer science and related fields. The colloquium provides a forum to share research, practice methods, distribute tools/software, and discuss current topics. Speakers will include scholars from academia and practitioners from the public and private sectors. Early sessions allow incoming students to familiarize themselves with the program, to other students, staff, and faculty. Offered on a credit, no-credit basis only. Course is repeatable, but only a combined total of 2 units can be used towards the Master's degree. Each week the colloquium will meet for 50 minutes. Prerequisite: Graduate standing.

Prerequisite by Topic

Admitted to MS CS program or permission of instructor.

Units and Contact Time

1 Semester Unit. 1 unit lecture (weekly: 50 minutes in-class, 2-3 hours outside of class)

Type

Core (Required) for Graduate Computer Science Students.

Required Textbook

None

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website.

Coordinator(s)

Vincent Wong On, Melissa Danforth, Anthony C. Bianchi, Alberto Cruz, Chengwei Lei, Nicholas Toothman, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

SP/Professional Communication

Student Learning Outcomes

MS-3. An ability to communicate effectively in a variety of professional contexts.

MS-3a) Write technical reports or academic papers at an appropriate level for the target audience.

Lecture Topics and Schedule

Weekly speaker schedule will be posted to the course website.

Prepared By

Vincent Wong On

CMPS 5010 Current Topics in Computer Science

Catalog Description

CMPS 5010 Current Topics in Computer Science (2)

This course focuses on discussions of current peer-reviewed literature in computer science and related topics. The course is in the format of a journal club and emphasis will be on research articles published in the last two years. Each week students will present and lead a discussion of one or more approved peer-reviewed articles. Students will be encouraged to discuss, analyze, critique, and implement the topics in each article. Students must submit reports on their related articles. Each week lecture meets for 100 minutes. Prerequisite: Graduate standing.

Prerequisite by Topic

Admitted to MS CS program or permission of instructor.

Units and Contact Time

2 Semester Units. 2 units lecture (weekly: 100 minutes in-class, 4-6 hours outside of class)

Type

Core (Required) for Graduate Computer Science Students.

Required Textbook

Required research articles will be posted to the course website.

Recommended Textbook and Other Supplementary Material

Students will conduct literature searches to find supplementary material on their research topic.

Coordinator(s)

Vincent Wong On, Melissa Danforth, Anthony C. Bianchi, Alberto Cruz, Chengwei Lei, Nicholas Toothman, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

SP/Professional Communication

Student Learning Outcomes

MS-3. An ability to communicate effectively in a variety of professional contexts.

MS-3b) Prepare and deliver oral presentations at an appropriate level for the target audience.

MS-4. An ability to recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

MS-4c) Demonstrate an ability to maintain a high standard of professional competence.

Lecture Topics and Schedule

Overview of Research Articles and Current Topics in Computer Science	Week 1
Literature Search Methods and Databases	Week 2
Topic Selection and Article Approval	Week 3
Presentations and Discussions on Articles	Weeks 4-15
Final Discussions	Week 16

Prepared By

Vincent Wong On

CMPS 5100 Research Methodologies and Professional Ethics

Catalog Description

CMPS 5100 Research Methodologies and Professional Ethics (2)

This course is designed to develop research and communication skills for graduate students. The topics covered in this course will include research processes, research methods, literature searches, literature analysis, scientific manuscripts and software licensing. The course will also focus on professional ethics related to computer science and various forms of data. There will be an emphasis on requirements and regulations for human/animal-subject testing, Institutional Review Board (IRB) approval, consent, conflicts of interest, misconduct, and authorship. Each week the course will meet for 100 minutes. Prerequisite: Graduate standing.

Prerequisite by Topic

Admitted to MS CS program or permission of instructor.

Units and Contact Time

2 Semester Units. 2 units lecture (weekly: 100 minutes in-class, 4-6 hours outside of class)

Type

Core (Required) for Graduate Computer Science Students.

Required Textbook

Zobel Justin, "Writing for Computer Science", Springer-Verlag, 3rd Edition, 2014, ISBN: 978-1-4471-6639-9 (eBook)

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website.

Coordinator(s)

Vincent Wong On, Melissa Danforth, Anthony C. Bianchi, Alberto Cruz, Chengwei Lei, Nicholas Toothman, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

SP/Analytical Tools

SP/Professional Ethics

SP/Intellectual Property

SP/Professional Communication

Student Learning Outcomes

MS-3. An ability to communicate effectively in a variety of professional contexts.

MS-3a) Write technical reports or academic papers at an appropriate level for the target audience.

MS-4. An ability to recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

MS-4a) Recognize and describe professional responsibilities in computing practice.

MS-4b) Make informed judgements based on legal and ethical principles and on professional responsibilities.

MS-4c) Demonstrate an ability to maintain a high standard of professional competence.

Lecture Topics and Schedule

Introduction to Research at CSU Bakersfield	Week 1
Research Processes	Week 2
Research Methods	Week 3
Scientific Literature and Review	Weeks 4-5
Scientific Writing	Week 6
Research Presentations	Week 7
Licensing and Patents	Week 8
Current Research Methods and Tools	Week 9
Research Ethics	Weeks 10-11
Student Research Presentations and Discussions	Weeks 12-16

Prepared By

Vincent Wong On

CMPS 5120 Graduate Algorithm Design and Analysis

Catalog Description

CMPS 5120 Graduate Algorithm Design and Analysis (3)

This is an advanced graduate course in the analysis of algorithms, in terms of time and space complexity for best/average/worst case execution using asymptotic notation; the application of standard algorithmic approaches, including divide-and-conquer, greedy algorithms, dynamic programming, and graph algorithms, to algorithm design. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in algorithm analysis (similar to CMPS 3120)
- Undergraduate course in linear algebra (similar to MATH 2610) is strongly recommended

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Core (Required) for Graduate Computer Science Students.

Required Textbook

Introduction to Algorithms, 3rd Edition; Cormen, Leiserson, Rivest, and Stein; MIT Press, Boston, 2009

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website.

Coordinator(s)

Chengwei Lei, Melissa Danforth, Anthony C. Bianchi, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

AL/Basic Analysis

9. Use big O notation formally to give expected case bounds on time complexity of algorithms.
10. Explain the use of big omega, big theta, and little o notation to describe the amount of work done by an algorithm.
11. Use recurrence relations to determine the time complexity of recursively defined algorithms.
12. Solve elementary recurrence relations, e.g., using some form of a Master Theorem.

AL/Algorithmic Strategies

1. For each of the strategies, identify a practical example to which it would apply.
2. Use a greedy approach to solve an appropriate problem and determine if the greedy rule chosen leads to an optimal solution.
3. Use a divide-and-conquer algorithm to solve an appropriate problem.
4. Use recursive backtracking to solve a problem such as navigating a maze.
5. Use dynamic programming to solve an appropriate problem.
6. Determine an appropriate algorithmic approach to a problem.

AL/Fundamental Data Structures and Algorithms

8. Solve problems using fundamental graph algorithms, including depth-first and breadth-first search.
9. Demonstrate the ability to evaluate algorithms, to select from a range of possible options, to provide justification for that selection, and to implement the algorithm in a particular context.
10. Describe the heap property and the use of heaps as an implementation of priority queues.
11. Solve problems using graph algorithms, including single-source and all-pairs shortest paths, and at least one minimum spanning tree algorithm.
12. Trace and/or implement a string-matching algorithm.

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

Lecture Topics and Schedule

Introduction, loop invariant, order of growth	Week 1
Asymptotic notation, analyzing non-recursive algorithms	Week 2
Analyzing recursive algorithms	Weeks 3-4
Quick sort, Heap sort & Priority queue	Weeks 5-6
Linear time sorting algorithms	Weeks 7-8
Order statistics	Week 9
Dynamic Programming	Weeks 10-11
Greedy Algorithm	Week 11
Intro to graphs, Minimum spanning tree	Week 12
Shortest paths	Week 13
Graph search, Topological sort	Week 14
String matching, Hashing, P/NP	Weeks 15-16

Prepared By

Chengwei Lei

CMPS 5150 Parallel Algorithms

Catalog Description

CMPS 5150 Parallel Algorithms (3)

This is an advanced graduate course in the design and analysis of algorithms for parallel systems. Theoretical topics include modeling the cost of parallel algorithms, and parallel algorithms for sorting, trees, graphs, and computational geometry. Practical topics will include data-parallelism, threads, futures, scheduling, synchronization, transactional memory and message passing. Students will design and present a project on parallel algorithms. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in algorithm analysis (similar to CMPS 3120), computer architecture (similar to CMPS 3240), and operating systems (similar to CMPS 3600)
- Undergraduate course in distributed and parallel computation (similar to CMPS 3640) is strongly recommended
- Undergraduate course in linear algebra (similar to MATH 2610) is strongly recommended

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Graduate elective in Parallel and Distributed Computing topic area.

Required Textbook

Parallel Algorithms by Guy Blelloch and Bruce Maggs. Computer Science Handbook, Allen B. Tucker (Ed). Available at <http://www.cs.cmu.edu/~guyb/papers/BM04.pdf>

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website.

Coordinator(s)

Alberto Cruz, Anthony C. Bianchi, Vincent Wong On, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

PD/Parallel Algorithms, Analysis, and Programming

9. Give examples of problems where pipelining would be an effective means of parallelization.
10. Implement a parallel matrix algorithm.

PD/Formal Models and Semantics

1. Model a concurrent process using a formal model, such as pi-calculus.
2. Explain the characteristics of a particular formal parallel model.
3. Formally model a shared memory system to show if it is consistent.
4. Use a model to show progress guarantees in a parallel algorithm.
5. Use formal techniques to show that a parallel algorithm is correct with respect to a safety or liveness property.

6. Decide if a specific execution is linearizable or not.

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

MS-3. An ability to communicate effectively in a variety of professional contexts.

MS-3b) Prepare and deliver oral presentations at an appropriate level for the target audience.

Lecture Topics and Schedule

Introduction to parallel algorithms	Week 1
Models of parallel computation (Brent's Theorem)	Weeks 2-3
Sequences (Prefix sums)	Weeks 4-5
Parallel sorting (Advanced mergesorting)	Weeks 6-7
Parallel tree search (Tree contraction, expression evaluation, MST, MIS)	Weeks 7-8
Computational geometry (Connected components, convex hull)	Weeks 8-9
Asynchronous algorithms	Weeks 10-11
Transactional memory, thread building, practical applications (CUDA, MPI)	Weeks 12-13
Student project presentations	Weeks 14-16

Prepared By

Alberto Cruz

CMPS 5160 Distributed Learning and Optimization

Catalog Description

CMPS 5160 Distributed Learning and Optimization (3)

Distributed computing architectures have led to adaptation of sequential algorithms to a distributed computation domain. Computer science subfields such as machine learning and optimization benefit greatly from these distributed architectures, thus have been adapted. Topics for this class include distributed learning and optimization, graph analysis, scaling, complexity analysis and evaluation of current platforms. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in algorithm analysis (similar to CMPS 3120)
- Undergraduate course in distributed and parallel computation (similar to CMPS 3640) is strongly recommended
- Undergraduate course in linear algebra (similar to MATH 2610) is strongly recommended

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Graduate elective in Parallel and Distributed Computing topic area.

Required Textbook

Joseph JáJá, Introduction to Parallel Algorithms, Addison Wesley, 1992.

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website. Recommended materials are:

- “Parallel Algorithms”, Guy Blelloch and Bruce Maggs
- “Introduction to Algorithms”, Cormen Leiserson and Rivest Stein
- “Learning Spark”, Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia
- “TensorFlow for Deep Learning”, Bharath Ramsundar and Reza Zadeh

Coordinator(s)

Anthony C. Bianchi, Alberto Cruz, Vincent Wong On

ACM CS 2013 Body of Knowledge Topics/Outcomes

PD/Parallel Algorithms, Analysis, and Programming

8. Provide an example of a problem that fits the producer-consumer paradigm. [Familiarity]
9. Give examples of problems where pipelining would be an effective means of parallelization. [Familiarity]
10. Implement a parallel matrix algorithm. [Usage]
11. Identify issues that arise in producer-consumer algorithms and mechanisms that may be used for addressing them. [Familiarity]

PD/Parallel Decomposition

3. Write a correct and scalable parallel algorithm. [Usage]
4. Parallelize an algorithm by applying task-based decomposition. [Usage]
5. Parallelize an algorithm by applying data-parallel decomposition. [Usage]
6. Write a program using actors and/or reactive processes. [Usage]

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

Lecture Topics and Schedule

Fundamentals of Distributed Algorithm analysis	Weeks 1-2
Scheduling	Week 3
Prefix Sum and Mergesort	Week 4
Introduction to TensorFlow	Weeks 5-6
Parallel Quicksort, Strassen's Algorithm, Minimum Spanning Tree	Week 7
Graph Contraction, Star Contraction	Week 8
Parallel Stochastic Gradient Decent	Week 9
Distributed Sort, Map Reduce, Sparse Matrix Multiplies using SQL	Weeks 10-11
Sparse Matrix Multiplication	Week 12
Introduction to Spark	Week 13
Communication Patterns, Partitioning for PageRank, Single Value Decomposition	Weeks 14-15
Spark vs Tensorflow	Week 16

Prepared By

Anthony C. Bianchi

CMPS 5240 Graduate Computer Architecture

Catalog Description

CMPS 5240 Graduate Computer Architecture (3)

This is a graduate survey course in computer architecture for graduate students who have some experience in computer organization and design. It covers early systems, microprocessor design, instruction set architecture, control, buses, ALU, memory and multiprocessor systems. The class focuses on memory hierarchies, caching, virtual memory, ISA design considerations (RISC, CISC, VLSI RISCs), branch speculation, advanced datapaths, multithreading, coherence and consistency, and processor heterogeneity. Students will present current work in architecture. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in discrete mathematics/structures (similar to CMPS 2120) or logic design / digital circuits (similar to ECE 3200)
- Undergraduate course in computer architecture and organization (similar to CMPS 3240)

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Core (Selected from List) for Graduate Computer Science Students.

Required Textbook

J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, 5th Edition, Morgan Kaufmann Publishing Co., Menlo Park, CA. 2011.

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website.

Coordinator(s)

Alberto Cruz, Melissa Danforth, Vincent Wong On, Mostafa Abdelrehim

ACM CS 2013 Body of Knowledge Topics/Outcomes

AR/Memory System Organization and Architecture

1. Identify the main types of memory technology (e.g., SRAM, DRAM, Flash, magnetic disk) and their relative cost and performance.
3. Describe how the use of memory hierarchy (cache, virtual memory) is used to reduce the effective memory latency.
5. Explain the workings of a system with virtual memory management.

AR/Multiprocessing and Alternative Architectures

2. Describe alternative parallel architectures such as SIMD and MIMD.
3. Explain the concept of interconnection networks and characterize different approaches.
4. Discuss the special concerns that multiprocessing systems present with respect to memory management and describe how these are addressed.

AR/Performance Enhancements

1. Describe superscalar architectures and their advantages.
2. Explain the concept of branch prediction and its utility.
4. Explain speculative execution and identify the conditions that justify it.
5. Discuss the performance advantages that multithreading offered in an architecture along with the factors that make it difficult to derive maximum benefits from this approach.
6. Describe the relevance of scalability to performance.

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

MS-3. An ability to communicate effectively in a variety of professional contexts.

MS-3b) Prepare and deliver oral presentations at an appropriate level for the target audience.

Lecture Topics and Schedule

Introduction to computer architecture (Historical lectures)	Week 1
Memory technologies (such as flash)	Week 2
Memory hierarchies and the virtual memory (Mapping strategies)	Week 3
Advanced caching, virtual memory protection (Sharing, protection)	Week 4
ISA designs (RISC, CISC, VLSI RISCs)	Weeks 5-6
Branch prediction / speculative execution (BTB, correlation, etc.)	Weeks 7-8
Dataflow and pipelining	Weeks 8-9
Multithreading, coherence and consistency	Weeks 9-10
Processor heterogeneity	Weeks 11-12
Student presentations	Weeks 13-16

Prepared By

Alberto Cruz

CMPS 5270 Hardware Security

Catalog Description

CMPS 5270 Hardware Security (3)

This course will study the principles of computer systems security from the hardware perspective, especially as it crosses layers of abstraction. Students will learn about the vulnerabilities in current digital system design flow and the challenges of building secure hardware for each layer of abstraction. Cutting edge research on these challenges will be discussed and hands-on experiences with performing attacks, developing countermeasures, and implementing secure hardware building blocks will be required. By the end of the course, students will be able to reason about security in terms of adversarial models, hardware vulnerabilities, and attacks. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in assembly language programming (similar to CMPS 2240) and computer architecture (similar to CMPS 3240).
- Students are expected to have a basic knowledge of digital logic and Register-Transfer Level (RTL) design, but no specific background in security/cryptography is necessary.

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Graduate elective in the Cybersecurity topic area.

Required Textbook

There is no required textbook for the course. It is based on a collection of classic and recent journal, conference, and several other papers on hardware security topics.

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website. The following books serve as reference for concepts explored in this course:

- Swarup Bhunia and Mark Tehranipoor. "Hardware Security: A Hands-on Learning Approach", 1st Edition, 2018. ISBN-13: 978-0128124772
- M. Tehranipoor and C. Wang (Eds.). "Introduction to Hardware Security and Trust", Springer, 2012. ISBN: 978-1-4419-8079-3
- Erickson, Jon. "Hacking: The Art of Exploitation." No Starch Press, San Francisco, 2008. ISBN: 1-59327-144-2
- Huang, Andrew. "Hacking the Xbox: An Introduction to Reverse Engineering." No Starch Press, San Francisco, 2003. ISBN: 1-59327-029-1
- Petzold, Charles. "Code: The Hidden Language of Computer Hardware and Software." Microsoft Press, Redmond, 2000. ISBN: 0-7356-1131-9

Coordinator(s)

Melissa Danforth, Alberto Cruz, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

IAS/Foundational Concepts in Security

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

MS-4. An ability to recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

MS-4b) Make informed judgements based on legal and ethical principles and on professional responsibilities.

Lecture Topics and Schedule

Introduction	Week 1
Ciphers: Historical; Block (AES/DES), stream, (Trivium) public key ciphers (RSA, ECC), hash functions (SHA-1)	Weeks 2-3
Physical unclonable functions: design principles and applications; Hardware Random Number Generators: design principles and applications	Weeks 4-5
Side channels: Overview; Fault attacks and countermeasures; Power attacks and countermeasures	Weeks 6-7
VLSI Testing is a portal for hackers: attacks and countermeasures	Weeks 8-9
Hardware Trojans: overview, attacks and defenses	Week 10
IP Piracy: Logic encryption	Week 11
Reverse Engineering: IC layout camouflaging, Gate level reversing, ESL reversing	Weeks 12-13
Hardware security patent presentations	Weeks 14-15
Course review and Final exam	Week 16

Prepared By

Antonio Cardenas (left CSUB in Aug. 2020)

CMPS 5350 Graduate Software Engineering

Catalog Description

CMPS 5350 Graduate Software Engineering (3)

A study of concepts and research in the area of software engineering, with attention on modeling, design patterns, software architecture, deployment, quality assurance, and communication.

Discussions will include presentations on historical and current research papers in the field with a special interest in ethical dilemmas in modern software development. A term project lets students apply and develop practical skills from the course material. Each week lecture meets for 150 minutes.

Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in software engineering (similar to CMPS 3350)

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Core (Selected from List) for Graduate Computer Science Students.

Required Textbook

Relevant materials (papers, articles) will be made available on the course website.

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website.

Coordinator(s)

Nicholas Toothman, Melissa Danforth

ACM CS 2013 Body of Knowledge Topics/Outcomes

CS-SE/Software Construction

CS-SE/Tools and Environments

CS-SE/Software Project Management

CS-SE/Software Design

CS-SE/Software Evolution

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

MS-3. An ability to communicate effectively in a variety of professional contexts.

MS-3b) Prepare and deliver oral presentations at an appropriate level for the target audience.

MS-4. An ability to recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

Lecture Topics and Schedule

Course overview, research skills	Week 1
Professional ethics, legality	Week 2
Communication, Remote development	Week 3
Project management	Week 4
Requirements	Week 5
Modeling and design	Weeks 6-7
Software architecture, abstraction	Weeks 8-9
Testing and automation	Weeks 10-11
Licensing, open-source development	Week 12
Deployment, localization	Weeks 13-16

Prepared By

Nicholas Toothman

CMPS 5420 Natural Language Processing

Catalog Description

CMPS 5420 Natural Language Processing (3)

This is a foundational course in natural language processing (NLP) for graduate students who have some experience in artificial intelligence or machine learning. The focus of the class is end-to-end systems for classification, understanding and organization of language, and generative models for communication. Topics include machine learning for text classification, bag-of-words representation, context-free parsing, semantics and machine translation. Students will present current work in NLP. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in calculus (similar to MATH 2510 and 2520)
- Undergraduate course in probability and statistics (similar to MATH 3200)
- Undergraduate course in artificial intelligence or machine learning (similar to CMPS 3560)
- Proficiency in Python programming language
- Undergraduate course in linear algebra (similar to MATH 2610) is strongly recommended

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Graduate elective in the Data Science / Artificial Intelligence / Machine Learning topic area.

Required Textbook

There are two textbooks that are available online for free:

- Eisenstein: Natural Language Processing. This is a current textbook. Available at <https://github.com/jacobeisenstein/gt-nlp-class/blob/master/notes/eisenstein-nlp-notes.pdf>
- Jurafsky and Martin: Speech and Language Processing (3rd ed. Draft). This is the classic NLP textbook. Available at <https://web.stanford.edu/~jurafsky/slp3/>

Reading assignments are assigned from both textbooks.

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website.

Coordinator(s)

Alberto Cruz, Anthony C. Bianchi

ACM CS 2013 Body of Knowledge Topics/Outcomes

IS/Natural Language Processing

1. Define and contrast deterministic and stochastic grammars, providing examples to show the adequacy of each.
3. Identify the challenges of representing meaning.
5. Identify techniques for information retrieval, language translation, and text classification.

IS/Advanced Machine Learning

5. Evaluate the performance of a simple learning system on a real-world dataset. [Assessment]
6. Characterize the state of the art in learning theory, including its achievements and its shortcomings.

Student Learning Outcomes

- MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.
- MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.
- MS-1b) Apply appropriate principles to analyze a complex computing problem.
- MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.
- MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.
- MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.
- MS-3. An ability to communicate effectively in a variety of professional contexts.
- MS-3b) Prepare and deliver oral presentations at an appropriate level for the target audience.
- MS-4. An ability to recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
- MS-4c) Demonstrate an ability to maintain a high standard of professional competence.

Lecture Topics and Schedule

Introduction to NLP, bag-of-words model	Week 1
Text classification (Binary and multi-class)	Week 2
Sequence models (HMM and CRFs)	Week 3
Neural networks for text classification (Backpropagation, Word2Vec)	Week 4
Deep neural networks for text classification (RNNs, CNNs)	Weeks 5-7
Tree-structured analysis, probabilistic context-free grammars	Weeks 8-9
Machine translation, encoder-decoder models	Weeks 10-11
Applications of machine translation (Regex generation and SQL generation)	Week 12
Improvements to machine translation (Attention and transformers)	Week 13
Student presentations	Weeks 14-16

Prepared By

Alberto Cruz

CMPS 5450 Graduate Data Mining

Catalog Description

CMPS 5450 Graduate Data Mining (3)

This course introduces concepts, principles, algorithms, techniques, performance, and applications of data mining and knowledge discovery. Topics may include data preprocessing, data visualization, data dissemination, the statistical foundations for data modeling, classification and prediction, clustering analysis, association and pattern analysis, and outlier detection. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in algorithm analysis (similar to CMPS 3120)
- Undergraduate course on calculus (similar to MATH 2510 and 2520)
- Undergraduate course on probability and statistics (similar to MATH 3200)
- Undergraduate course on linear algebra (similar to MATH 2610) is strongly recommended

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Graduate elective in the Data Science / Artificial Intelligence / Machine Learning topic area.

Required Textbook

Data Mining: Concepts and Techniques, by Jiawei Han and Micheline Kamber

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website.

Coordinator(s)

Chengwei Lei, Anthony C. Bianchi, Alberto Cruz, Vincent Wong On

ACM CS 2013 Body of Knowledge Topics/Outcomes

IM/Data Mining

1. Compare and contrast different uses of data mining as evidenced in both research and application.
2. Explain the value of finding associations in market basket data.
3. Characterize the kinds of patterns that can be discovered by association rule mining.
4. Describe how to extend a relational system to find patterns using association rules.
5. Evaluate different methodologies for effective application of data mining.
6. Identify and characterize sources of noise, redundancy, and outliers in presented data.
7. Identify mechanisms (on-line aggregation, anytime behavior, interactive visualization) to close the loop in the data mining process.
8. Describe why the various close-the-loop processes improve the effectiveness of data mining.

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

Lecture Topics and Schedule

Introduction to Data Mining, Data Warehousing & OLAP	Week 1
Data Preprocessing and Exploration	Week 2
Feature Engineering	Week 3
Decision Trees	Week 4
Overfitting & Cross-Validation	Week 5
Nearest Neighbor, Naïve Bayes	Week 6
Prediction	Week 7
Classifier Accuracy and Evaluation	Week 8
Density-Based Clustering	Weeks 9-10
Hierarchical Clustering	Weeks 11-12
Evaluating Clusters	Weeks 13-14
Anomaly Detection	Weeks 15-16

Prepared By

Chengwei Lei

CMPS 5500 Graduate Programming Languages and Compilers

Catalog Description

CMPS 5500 Graduate Programming Languages and Compilers (3)

This is an advanced graduate course where students will study programming languages with an emphasis on their implementation. Topics include lexical analysis, language syntax, control structures, the binding of names, procedures, and their implementation in compilers. Students will design and present a project on related topics. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in programming languages (similar to CMPS 3500)
- Undergraduate course in compiler design (similar to CMPS 4500) is strongly recommended

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Core (Selected from List) for Graduate Computer Science Students.

Required Textbook

Compilers: Principles, Techniques, and Tools, by Aho, Lam, Sethi, & Ullman

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website.

Coordinator(s)

Chengwei Lei, Melissa Danforth

ACM CS 2013 Body of Knowledge Topics/Outcomes

PL/Syntax Analysis

1. Use formal grammars to specify the syntax of languages.
2. Use declarative tools to generate parsers and scanners.
3. Identify key issues in syntax definitions: ambiguity, associativity, precedence.

PL/Compiler Semantic Analysis

1. Implement context-sensitive, source-level static analyses such as type-checkers or resolving identifiers to identify their binding occurrences.
2. Describe semantic analyses using an attribute grammar.

PL/Formal Semantics

1. Give a formal semantics for a small language.
2. Write a lambda-calculus program and show its evaluation to a normal form.
3. Discuss the different approaches of operational, denotational, and axiomatic semantics.
4. Use induction to prove properties of all programs in a language.

5. Use induction to prove properties of all programs in a language that are well-typed according to a formally defined type system.
6. Use parametricity to establish the behavior of code given only its type.
7. Use formal semantics to build a formal model of a software system other than a programming language.

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

Lecture Topics and Schedule

Introduction	Week 1
Syntax- Lexical Analysis	Week 2
Syntax- Grammars	Week 3
Syntax- Parsing	Week 4
Syntax- Semantic Analysis	Weeks 5
Syntax- Error Handling	Weeks 6
Symbol Tables	Weeks 7-8
Intermediate Code	Weeks 9-10
Runtime Support	Weeks 11-12
Code Generation	Weeks 13-14
Optimization	Weeks 15-16

Prepared By

Chengwei Lei

CMPS 5510 Reverse Engineering

Catalog Description

CMPS 5510 Reverse Engineering (3)

Investigation into reverse engineering techniques for both normal executables and malware. Topics include behavioral analysis of executables, static binary analysis, dynamic binary analysis, anti-analysis and evasion techniques, obfuscation, shellcode, and code injection. Hands-on activities will reinforce the theoretical concepts being discussed. Each week lecture meets for 150 minutes.

Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in assembly language programming (similar to CMPS 2240)
- Undergraduate course in programming languages / language design (similar to CMPS 3500)
- Familiarity with Intel 32-bit (IA-32 x86) and 64-bit (x64 / x86-64) assembly

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Graduate elective in the Cybersecurity topic area.

Required Textbook

Practical Malware Analysis. Michael Sikorski and Andrew Honig. No Starch Press, 2012, ISBN-13: 9781593272906.

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website. Recommended textbooks are:

- Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and Obfuscation. Bruce Dang, Alexandre Gazet, and Elias Bachaalany. Wiley, 2014, ISBN: 978-1-118-78731-1.
- The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory. Michael Hale Ligh, Andrew Case, Jamie Levy, and Aaron Walters. Wiley, 2014, ISBN: 978-1-118-82509-9.

Coordinator(s)

Melissa Danforth, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

AR/Assembly Level Machine Organization

- Assembly/machine language programming
- Heap vs. Static vs. Stack vs. Code segments

IAS/Foundational Concepts in Security

- Concepts of risk, threats, vulnerabilities, and attack vectors
- Ethics

IAS/Threats and Attacks

- Examples of malware (e.g., viruses, worms, spyware, botnets, Trojan horses or rootkits)

PL/Language Translation and Execution

- Language translation pipeline: parsing, optional type-checking, translation, linking, execution
- Run-time representation of core language constructs
- Run-time layout of memory: call-stack, heap, static data

PL/ Runtime Systems

- Dynamic memory management approaches and techniques
- Data layout for objects and activation records

SP/Security Policies, Laws and Computer Crimes

- Effects of malware, such as viruses, worms and Trojan horses

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

MS-4. An ability to recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

MS-4b) Make informed judgements based on legal and ethical principles and on professional responsibilities.

Lecture Topics and Schedule

Introduction and Professional ethics	Week 1
Review of Intel 32-bit and 64-bit assembly	Week 2
Static binary analysis – Basic techniques	Week 3
Static binary analysis – Advanced techniques	Weeks 4-5
Dynamic binary analysis – Basic techniques	Week 6
Dynamic binary analysis – Advanced techniques	Weeks 7-8
Behavioral analysis and Malware functionality	Week 9-10
Anti-analysis techniques and Evasion techniques	Week 11-12
Code obfuscation	Weeks 13-14
Shellcode and Code injection	Weeks 15-16

Prepared By

Melissa Danforth

CMPS 5560 Machine Learning

Catalog Description

CMPS 5560 Machine Learning (3)

This course introduces concepts of machine learning with a focus of supervised learning methods. Foundational modeling of classification and regression problems will be covered. Topics include linear discriminate analysis (LDA), logistic regression, support vector machines (SVM), maximum likelihood estimation (MLE), nearest neighbor, neural networks (NN), decision trees, decision forest, AdaBoost, convolutional NN, recurrent NN. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course on calculus (similar to MATH 2510 and 2520)
- Undergraduate course on probability and statistics (similar to MATH 3200)
- Basic programming skills
- Undergraduate course on linear algebra (similar to MATH 2610) is strongly recommended

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Graduate elective in the Data Science / Artificial Intelligence / Machine Learning topic area.

Required Textbook

“The Elements of Statistical Learning (2nd Edition)”, Trevor Hastie, Robert Tibshirani, and Jerome Friedman, ISBN: 0387848576. (online free)

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website. Other recommended textbooks are:

- “An Introduction to Statistical Learning with Applications in R”, Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, ISBN # 978-1-4614-7137-0 (online free)
- “Deep Learning”, Ian Goodfellow, Yoshua Bengio and Aaron Courville, ISBN # 0262035618

Coordinator(s)

Anthony C. Bianchi, Alberto Cruz, Chengwei Lei, Vincent Wong On

ACM CS 2013 Body of Knowledge Topics/Outcomes

IS/Basic Machine Learning

1. List the differences among the three main styles of learning: supervised, reinforcement, and unsupervised. [Familiarity]
2. Identify examples of classification tasks, including the available input features and output to be predicted. [Familiarity]
4. Describe over-fitting in the context of a problem. [Familiarity]
5. Apply the simple statistical learning algorithm such as Naive Bayesian Classifier to a classification task and measure the classifier's accuracy. [Usage]

IS/Advanced Machine Learning

2. Implement simple algorithms for supervised learning, reinforcement learning, and unsupervised learning. [Usage]
4. Compare and contrast each of the following techniques, providing examples of when each strategy is superior: decision trees, neural networks, and belief networks. [Assessment]
5. Evaluate the performance of a simple learning system on a real-world dataset. [Assessment]
6. Characterize the state of the art in learning theory, including its achievements and its shortcomings. [Familiarity]
7. Explain the problem of overfitting, along with techniques for detecting and managing the problem. [Usage]

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

Lecture Topics and Schedule

Introduction to Classification and Regression / Training and Testing	Weeks 1-2
Linear Regression and Classification	Week 3
Support Vector Machines	Week 4
Bayes decision rule and maximum likelihood estimation	Week 5
Decision Trees	Week 6
Boosting and Bagging Decision Forest	Weeks 7-8
Adaboost	Week 9
K-th Nearest Neighbor	Week 10
Neural Networks	Weeks 11-12
Convolutional Neural Networks	Week 13
Recurrent Neural Networks	Week 14
Student Presentations	Weeks 15-16

Prepared By

Anthony C. Bianchi

CMPS 5600 Graduate Operating Systems

Catalog Description

CMPS 5600 Graduate Operating Systems (3)

This course exposes students to recent developments in operating systems research and design. Course lectures and reading assignments will be on classic and recent papers that shaped the field on a range of topics, including OS design, virtual memory management, file systems, virtualization, concurrency and synchronization, cloud systems, heterogeneity, and security. The course also exposes students to basic system-building and evaluation methodologies through programming assignments and a final project. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in operating systems (similar to CMPS 3600)
- Principles of computer systems design knowledge
- C programming language, system programming

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Core (Selected from List) for Graduate Computer Science Students.

Required Textbook

This course does not have a required textbook. It is based on a collection of classic and recent journal, conference, and several other papers on operating systems topics. The list of papers and schedule is available on the course website.

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website. It is also useful to use an undergraduate operating systems textbook as a reference.

Coordinator(s)

Melissa Danforth, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

OS/Security and Protection

OS/Fault Tolerance

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

Lecture Topics and Schedule

Storage and File Systems	Weeks 1-2
Concurrency	Weeks 3-4
Memory Management	Weeks 5-6
Virtual Machines	Weeks 7-8
Embedded/Mobile Systems	Weeks 9-10
System Security	Weeks 11-12
Speculative scheduling	Week 13
Speculative synchronization	Week 14
Cooperative caching	Week 15
Presentations and course review	Week 16

Prepared By

Antonio Cardenas (left CSUB in Aug. 2020)

CMPS 5640 Graduate Distributed Computation

Catalog Description

CMPS 5640 Graduate Distributed Computation (3)

With the growth of large-scale systems, there is an increasing need for distributed systems that can cover the load. This class will cover MapReduce, cloud computing networks, timing, fault tolerance, consistency, transaction, dataflow and peer to peer systems. This course emphasizes the evaluation of real-world systems from multiple contexts. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in algorithm analysis (similar to CMPS 3120)
- Undergraduate course in distributed and parallel computation (similar to CMPS 3640) is strongly recommended

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Core (Selected from List) for Graduate Computer Science Students.

Required Textbook

“Distributed Systems Concepts and Design, Fifth Edition”, George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, ISBN 0-13-214301-1

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website.

Coordinator(s)

Anthony C. Bianchi, Vincent Wong On, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

PD/Distributed Systems

1. Distinguish network faults from other kinds of failures. [Familiarity]
2. Explain why synchronization constructs such as simple locks are not useful in the presence of distributed faults. [Familiarity]
3. Write a program that performs any required marshaling and conversion into message units, such as packets, to communicate interesting data between two hosts. [Usage]
4. Measure the observed throughput and response latency across hosts in a given network. [Usage]
5. Explain why no distributed system can be simultaneously consistent, available, and partition tolerant.[Familiarity]
6. Implement a simple server -- for example, a spell checking service. [Usage]
7. Explain the tradeoffs among overhead, scalability, and fault tolerance when choosing a stateful v. stateless design for a given service. [Familiarity]

8. Describe the scalability challenges associated with a service growing to accommodate many clients, as well as those associated with a service only transiently having many clients.
[Familiarity]
9. Give examples of problems for which consensus algorithms such as leader election are required.
[Usage]

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

Lecture Topics and Schedule

MapReduce	Week 1
Cloud Computing Networks	Weeks 2-3
RPC	Week 4
Distributed Clocks	Week 5
Fault Tolerance	Week 6
CAP Theorem for Consistency Modeling	Week 7
Consensus	Weeks 8-9
Relaxed Consistency	Week 10
Distributed Transactions	Weeks 11-12
Data Flow	Week 13
Peer to Peer Systems	Weeks 14-16

Prepared By

Anthony C. Bianchi

CMPS 5650 Operations Security

Catalog Description

CMPS 5650 Operations Security (3)

This course covers the theoretical and applied aspects of operations security (OPSEC) in cyber systems to protect sensitive and/or confidential data. Topics include threat and adversarial modeling, vulnerability analysis, penetration testing, risk assessment, countermeasures, systems hardening, and other defensive operations. Each week lecture meets for 150 minutes. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

- Undergraduate course in computer networking (similar to CMPS 3620)
- Undergraduate course in operating systems (similar to CMPS 3600)

Units and Contact Time

3 Semester Units. 3 units lecture (weekly: 150 minutes in-class, 6-9 hours outside of class)

Type

Graduate elective in the Cybersecurity topic area.

Required Textbook

Computer Security: Principles and Practice, 4th edition, William Stallings and Lawrie Brown. Pearson, 2018, ISBN-13: 9780134794105. More information at <http://williamstallings.com/ComputerSecurity/>

Recommended Textbook and Other Supplementary Material

Supplemental material may be posted on the course website. Recommended textbooks are:

- Computer Security: Art and Science. 2nd edition, Matt Bishop. Addison-Wesley, 2019, ISBN-13: 978-0-321-71233-2. More information available at <http://nob.cs.ucdavis.edu/book/>

Coordinator(s)

Melissa Danforth, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

HCI/Human Factors and Security

- Applied psychology and security policies
- Organizational vulnerabilities and threats
- Trust, privacy and deception

IAS/Foundational Concepts in Security

- Confidentiality, Integrity, Availability
- Concepts of risk, threats, vulnerabilities, and attack vectors
- Ethics

IAS/Threats and Attacks

- Attacker goals, capabilities, and motivations
- Social engineering

IAS/Network Security

- Network specific threats and attack types
- Defense mechanisms and countermeasures

OS/Security and Protection

- Security methods and devices

SP/Security Policies, Laws and Computer Crimes

- Issues surrounding the misuse of access and breaches in security
- Motivations and ramifications of cyber terrorism and criminal hacking, “cracking”
- Effects of malware, such as viruses, worms and Trojan horses

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1a) Apply appropriate mathematical foundations and perform correct mathematical analysis.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

MS-4. An ability to recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

MS-4b) Make informed judgements based on legal and ethical principles and on professional responsibilities.

Lecture Topics and Schedule

Professional ethics; Threats, risks, assets, and cybersecurity goals	Week 1
Psychological aspects of cybersecurity; Adversarial modeling	Weeks 2-3
Vulnerability analysis – Human factors	Week 4
Vulnerability analysis – Software and configuration factors	Weeks 5-7
Network-based attacks	Weeks 8-9
Penetration testing	Week 10
Threat modeling	Week 11
Advanced persistent threats (APTs)	Week 12
Risk assessment	Weeks 13-14
Countermeasures and System hardening	Weeks 15-16

Prepared By

Melissa Danforth

CMPS 5770 Special Topics in Computer Science

Catalog Description

CMPS 5770 Special Topics in Computer Science (1-3)

Contemporary topics at a graduate level in computer science, as announced in Schedule of Classes.

May be repeated to maximum of 9 units in different topics. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

Varies each offering depending on the specific special topic chosen.

Units and Contact Time

Variable Semester Units. Expected 50 minutes per week in-class and 2-3 hours per week outside of class for each lecture unit.

Type

Graduate elective in the Individual Study / Special Topics topic area.

Required Textbook

Varies each offering depending on the specific special topic chosen.

Recommended Textbook and Other Supplementary Material

Varies each offering depending on the specific special topic chosen.

Coordinator(s)

Melissa Danforth, Anthony C. Bianchi, Alberto Cruz, Chengwei Lei, Vincent Wong On, Nicholas Toothman, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

Varies each offering depending on the specific special topic chosen.

Student Learning Outcomes

Varies each offering depending on the specific special topic chosen.

Lecture Topics and Schedule

Varies each offering depending on the specific special topic chosen.

Prepared By

Chengwei Lei

CMPS 5800 Graduate Research

Catalog Description

CMPS 5800 Graduate Research (1-3)

Independent investigation and study of an advanced topic in computer science under direct supervision of an instructor. The graduate research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 units. Prerequisite: Classified graduate student status or permission of the instructor.

Prerequisite by Topic

Depends on research topic chosen between student and instructor.

Units and Contact Time

Variable Semester Units. Individual study – Expected 3-4 hours of work per week per unit.

Type

Graduate elective in the Individual Study / Special Topics topic area.

Required Textbook

Will be determined by instructor based on research topic selected.

Recommended Textbook and Other Supplementary Material

None

Coordinator(s)

Melissa Danforth, Anthony C. Bianchi, Alberto Cruz, Chengwei Lei, Vincent Wong On, Nicholas Toothman, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

Depends on research topic chosen between student and instructor.

Student Learning Outcomes

Depends on research topic chosen between student and instructor.

Lecture Topics and Schedule

Not applicable to an individual study course.

Prepared By

Chengwei Lei

CMPS 6910 Thesis Research

Catalog Description

CMPS 6910 Thesis Research (1-3)

The systematic study of a research problem of significant scope and novelty as determined by the Thesis Committee. Student will identify a problem, articulate the significance of the work, determine sources and methods for gathering data (laboratory, simulation and/or field work), experiment and analyze the data, and offer a conclusion or recommendation to the research question. Students receive training and preparation for the Thesis Defense. This is required for Master's students who select the Thesis option for their capstone. Course is repeatable, but only a combined total of 5 units can be used towards the Master's degree. Prerequisite: CMPS 5100, Classified graduate student status, and Approval of the instructor (Thesis Advisor).

Prerequisite by Topic

- Graduate course on research methodologies and professional ethics in computer science
- Selection of a Thesis Advisor
- Selection of a Thesis Committee, with the guidance of the Thesis Advisor
- Selection of a thesis topic, with the guidance of the Thesis Advisor

Units and Contact Time

Variable Semester Units. Capstone individual study – Expected 4-5 hours of work per week per unit.

Type

Core (Required) for Graduate Computer Science Students who selected Thesis Option.

Required Textbook

There is no general textbook, although the Thesis Advisor may recommend books throughout the capstone experience to specific students.

Recommended Textbook and Other Supplementary Material

None

Coordinator(s)

Alberto Cruz, Melissa Danforth, Anthony C. Bianchi, Chengwei Lei, Vincent Wong On, Nicholas Toothman, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

SP/Professional Communication

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

General Overview and Schedule

Thesis preparation spans many semesters, and the content of the class can vary greatly based on the expectations of your Thesis Advisor and your completion of the manuscript. The following is a general overview of milestones for the last year of the M.S. Computer Science degree program (2 semesters covering 32 weeks):

Goal	Expected Timeline
Organization of committee	Before start of class
Selection of Thesis chair	Before start of class
Selection of Thesis topic	Before start of class
Completion of literature search	Week 8
Completion of initial experimentation and/or field work	Week 20
Completion of first draft and submission of draft to committee	Week 24
Completion of second draft and submission of draft to committee	Week 28

Goals in Conjunction with Thesis Defense Course

Most students will take the Thesis Research course in conjunction with the Thesis Defense course during their last semester of Thesis Research (typically their fourth semester in the program for full-time students). Goals that will be organized in conjunction with the Thesis Defense course are Submission of final draft to the Thesis Committee, scheduling the public defense, conducting the public defense, and publishing the Thesis manuscript. This will typically occur in weeks 30-32 of the Thesis Research course.

Grading Policy

Expectations will vary based on topic and Thesis Advisor, though satisfactory grades will be given by:

- Thorough investigation and search of related works
- Significant progress toward writing the Thesis manuscript
- Completing results and/or field work to be included in the Thesis manuscript
- Regularly meeting with the Thesis Advisor or Thesis Committee
- Completing revisions of the Thesis manuscript as requested by the Thesis Committee

Failing to meet these expectations may result in a less than satisfactory grade and affect a student's timeline to graduation.

Prepared By

Alberto Cruz

CMPS 6920 Thesis Defense

Catalog Description

CMPS 6920 Thesis Defense (1)

Final preparation for the Thesis Defense. This should only be taken after the Thesis demonstrates originality, critical and independent thinking, appropriate organization and format, and thorough documentation, and readiness for oral defense. Activities vary depending on topic, though all Thesis Defense classes include review and revision of the presentation by the Thesis Advisor, an oral defense and an acceptance/pass or rejection/failure decision by the Thesis Committee. This is required for Master's students who select the Thesis option for their capstone. Offered on a credit, no-credit basis only. Students who receive the no-credit grade may repeat the course, although a subsequent rejection of Thesis Defense may result in dismissal from the program. Prerequisite: CMPS 6910, Advancement to candidacy, and Approval of the instructor (Thesis Advisor).

Prerequisite by Topic

- Thesis has significant progress to satisfaction of Thesis Advisor

Units and Contact Time

1 Semester Unit. Capstone individual study – Expected 4-5 hours of work per week.

Type

Core (Required) for Graduate Computer Science Students who selected Thesis Option.

Required Textbook

There is no textbook, although the Thesis Advisor may recommend books throughout the capstone experience.

Recommended Textbook and Other Supplementary Material

None

Coordinator(s)

Alberto Cruz, Melissa Danforth, Anthony C. Bianchi, Chengwei Lei, Vincent Wong On, Nicholas Toothman, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

SP/Professional Communication

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

MS-3. An ability to communicate effectively in a variety of professional contexts.

MS-3a) Write technical reports or academic papers at an appropriate level for the target audience.

MS-3b) Prepare and deliver oral presentations at an appropriate level for the target audience.

MS-4. An ability to recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

MS-4a) Recognize and describe professional responsibilities in computing practice.

MS-4b) Make informed judgements based on legal and ethical principles and on professional responsibilities.

MS-4c) Demonstrate an ability to maintain a high standard of professional competence.

General Overview and Schedule

This class should only be taken if the Thesis Advisor believes that the student is ready to defend their Thesis, based on their progress in the Thesis Research course. The following is a general timeline that describes the preparations for an oral Thesis Defense, though an individual's timeline to defense may vary:

Goal	Expected Timeline before Defense
Submission of final Thesis draft to the Thesis Committee (in coordination with Thesis Research course)	6-8 weeks
Final comments of Thesis draft returned to student by Thesis Committee	3-6 weeks
Scheduling of public defense	2-4 weeks
Submission of final draft to committee	1-2 weeks
Public defense of Thesis (Thesis Defense)	0 weeks
Submission of electronic Thesis and signature page to CSUB Library	By Academic Calendar deadline

Grading Policy

Grade is based on performance during the Thesis Defense. The Thesis Defense is a public, oral presentation of the written Thesis. All members of the Thesis Committee must be present for the Thesis Defense to take place. If members are missing, it must be rescheduled.

Immediately following the Thesis Defense, Thesis Committee members deliberate in private to either accept or reject the Thesis. If most members vote to accept the Thesis, it is accepted, the student passes the class, and the Thesis is published. If most members vote to reject the Thesis, the student fails the class and must re-defend the Thesis. The Thesis Defense can be repeated though subsequent failures may result in dismissal based on departmental policy.

Prepared By

Alberto Cruz

CMPS 6950 Graduate Project I

Catalog Description

CMPS 6950 Graduate Project I (2)

Students will undertake a significant project within the scope of Computer Science under the supervision of a faculty member serving as Project Advisor. The project must be original, demonstrate independent thought, possess appropriate form and organization, and include a market analysis. Students must demonstrate progress with written reports and oral presentations, to be reviewed by the Project Advisor. Prerequisite: Classified graduate student status and Approval of the instructor (Project Advisor).

Prerequisite by Topic

Approval from Project Advisor

Units and Contact Time

2 Semester Units. Capstone individual study – Expected 8-10 hours of work per week.

Type

Core (Required) for Graduate Computer Science Students who selected Project Option.

Required Textbook

None

Recommended Textbook and Other Supplementary Material

None

Coordinator(s)

Anthony C. Bianchi, Melissa Danforth, Alberto Cruz, Chengwei Lei, Vincent Wong On, Nicholas Toothman, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

SP/Professional Communication

1. Write clear, concise, and accurate technical documents following well-defined standards for format and for including appropriate tables, figures, and references. [Usage]
2. Evaluate written technical documentation to detect problems of various kinds. [Assessment]
5. Describe the strengths and weaknesses of various forms of communication (e.g. virtual, face-to-face, shared documents). [Familiarity]
6. Examine appropriate measures used to communicate with stakeholders involved in a project. [Usage]

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

General Overview and Schedule

Goal	Expected Timeline
Selection of Project Advisor	Before start of class
Selection of Project Topic	Before start of class
Completion of background research	Week 5
Completion of initial project platform	Week 15
Completion of project report draft	Week 16

Grading Policy

Pass/fail determined by the Project Advisor based on progress on project and project report.

Prepared By

Anthony C. Bianchi

CMPS 6960 Graduate Project II

Catalog Description

CMPS 6960 Graduate Project II (1)

This is a culminating experience for the Project tract students. Students will complete their project and present it to the satisfaction of the Project Committee. A written technical document (Master Project Report) that describes the project's significance, objectives, methodology and conclusion in abstract, will be reviewed by the Project Advisor and approved by the Project Committee. At the end of the course the student may publicly present the results of their project. Offered on a credit, no-credit basis only. Prerequisite: CMPS 6950, Advancement to candidacy, and Approval of the instructor (Project Advisor).

Prerequisite by Topic

CMPS 6950

Units and Contact Time

1 Semester Unit. Capstone individual study – Expected 4-5 hours of work per week.

Type

Core (Required) for Graduate Computer Science Students who selected Project Option.

Required Textbook

None

Recommended Textbook and Other Supplementary Material

None

Coordinator(s)

Anthony C. Bianchi, Melissa Danforth, Alberto Cruz, Chengwei Lei, Vincent Wong On, Nicholas Toothman, Kanwal Gagneja

ACM CS 2013 Body of Knowledge Topics/Outcomes

SP/Professional Communication

1. Write clear, concise, and accurate technical documents following well-defined standards for format and for including appropriate tables, figures, and references. [Usage]
2. Evaluate written technical documentation to detect problems of various kinds. [Assessment]
3. Develop and deliver a good quality formal presentation. [Assessment]
4. Plan interactions (e.g. virtual, face-to-face, shared documents) with others in which they are able to get their point across, and are also able to listen carefully and appreciate the points of others, even when they disagree, and are able to convey to others what they have heard. [Usage]
5. Describe the strengths and weaknesses of various forms of communication (e.g. virtual, face-to-face, shared documents). [Familiarity]
6. Examine appropriate measures used to communicate with stakeholders involved in a project. [Usage]

Student Learning Outcomes

MS-1. An ability to analyze a complex computing problem, utilizing appropriate principles of computer science theory, computing, and other relevant disciplines.

MS-1b) Apply appropriate principles to analyze a complex computing problem.

MS-2. An ability to apply computer science theory and fundamentals to evaluate and produce computing-based solutions.

MS-2a) Evaluate alternative designs and choose the desirable solution for a given context.

MS-2b) Apply appropriate computer science theory and fundamentals when producing a solution.

MS-3. An ability to communicate effectively in a variety of professional contexts.

MS-3a) Write technical reports or academic papers at an appropriate level for the target audience.

MS-3b) Prepare and deliver oral presentations at an appropriate level for the target audience.

MS-4. An ability to recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

MS-4a) Recognize and describe professional responsibilities in computing practice.

MS-4b) Make informed judgements based on legal and ethical principles and on professional responsibilities.

MS-4c) Demonstrate an ability to maintain a high standard of professional competence.

General Overview and Schedule

Goal	Expected Timeline
Completion of project completion plan	Week 2
Completion of draft of Masters Project Report	Week 14
Presentation of project to committee	Week 15
Completion of final Masters Project Report	

Grading Policy

Pass/fail based on the evaluation of the Masters Project Report by the Project Advisor and the Project Committee.

Prepared By

Anthony C. Bianchi

Appendix H: Environmental Scan Report from UPCEA

The Environment Scan Report prepared by Jim Fong at the UPCEA Center for Research and Marketing Strategy from February 2016 begins on the next page.

Environmental Scan
Master of Computer Science
California State University, Bakersfield

DRAFT Report

Submission by:



Center for Research and Marketing Strategy

February 2016

I. Objective

The California State University, Bakersfield seeks assistance in gathering and analyzing exploratory data to guide planning and program development for a potential Master of Computer Science degree.

The goal of this environmental scanning effort is to answer the following questions:

- What is the condition of the market for a master's degree in computer science?
- What occupations make up the target market and what is their projected growth and anticipated demand for this type of education?
- Is there information available that could impact content development or course offerings?

Environmental scanning is a cost-efficient and insightful exploratory research method regarding program assessment, design, and delivery—an internal stakeholder engagement and planning adaptation enabler.

II. Methodology

The University Professional and Continuing Education Association (UPCEA) and its Center for Research and Marketing Strategy (CREMS) conducted an environmental scan that included a review of consumer and occupational demographics, Internet and library scans, and a brief competitive analysis.

III. Key Findings

The proposed Master of Computer Science is well suited for a field with a growing demand but CSU Bakersfield's local economy will be a competitive challenge.

- Technology trends to improve data collection, storage, use, and security are driving a strong job market for most computer related jobs and industries.
- Computer occupations overall are poised for strong growth in Kern County, California and the US. However, in the county, the actual number of jobs projected to be added is only 571 over ten years. There will be some additional demand from vacancies left by retiring Baby Boomers. Only two of the occupations prefer or require a graduate degree and an MBA is preferred.
- Top computer related industries are projected to have strong growth in California (27%), but in Kern County, employment in these same industries is only expected to grow by 4% by 2025.
- California has a strong location quotient (LQ) for computer occupations (1.17) which ranks eighth nationwide. While some areas of the state have very strong employment in this area, Kern County is well below average with an LQ of only 0.47.
- While there were 308 computer occupation job postings in Kern County in December 2015, the job posting frequency averaging 4:1 (or four job posts per unique position) suggests that employers did not have to try hard to fill those positions.
- Statewide, 16,002 bachelor's degrees were awarded in computer-related fields. However, there were a corresponding 41,024 jobs available for those graduates who were qualified.
- At least 39 other California institutions offer a master's degree in computer science. All of these are at least 70 miles away from CSU Bakersfield but several offer distance education options. In addition, there are six of the top 20 US News and World Report-ranked best graduate schools in computer science located in California.
- Most Master of Computer Science programs are offered on campus. A few programs including University of Southern California, Stanford University, and National University offer online degrees. California State University at Fullerton has a blended program.
- Selected competitors programs require from 24 to 52 units and tuition ranges from \$1,953 to \$16,240 per semester. Most offer flexibility in class selection or several areas of specialization from which to choose.
- International students may have a strong interest in the Master of Computer Science degree from a US university. They make up a large part of the student body for at least one competitor.

IV. Summary of Market Factors

Factor	Pros	Cons
Product: <i>Master of Computer Science</i>	<ul style="list-style-type: none"> ▪ Computer occupations are projected to have strong growth ▪ International student interest is high for computer science degrees 	<ul style="list-style-type: none"> ▪ Despite high growth rates, the number of jobs added in Kern County will be limited ▪ Most occupations do not require a graduate degree at this time
Brand:	<ul style="list-style-type: none"> ▪ CSU Bakersfield benefits from the California State University institutional brand strength and recognition 	<ul style="list-style-type: none"> ▪ Several highly-ranked and well-recognized competitors in state, including USC and Stanford
Competition:	<ul style="list-style-type: none"> ▪ Regional competition is limited 	<ul style="list-style-type: none"> ▪ There are a number of competitors in California including several highly- ranked programs ▪ Online programs are available ▪ Alternative degrees may attract some students
Market:	<ul style="list-style-type: none"> ▪ Potential for state reach ▪ Potential international interest 	<ul style="list-style-type: none"> ▪ Regional demand is limited ▪ Student motivations may be limited at this time
Marketing Reach:	<ul style="list-style-type: none"> ▪ Positive regional reputation ▪ Experience targeting regional market 	<ul style="list-style-type: none"> ▪ International brand appeal is unknown and will require additional resources to attract prospective students
Price:	<ul style="list-style-type: none"> ▪ CSU Bakersfield standard tuition is competitive and aligned with other state institutions 	<ul style="list-style-type: none"> ▪ Price competitive options are available regionally, nationally, and online
Economic Situation:	<ul style="list-style-type: none"> ▪ Most computer occupations pay well ▪ Excellent employment prospects for graduates 	<ul style="list-style-type: none"> ▪ Employer’s willingness to fund is unknown
OVERALL RECOMMENDATION: <i>Proceed if a small cohort is part of the goals for the degree</i>	<ul style="list-style-type: none"> ▪ Computer Science is a growing field and new skills are constantly required ▪ California is a strong employer of computer professionals ▪ International interest may be strong 	<ul style="list-style-type: none"> ▪ Demand and motivation for local audience is questionable ▪ Local market is very small

V. Recommendations

CSU Bakersfield should be aware that the local market is limited and a broader marketing reach will be required. Demand may be limited, especially in the current workplace environment, but will likely grow.

- Marketing should be targeted beyond the local area. A statewide, national, and even international audience is recommended. CSU Bakersfield can take advantage of the state of California's reputation in the computer field to help boost the esteem of the program when marketing nationally and internationally. Internationally, students from China and India appear to have a strong interest in graduate degrees in computer science granted by US institutions.
- In the United States, CSU Bakersfield should consider targeting working adults looking to advance or change careers. As the current job market for recent computer science bachelor's degree holders is strong, the master's degree is more likely to appeal to those looking to move up the ladder or enter the computer fields. Although prerequisite courses may be required for career changers, this audience could help meet the demands of projected growth in the field and would be most likely to receive employer tuition assistance for a graduate degree. CSU Bakersfield's computer science undergraduate alumni would be an obvious group to target.
- Flexible scheduling options and/or blended delivery may also help create a competitive advantage. Many of the competitor programs are full-time, residential programs with only a few offering weekend classes and blended or online delivery.
- Curriculum flexibility may be a good way to launch the program. The selected competitors either offer a very flexible "make your own" specialization approach or offer several specific specializations. Initial focus can be on developing electives that align with trends such as data structuring, cyber security, and machine learning without initially committing to a long-term degree specialization. Over time, industry trends and faculty and student interest may inform which specializations will be beneficial for the University.
- Practical experience is highly regarded by computer occupation employers. This experience will be especially beneficial for any traditional age students or career changers. CSU Bakersfield should look for opportunities to partner with local businesses for project experience and internship opportunities for students.
- While the number of degrees conferred varies dramatically across the state, most of the highly-ranked competitors have very large programs. CSU Bakersfield may benefit from positioning the program as one with small class sizes and greater student-professor interaction.

- Incorporate some soft skills and general business topics. Computer science and information technology professionals continue to be perceived as out of touch with the business world and lacking in personal skills, especially communication. Graduates may be able to leverage these assets when seeking employment.
- CSU Bakersfield may benefit from primary research with employers in the state to determine their desire for a graduate degree for employee advancement and their willingness to pay for it. Their perceptions of and interest in applicants with a master's degree but limited experience and need for improved personal and general management skills could also be insightful.

VI. Technology Trends

- Current research identifies technology trends which will impact the computer science profession. Big data continues to drive innovation as computer and information professionals enhance sensors and analytics while grappling with storage and security issues.
- The Internet of Things (IoT) refers to the web of sensors and network-enabled devices that are the source of big data and provide the context data to aid in improved analysis. This includes everything from smart phones and watches, to the new clothes dryer that sends a text when clothes are dry and the gadget in cars determining insurance rates. Applications for embedding smart sensors are growing exponentially to include everything from pacemakers to newly poured concrete on bridges.
- Data analytics continues to grow as it finds new ways to transform this raw data into actionable feedback. The speed with which analyses can be completed is a top priority moving forward. Having the results trigger extremely personalized feedback, including advertising, is also key.
- Ecommerce is another source of data and revenue. Consumers have shifted to mobile devices to complete most online purchases. Retailers are working to simplify processes as well as releasing “nearable” devices like Amazon’s dash buttons.
- Customers are increasingly interacting with brands through apps. The functionality and usability of these apps are constantly under evaluation and improvement with faster update cycles than previously experienced in the computer and information technology fields. Creating an ambient user experience requires using IoT, big data analytics, and mobile devices to function together seamlessly across environments in real time. Advanced machine learning is being employed to help accomplish this goal.
- Cloud computing is another mega trend enabling all these changes. The cloud warehouses both the data and the apps and allows for sharing between people, data sources, and data users.
- Cyber security and privacy are critical as the gathering and storage of vast amounts of personal and personally identifiable information in the cloud intensifies. Cyber security professionals have to fend off attacks from random hackers, organized hacktivism, and even foreign governments. Employing behavioral laws and advanced machine learning to recognize attempted security breaches is a current goal.

VII. Occupational Analysis

According to the Department of Labor, Bureau of Labor Statistics (BLS), nationwide employment of computer and information technology occupations is projected to grow about 14% which is faster than the average for all occupations over the next decade. Growth of the selected computer occupations in California is even higher at 20%.

The selected occupations (excluding “other”) require at least a bachelor’s degree. Computer Information Systems Managers and Computer and Information Research Scientists may require a graduate degree, although an MBA is generally preferred as employers are looking for a mix of technical and management or business knowledge and skills.

Experience is heavily weighted in information technology hiring but technical skill remains paramount. Thus a master’s degree of an applied nature would be a competitive advantage for a graduate seeking to enter or advance in any of these occupations. Occupation descriptions are included in Appendix I.

Table 1. Selected Computer Occupations: California¹

Description	Jobs		Change	Percentage Change	Avg. Hourly Earnings
	2015 Jobs	2025 Jobs			
Computer and Information Systems Managers	54,653	63,810	9,157	17%	\$75.34
Computer and Information Research Scientists	6,243	7,055	812	13%	\$59.90
Computer Systems Analysts	78,833	96,570	17,737	22%	\$44.38
Information Security Analysts	8,705	11,853	3,148	36%	\$51.05
Software Developers, Applications	119,150	148,209	29,059	24%	\$57.08
Software Developers, Systems Software	87,203	102,653	15,450	18%	\$59.19
Database Administrators	12,305	14,637	2,332	19%	\$44.87
Network and Computer Systems Administrators	46,838	53,707	6,869	15%	\$42.27
Computer Network Architects	15,870	18,736	2,866	18%	\$57.60
Computer Occupations, All Other	25,675	28,227	2,552	10%	\$43.61
	455,475	545,458	89,983	20%	\$54.79

Application software developers—with 119,150 current jobs—is the largest occupational group in California and will add the greatest number of jobs by 2025. Information Security Analysts has the highest projected growth rate at 36%. Computer and Information Systems Managers earn the highest wages, \$75.34 per hour.

Note the “other” occupations, requiring fewer skills, show the weakest growth rate.

¹ Economic Modeling Specialists Intl.

Table 2. Selected Computer Occupations: Kern County, CA²

Description	Jobs		Change	Percentage Change	Avg. Hourly Earnings
	2015 Jobs	2025 Jobs			
Computer and Information Systems Managers	318	384	66	21%	\$60.21
Computer and Information Research Scientists	119	124	5	4%	\$52.93
Computer Systems Analysts	552	697	145	26%	\$41.04
Information Security Analysts	55	76	21	38%	\$48.42
Software Developers, Applications	351	450	99	28%	\$51.26
Software Developers, Systems Software	557	665	108	19%	\$54.01
Database Administrators	93	115	22	24%	\$36.38
Network and Computer Systems Administrators	605	687	82	14%	\$41.58
Computer Network Architects	92	118	26	28%	\$53.57
Computer Occupations, All Other	574	573	(1)	(0%)	\$39.06
	3,316	3,887	571	17%	\$46.65

In Kern County, Network and Computer Systems Administrators currently have the highest employment numbers with 605 jobs. Systems Software Developers and Computer Systems Analysts also have strong employment in the county. Computer Systems Analysts is poised to take the top spot by 2025 by adding 145 jobs. The fastest growing occupation over the next decade is Information Security Analysts (38%); however, the actual number of analysts will only total 76 after adding 21 positions over the next decade. Computer and Information Systems Managers earn the most at \$60.21 per hour. Overall, wages follow a similar pattern but are slightly lower than the state average.

“Other” computer occupations are expected to remain essentially flat moving forward.

Top Industries

The top three industries employing computer professionals in California are Customer Computer Programming Services, Computer Systems Design Services, and Software Publishers.

Table 3: Top Industries Employing Computer Professionals: California³

Description	Jobs		Change	Percentage Change	Wages
	2015 Jobs	2025 Jobs			
Software Publishers	57,922	74,263	16,341	28%	\$176,216
Custom Computer Programming Services	171,337	215,821	44,484	26%	\$128,986
Computer Systems Design Services	112,782	143,894	31,112	28%	\$118,565
	342,041	433,978	91,937	27%	\$133,548

² Ibid.

³ Ibid.

Statewide all three industries are forecasted to experience strong growth. Salaries across all industries are high.

Table 4: Top Industries Employing Computer Professionals: Kern County, CA⁴

Description	Jobs		Change	Percentage Change	Wages
	2015 Jobs	2025 Jobs			
Custom Computer Programming Services	524	474	(50)	(10%)	\$77,110
Computer Systems Design Services	636	684	48	8%	\$85,697
Corporate, Subsidiary, and Regional Managing Offices	3,503	4,213	710	20%	\$93,247
Federal Government, Civilian, Excluding Postal Service	8,804	7,981	(823)	(9%)	\$117,364
Elementary and Secondary Schools	24,922	27,649	2,727	11%	\$68,153
	38,389	41,001	2,612	7%	\$82,142

In Kern County the top industry lineup is somewhat different with the Federal Government, Elementary and Secondary Schools and Corporate, Subsidiary and Regional Managing Offices coming into play. Growth in all these industries is projected to be slower than for the statewide top industries. Wages for top industries in Kern County are lower than the state average.

Location Quotient

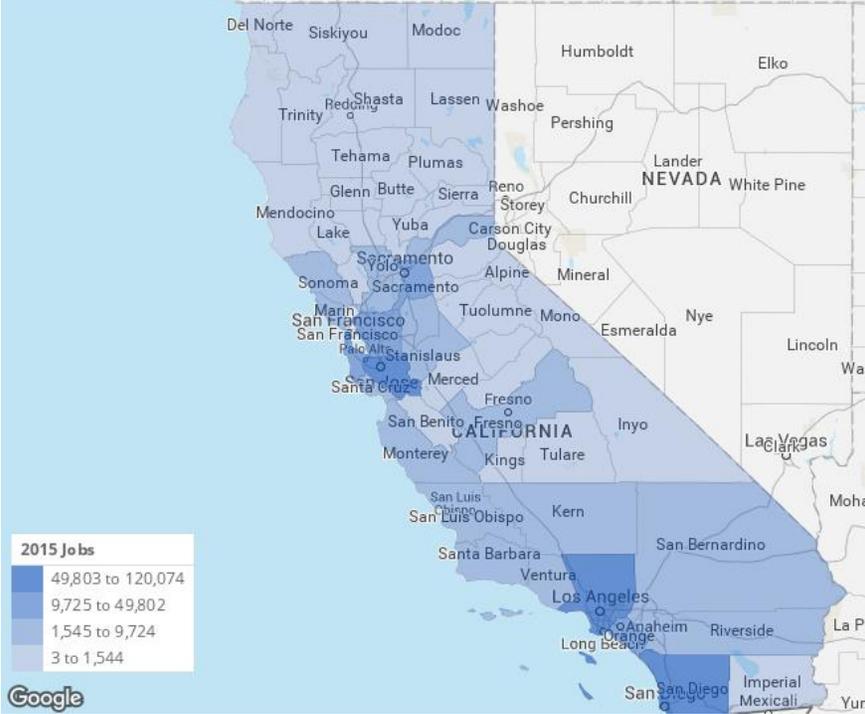
Location Quotients (LQs) are ratios that compare distribution of employment by industry to a base distribution. An LQ of greater than 1 indicates an industry with a greater share of local employment than is the case for the reference area.

California has a computer occupations LQ of 1.17 which is eighth nationwide. Higher LQs can be found in Virginia, the District of Columbia, Maryland, Washington, Massachusetts, Colorado, and New Jersey. This indicates that California is quite competitive in computer occupations nationally.

Within California, employment is heavily concentrated in a few counties and strong in several more which together account for the strong statewide LQ. The strongest computer occupation markets are Santa Clara (3.95), San Francisco (2.73), and San Mateo (2.52). Other counties with an LQ of greater than 1 (i.e., higher than the state average) include San Diego, Orange, Alameda, Sacramento, Contra Costa, Morin, and Alpine. The LQ for Kern County is only 0.47 indicating employment in the computer occupations is weak compared to the state average. See Figure 1 and Appendix II for current employment figures by county.

⁴ Ibid.

Figure 1. Computer Occupations LQ by County⁵



⁵ Ibid.

Job Openings

There were 308 unique job postings listed in Kern County in December. The frequency ratio indicates how many times the job was posted and is used as a measure of how difficult a position is to fill.

Table 5. Job Postings in Kern County, December 2015⁶

Description	Unique Job Postings	Frequency Ratio
Computer and Information Systems Managers	11	1:1
Computer and Information Research Scientists	11	3:1
Computer Systems Analysts	62	4:1
Information Security Analysts	38	4:1
Software Developers, Applications	35	3:1
Software Developers, Systems Software	49	5:1
Database Administrators	8	3:1
Network and Computer Systems Administrators	79	3:1
Computer Network Architects	7	5:1
Computer Programmers	8	4:1
Regional Average		4:1

The very low 1:1 ratio suggests that local companies are easily able to fill Computer and Information Systems Managers jobs. Even the higher volume positions, like Computer Systems Analysts with 62 openings has a ratio of only 4:1, equal to the regional average and average for all occupations. These figures suggest that local businesses do not have difficulty hiring qualified computer professionals.

Educational Feeder Markets

In 2014, institutions in California awarded 16,022 bachelor's degrees to students in undergraduate technology programs to fill 41,024 computer industry jobs. Computer science degrees were the most popular, representing 31% of the graduates. The number of graduates and number of openings suggests that job seekers with bachelor's degrees are facing minimal competition finding jobs.

Counties with the largest number of computer science graduates were Los Angeles (1,425), San Diego (675), Santa Clara (590), Orange (426) and Alameda (408). There were 29 graduates in Kern County.

⁶ Ibid.

VIII. Competitive Analysis

Six of U.S. News and World Report's top 20 best graduate schools, last ranked in 2014, in computer science⁷ are located in California. Stanford University and University of California—Berkeley were in a four-way tie for first place. California Institute of Technology placed eleventh. University of California—Los Angeles ranked fifteenth. Twentieth was the University of Southern California.

According to the National Center for Educational Statistics (NCES), there were 39 institutions that graduated computer science master's degree students in 2014. The programs with the most graduates are the University of Southern California (475), Stanford University (170) and the Naval Postgraduate School (126); all of which offer online delivery of at least some degree specializations. See Table 6 for a complete list of master's completions.

Only seven of the programs are within a 100 mile radius from CSU Bakersfield. The geographically closest potential competitor is UC Santa Barbara, 72 miles away. As there are few programs geographically proximate to Bakersfield, competitors profiled include those within 100 miles with ten or more graduates in 2014 as well as California programs with a distance education option.

Programs tend to be full time and offered on campus only. However, the CSU Fullerton program is blended and a few other programs offer fully online options. Some of the programs are completely flexible in course choice and most have several areas of specialization from which to choose.

Degree requirements range from 24 to 52 units. Tuition at some state institutions is very reasonable as low as \$1,953 per semester. Stanford University is \$16,240 per semester and USC charges less at \$1,774 per unit, or about \$12,418 per semester (Table 7).

Program and enrollment information indicated that a number of computer science students at the competitor schools are international. University of California Los Angeles reports that the majority of the program's students are international with China and India being the most common countries of origin.

In addition to the number of computer science programs, it should be noted that graduates from related fields such as information technology and computer engineering will be eligible to compete for many of the same job positions.

⁷ U.S. News and World Report, last ranked 2014

Table 6. Master of Computer Science Completions 2014⁸

Name	Graduates 2014
University of Southern California	475
Stanford University	170
Naval Postgraduate School	126
University of California-Berkeley	89
California State University-Fullerton	88
University of California-Los Angeles	85
University of California-Irvine	84
University of California-San Diego	72
California State University-Long Beach	71
San Diego State University	64
California State University-East Bay	49
California University of Management and Sciences	43
San Jose State University	41
California State University-Los Angeles	38
University of San Francisco	38
University of California-Riverside	36
University of California-Davis	33
National University	29
University of California-Santa Barbara	28
California State University-Sacramento	25
University of Redlands	24
DeVry University-California	23
University of California-Santa Cruz	21
San Francisco State University	20
California Polytechnic State University-San Luis Obispo	19
Claremont Graduate University	17
California State Polytechnic University-Pomona	15
California State University-San Bernardino	13
California State University-Fresno	12
California State University-Chico	11
Pacific States University	9
California State University-Northridge	8
California State University-San Marcos	6
California Institute of Technology	5
California State University-Dominguez Hills	4
Mills College	2
California State University-Channel Islands	1
Chapman University	1
University of California-San Francisco	1

⁸ National Center for Education Statistics

Table 7: Selected Competitive Master of Computer Science⁹

Institution	Delivery	Area(s) of Specialization	Requirements	Tuition
California State University, Los Angeles	Classroom	Application Software, System Software, Computer Theory	45-52 units	\$1,953 / semester (0-6 units)
California Polytechnic State University, San Luis Obispo	Classroom		45 units	\$1,953 / semester (0-6 units)
California State University, Fullerton	Blended		30 units	\$1,953 / semester (0-6 units)
National University	Classroom Online	Advanced Computing, Database Engineering, Software Engineering	67.5 quarter units	\$406 per quarter unit
Naval Postgraduate School	Classroom Online		40 Quarter hours	N/A must be sponsored
Stanford University	Classroom Online	Artificial Intelligence, Biocomputation, Computer and Network Security, Database Systems, Human-Computer Interaction, Numerical Analysis/Scientific Computation, Real-World Computing	45 Credit Hours	\$16,240 / semester
University of California, Berkeley	Classroom		24 units	\$5,610 / semester
University of California, Los Angeles	Classroom		9 courses	\$11,220 / year
University of California, Santa Barbara	Classroom	Theory, Systems, or Applications	42 units	\$12,240 / year
University of Southern California	Classroom Online	Computer Networks, Computer Security, Data Science, Game Development, High Performance Computing and Simulation, Intelligent Robotics, Multimedia and Creative Technologies, Software Engineering, Scientists and Engineers	28 units	\$1,774 / unit

Program descriptions can be found in Appendix III.

⁹ Information obtained from program websites

Appendix I

Selected Computer and Information Science Occupations BLS Descriptions¹⁰

Computer support occupations were excluded as they are more customer service oriented requiring minimal technical skills and educational prerequisites.

Computer and Information Systems Managers

Computer and information systems managers, often called information technology (IT) managers or IT project managers, plan, coordinate, and direct computer-related activities in an organization. They help determine the information technology goals of an organization and are responsible for implementing computer systems to meet those goals. A bachelor's degree and experience is required although many IT managers have a graduate degree. An understanding of technology as well as management is required.

Computer and Information Research Scientists

Computer and information research scientists invent and design new approaches to computing technology and find innovative uses for existing technology. They study and solve complex problems in computing for business, science, medicine, and other fields. Typically requires a Ph.D. but in some cases a bachelor's degree is sufficient.

Computer Systems Analysts

Computer systems analysts study an organization's current computer systems and procedures and design information systems solutions to help the organization operate more efficiently and effectively. They bring business and information technology (IT) together by understanding the needs and limitations of both. Analysts need a bachelor's degree, typically in computer science or information technology.

Information Security Analysts

Information security analysts plan and carry out security measures to protect an organization's computer networks and systems. Their responsibilities are continually expanding as the number of cyberattacks increases. Most positions require a bachelor's degree; however, employers may prefer an MBA.

Software Developers

Software developers are the creative minds behind computer programs. Some develop the applications that allow people to do specific tasks on a computer or another device. Others

¹⁰ Bureau of Labor Statistics, Occupational Outlook Handbook

develop the underlying systems that run the devices or that control networks. Software developers usually have a bachelor's degree.

Database Administrators

Database administrators use specialized software to store and organize data, such as financial information and customer shipping records. They make sure that data are available to users and are secure from unauthorized access. Database administrators usually have a bachelor's degree and related experience.

Network and Computer Systems Administrators

Computer networks are critical parts of almost every organization. Network and computer systems administrators are responsible for the day-to-day operation of these networks. They organize, install, and support an organization's computer systems, including local area networks (LANs), wide area networks (WANs), network segments, intranets, and other data communication systems. Most employers require a bachelor's degree.

Computer Network Architects

Computer network architects design and build data communication networks, including local area networks (LANs), wide area networks (WANs), and intranets. These networks range from small connections between two offices to next-generation networking capabilities such as a cloud infrastructure that serves multiple customers. Network architects must have extensive knowledge of an organization's business plan to design a network that can help the organization achieve its goals. Employers typically require at least a bachelor's degree, although an MBA is preferred.

Computer Programmers

Computer programmers write and test code that allows computer applications and software programs to function properly. They turn the program designs created by software developers and engineers into instructions that a computer can follow. In addition, programmers test newly created applications and programs to ensure that they produce the expected results. If they do not work correctly, computer programmers check the code for mistakes and fix them. Most computer programmers have a bachelor's degree.

Appendix II

Computer Occupations LQs by California County¹¹

County	County Name	2015 Jobs	2025 Jobs	2015 - 2025 Change	2015 - 2025 % Change	Annual Openings	Avg. Hourly Earnings	2025 Location Quotient
6085	Santa Clara	120,074	145,488	25,414	21%	4,554	\$58.71	3.95
6037	Los Angeles	104,575	117,097	12,522	12%	3,051	\$41.51	0.77
6073	San Diego	50,660	58,825	8,165	16%	1,687	\$42.82	1.14
6059	Orange	48,925	55,416	6,491	13%	1,497	\$42.07	1.05
6075	San Francisco	47,942	66,541	18,599	39%	2,782	\$49.46	2.73
6001	Alameda	34,739	41,045	6,306	18%	1,230	\$47.05	1.60
6081	San Mateo	28,892	35,596	6,704	23%	1,176	\$53.58	2.52
6999	[California, county not reported]	26,981	36,432	9,451	35%	1,458	\$40.24	2.65
6067	Sacramento	23,328	26,081	2,753	12%	673	\$40.62	1.23
6013	Contra Costa	11,913	13,966	2,053	17%	413	\$47.79	1.11
6071	San Bernardino	9,030	10,532	1,502	17%	311	\$36.57	0.43
6065	Riverside	7,460	8,919	1,459	20%	281	\$35.03	0.37
6111	Ventura	7,336	8,350	1,014	14%	231	\$41.51	0.73
6083	Santa Barbara	5,282	6,321	1,039	20%	195	\$41.12	0.89
6061	Placer	4,691	5,603	912	19%	178	\$37.12	0.99
6029	Kern	4,564	5,274	710	16%	154	\$39.82	0.47
6041	Marin	4,189	4,602	413	10%	113	\$44.34	1.08
6019	Fresno	4,032	4,730	698	17%	141	\$33.23	0.38
6097	Sonoma	3,577	4,120	543	15%	117	\$39.58	0.59
6113	Yolo	2,855	3,423	568	20%	109	\$35.37	1.00
6053	Monterey	2,370	2,541	171	7%	58	\$39.63	0.39
6099	Stanislaus	2,183	2,525	342	16%	73	\$37.45	0.41
6079	San Luis Obispo	2,178	2,906	728	33%	115	\$35.15	0.68
6087	Santa Cruz	2,141	2,161	20	1%	47	\$37.26	0.59
6077	San Joaquin	2,081	2,576	495	24%	89	\$32.09	0.33

¹¹ Economic Modeling Specialists Intl.

County	County Name	2015 Jobs	2025 Jobs	2015 - 2025 Change	2015 - 2025 % Change	Annual Openings	Avg. Hourly Earnings	2025 Location Quotient
6095	Solano	1,956	2,204	248	13%	59	\$40.00	0.46
6017	El Dorado	1,342	1,609	267	20%	51	\$36.78	0.84
6007	Butte	1,215	1,570	355	29%	59	\$30.65	0.57
6107	Tulare	998	1,215	217	22%	41	\$30.77	0.24
6047	Merced	715	829	114	16%	25	\$28.92	0.32
6089	Shasta	690	819	129	19%	26	\$28.86	0.38
6055	Napa	579	718	139	24%	26	\$35.40	0.26
6023	Humboldt	500	519	19	4%	11	\$27.22	0.33
6025	Imperial	432	532	100	23%	18	\$28.25	0.22
6057	Nevada	428	511	83	19%	17	\$33.26	0.46
6069	San Benito	350	532	182	52%	25	\$49.20	0.81
6039	Madera	331	398	67	20%	13	\$29.69	0.23
6045	Mendocino	261	292	31	12%	8	\$27.21	0.26
6115	Yuba	243	241	-2	-1%	5	\$32.58	0.33
6101	Sutter	221	276	55	25%	10	\$32.63	0.27
6031	Kings	217	275	58	27%	10	\$33.20	0.17
6109	Tuolumne	160	173	13	8%	4	\$32.94	0.29
6033	Lake	144	177	33	23%	6	\$27.47	0.30
6093	Siskiyou	138	169	31	22%	6	\$29.33	0.38
6005	Amador	105	125	20	19%	4	\$32.75	0.32
6035	Lassen	102	108	6	6%	3	\$30.64	0.33
6103	Tehama	93	110	17	18%	4	\$30.82	0.20
6015	Del Norte	86	105	19	22%	4	\$25.84	0.40
6027	Inyo	83	91	8	10%	2	\$36.50	0.34
6009	Calaveras	70	88	18	26%	3	\$28.76	0.28
6063	Plumas	63	81	18	29%	3	\$30.21	0.38
6051	Mono	50	56	6	12%	2	\$37.20	0.26
6043	Mariposa	48	66	18	38%	3	\$30.45	0.36
6011	Colusa	46	65	19	41%	3	\$30.76	0.22
6021	Glenn	35	46	11	31%	2	\$31.65	0.14

County	County Name	2015 Jobs	2025 Jobs	2015 - 2025 Change	2015 - 2025 % Change	Annual Openings	Avg. Hourly Earnings	2025 Location Quotient
6105	Trinity	18	22	4	22%	Insf. Data	\$28.85	0.21
6049	Modoc	16	18	2	13%	Insf. Data	\$30.48	0.20
6003	Alpine	13	23	10	77%	1	\$46.61	1.08
6091	Sierra	<10	<10	Insf. Data	Insf. Data	Insf. Data	Insf. Data	0.24
		573,749	685,138	111,389	19%	21,185	\$46.20	

This report uses state data from the California Labor Market Information Department

Appendix III

Selected Competitor Program Descriptions¹²

California State University, Los Angeles

The program is designed to prepare students for doctoral research, college teaching, public school teaching, or for careers in computer science. The department is well equipped with computer hardware, software, and modern computer laboratories.

The graduate enrollment in the computer science program currently exceeds 100 students and has gradually increased since the program's inception. The department has made special efforts to schedule evening classes to accommodate professionals who wish to continue their education.

Thesis and non-thesis options.

University of Southern California

The M.S. in Computer Science provides intensive preparation in the concepts and techniques related to the design, programming, and application of computing systems. Students are provided a deep understanding of both fundamentals and important current issues in computer science and computer engineering so that they may either obtain productive employment or pursue advanced degrees.

The program requires the student to take a broad spectrum of courses, while simultaneously allowing for emphasis in desired areas of specialization.

Areas of specialization: Computer Networks, Computer Security, Data Science, Game Development, High Performance Computing and Simulation, Intelligent Robotics, Multimedia and Creative Technologies, Software Engineering, Scientists and Engineers

University of California, Los Angeles

The Department of Computer Science and the John E. Anderson Graduate School of Management offer a concurrent degree program that enables students to complete the requirements for the MS in Computer Science and the MBA in three academic years. Graduate degree programs in computer science prepare students for leadership positions in the computer field. A total of nine courses is required for the M.S. degree.

Option of thesis or comprehensive exam.

¹² As provided on program websites

Areas of emphasis: Artificial Intelligence, Computational Systems Biology, Computer Science Theory, Computer System Architecture, Graphics and Vision, Information and Data Management, Network Systems, & Software Systems

California Polytechnic State University, San Luis Obispo

The MS program in Computer Science offers students the opportunity to prepare for careers in several areas of emphasis including software engineering, computer architecture, programming languages, theory of computing, operating systems, database systems, distributed computing, computer networks, artificial intelligence, computer graphics, and human computer interaction. The program is designed for maximum flexibility to allow students to concentrate in one or more areas of study.

University of California, Santa Barbara

The graduate program offers a Master of Science and a Ph.D. in Computer Science. The research interests of students and faculty span a broad cross-section of computer science ranging from bioinformatics, cloud computing, computer architecture, computational science and engineering, database and information systems, foundations and algorithms, intelligent and interactive systems, networks and wireless networks, operating systems and distributed systems, programming languages, quantum computing, software engineering and security.

Students must choose one major area: theory, systems, or applications.

Thesis, project, or exam options for MS students.

California State University, Fullerton

The program objectives of the master's degree in computer science are:

- To prepare you for the increasingly sophisticated application of computers to the needs of industry and society;
- To prepare you for research, teaching, and further graduate studies in computer science;
- To prepare you for leadership roles in your industry career;
- To provide you with graduate level course work in computer science that supplements the curriculum in other disciplines.

Elective tracks include software engineering, database & web programming, computer networks & security, distributed systems, machine intelligence, bioinformatics, and computer graphics & multimedia.

Department also offers an MS in Software Engineering.

National University

The Master of Science in Computer Science (MSCS) program at National University provides students with a solid foundation in the fundamental knowledge and skills of software engineering, database theory and design and cloud computing, exposing them to best practice methodologies using a variety of tools and techniques required for solving real world problems and to be of immediate benefit to the computing industry.

National University's MSCS program not only prepares students in the theoretical and practical aspects of solving complex computing problems but also develops other essential communication skills. MSCS graduates are able to clearly discuss issues, trends, and solutions with both technical and non-technical audiences. In addition, every part of the curriculum is devoted towards developing people skills, ethics, and standards of professionalism.

The rigorous scientific and analytical techniques taught in the MSCS program have four primary goals: (1) to provide a clear understanding of scope and limitations of computational models, (2) to facilitate acquisition of marketable skills throughout the program, (3) to facilitate logical discussion of concepts, trends and issues including cloud computing and security in computing, and underlying problem solving strategies, and (4) to facilitate lifelong learning. National University's approach to teaching in the MSCS program allows graduates to immediately become highly productive members of a real-world computing team.

Specializations: Advanced Computing, Software Engineering, and Database Engineering

Naval Post Graduate School

The national security focus woven through the computer science curriculum and research is unique among higher education institutions. Discipline skills in the context of national security concerns are taught, making computer science directly relevant to the national security thinking, operations, practice, and research. The institution maintains numerous connections with national security people and makes them available to students.

Students learn to be individual thinkers -- able to question, provide well-grounded assessments, extract the essence of other works, and write well-reasoned reports -- as they approach national security issues.

Students do not have to be military, but they do have to be sponsored.

Also offers Master of Arts in Identity Management and Cyber Security, Master of Science in Software Engineering, and Master of Computing Technology.

Stanford University

MSCS students choose one of ten predefined specializations or a combination of any two specializations (dual depth). There is some overlap between the different specializations, as some courses can be applied to more than one specialization.

Specializations: Artificial Intelligence, Biocomputation, Computer and Network Security, Human-Computer Interaction, Information Management and Analytics, Mobile and Internet Computing, Real-World Computing, Software Theory, Systems, and Theoretical Computer Science

Only the systems specialization can be completed entirely remotely.

Also offers joint Computer Science MS/MBA and Computer Science MS/Law degrees.

University of California, Berkeley

The Master of Science emphasizes research preparation and experience, and for most students is a chance to lay the groundwork for pursuing a PhD. It requires either a research thesis (Plan I) or a report on a research project (Plan II). It is possible to complete the degree in a single academic year, but most students take three to four semesters while they are also filling in undergraduate prerequisites they may be missing, preparing for PhD preliminary exam, and becoming involved in a research group.

Also offers a MS in Electrical Engineering and Computer Science as well as a joint MS in Electrical Engineering and Computer Science and Public Policy.

Master in Advanced Study of Integrated Circuits offered online