Graduate Faculty Senate

Meeting Minutes

September 29, 2020; 1:30-3:00 PM
https://umsystem.zoom.us/j/92868757513

Azlin Mustapha, Anita Cowan, Corinne Valdiva, Dana Martin, Keith Greenwood, Lissa Behm-Morawitz, Julija Sukys, Chris Daniggelis, Erin Robinson, Ashley Siebenaler, Mick Calcutt, Miram Butler, Jesse Wyatt, Rajiv Mohan, Candace Kuby, Stevanie Neuman, Athanasios Micheas, Gary Yao, Chad Rose, Wilson Freyermuth, Chris VanPool, Sue Boren, Gui DeSouza, Yi Shang, Alan Parrish, Tony Lupo, Jeni Hart

1. Call to order
   1:31pm

2. Acceptance of the agenda
   Motioned-Keith Greenwood
   Seconded- Julija Sukys

3. Approval of minutes from August 25, 2020 meeting
   Motioned- Erin Robinson
   Seconded – Mick Calcutt

4. Committee Reports:

   a. Academic Affairs – Prof. Keith Greenwood, chair
      i. Approval of any new course requests:
      For review, go to https://nextcatalog.missouri.edu/courseadmin/
      (after you log in, click on AAC-GFS Vote in the Quick Searches box on the far right)

      Dr. Micheas – questioned Plant Science 8441 being the same as Stat 4540, 7540and and Nat Res 7110 7110 very close to one of their classes
      Before approval would like clarification.
      Hold - Nat R 7110, Plant Science 8441 for further clarification.
      Remainder of classes have been approved-unanimously

      ii. New Programs and Program Changes:
         1. Graduate Certificate in Digital Merchandising (New)
            Dept. of Textile & Apparel Mgmt., HES; Prof. Jung Ha-Brookshire

            Dr. Ha Brookshire presented proposal – see proposal below. Wanting to add 4 classes to program that can assist students with target marketing. All online and can be offered to persons in industry that would like to update knowledge and for current students.
            K. Greenwood- eligibility question- language for eligibility, take out bachelor's degree in Textile & Apparel Mgmt.
            A. Mustapha- concern for higher fee – fee is to cover high cost for materials
            C. Valdivia – question regarding who is teaching (TA's) – to help elevate instructors schedule so they can teach Graduate level classes.
            Discussion – concern for tuition costs. Programs can charge what they would like as market allows.

Motioned to approve – Rajiv Mohan
Seconded – Keith Greenwood
Approved - unanimous

2. Accelerated M.S. in Biological Engin. (New)
Dept. of Biomed., Biol. & Chem. Engin., CoE; Prof. Gary Yao

Dr. Gary Yao presented proposal. (see below for proposal)
Based on existing courses and do not need to create any new courses
Offers both thesis and non-thesis programs.
Mustapha – net revenue and new graduate finance model. Students that are "graduate student" could work as a TA to possibly offset costs to department.

Motioned to approve - Rajiv Mohan
Seconded – Keith Greenwood
Approved - unanimous

3. Graduate Certificate in Data Analytics Engin. (New)
Dept. of Electrical Engin. & Computer Sci., CoE; Prof. Yi Shang

Dr. Yi Shang presented proposal (see proposal below)
Mustapha – will there be competition – should not be because of technical level experience. They will be working more with computer language; emphasis will be different. Focus is for data engineers rather than data analyst.

Discussion: none
Motioned- Keith Greenwood
Seconded – Gui Desouza
Approved- unanimous

4. Graduate Certificate in Neural Engin. – Signals, Systems & Machine Learning (New)
Dept. of Electrical Engin. & Computer Sci., CoE; Profs. Satish Nair & Dominic Ho

Discussion is carried over from August meeting pending questions.
GPA requirement corrected to 3.0
Minimum credits corrected to 12 hours

Motioned for approval – Keith Greenwood
Seconded – Sue Boren
Approved unanimous

b. Awards – Prof. Chad Rose, chair

Graduate students have been notified and committee will be notified when applicants have been added to the canvas sight.

c. Policy subcommittee – Prof. Alan Parrish, chair

No updates

5. Continued discussion on ITAP appeal process and GFS ad hoc committee – Prof Gui DeSouza

   Has not received any additional feedback. ITAP has agreed to change wording in guidelines that video has to be recorded unrehearsed and unedited.

6. Report: Graduate School – Dean Jeni Hart

Graduate students concerned with Rec fee who lived outside Columbia and never use. Rec services has reopened waiver form for students who would like to be exempt from these fees. Student affairs will review applications.
Graduate students that live in campus housing who test positive of COVID-19 and need to isolate– will be offered reimbursement for hotel/food or offered optional housing.
Chancellor has donated money on behalf of the Graduate school to Tiger Pantry. Majority of students who use the pantry are Graduate and International students.
Chancellor has set aside 500,000 for bridge funding. More information is forthcoming.
Number of institutions have suspended doctoral programs because of funding.
Undergrad applications are significantly down nationwide which can have implications for Graduate programs.

Last week, homeland security restricting J-1 visa, Organizations are working on options to address this issue which will have a large impact on Graduate students

Whitehouse executive order limiting inclusive/diversity training, legal council is working on issue.

Graduate education week – October 12-16th. More information will be sent out first part of October.

7. Report: Liaison to Faculty Council – Prof. Tony Lupo

   Q/A with Dr. Choi and Dr. Ramchand – discussed issues with COVID and data, comparison to other schools.

8. Report: Graduate Professional Council – Mr. Jesse Wyatt, GPC Representative

   Trying to roll out “celebrate graduate students” on social media.

9. Resolutions

   None

10. Adjournment

    2:52 pm

GRADUATE CERTIFICATE PROGRAM PROPOSAL COVERSHEET
Graduate Faculty Senate Approval Form

Name of Proposed Graduate Certificate Program

Digital Merchandising

Proposal Contact Person

Name: Jung Ha-Brookshire Academic Title: Department Chair and Professor

Campus Address: 137 Stanley Hall

E-mail Address: habrookshirej@missouri.edu Phone: 573-864-4133

Signature Date

Approval Signatures

Graduate Studies Director(s)*	1.	Jung Ha-Brookshire	Jeghaerne	8/21/2020
	2.	Bimal Balakrishnan	B.I	8/21/2020
		Printed Name	Signature	Date
Department Chair(s)*	1.	Jung Ha-Brookshire	Jeghaerne	8/21/2020
	2.	Bimal Balakrishnan	B.I	8/21/2020
		Printed Name	Signature	Date
Academic Unit Dean(s)*	1.	Brenda Lohman	Brenda Lohman	09/10/20
	2.			
		Printed Name	Signature	Date
Graduate School Dean		Jeni Hart		
		Printed Name	Signature	Date
Graduate Faculty Senate President				
		Printed Name	Signature	Date
Provost				
		Printed Name	Signature	Date
Chancellor				
		Printed Name	Signature	Date
UM Vice President For Academic Affairs				
		Printed Name	Signature	Date

Proposal Submission Check List

☑Coversheet with necessary signatures
☑Clear statement of the educational objective
☑Indication certificate is stand-alone, for degree-seeking or both
☑Explanation of a demonstrated need
☑Assessment of impact on existing graduate degree programs
☑Course work list
☑Sample plan of study and the proposed completion timeline
☑Explanation of the management structure
☑A blank Plan of Study Form
☑Send this packet in c/o Ruth Erwin to the Graduate School, 210 Jesse Hall

*Add additional signature pages if necessary

Revised 11/07

Proposal for Graduate Certificate in Digital Merchandising

Jung Ha-Brookshire
Chair, DGS, and Professor of Textile and Apparel Management

Program Objective:

To enhance new knowledge and skills in digital merchandising for today's fashion/retail industry professionals who have been out of school for at least 7+ years by providing a short-term, micro-credential graduate certificate program, 100% online. **CIP Code: 52.1902 Fashion Merchandising**

Upon completion of the certificate program, students will be able to:

- Propose new digital merchandising strategies that would enhance digital commerce after analyze best practices in crafting merchandise assortments, web copy, photography, SEO, and other key techniques; comparing all major costs of running digital commerce, such as shipping, returns, marketing, inventory management, and/or fulfillment.

- Create brand growth strategies in digital commerce space after evaluating digital branding processes in products, place, pricing, and promotions.

- Develop new digital marketing strategies after analyzing digital marketing tools currently available for business and marketing communications, such as google analytics and visualization tools; and evaluating the interaction between the marketers and the consumers on digital marketing channels, including email, text and various social media platforms.

- Evaluate appropriateness of digital data visualization techniques and software tools for a visualization task at hand after learning the principles and various techniques of information visualization.

- Create overall digital commerce strategies by applying branding, merchandising, marketing and data visualization knowledge and techniques.

This will be a stand-alone graduate certificate independent of our MS program to serve a greater group of potential students. However, current TAM graduate students may take these courses as part of their degree if they want to do so. A post-baccalaureate, non-degree seeking student may also enroll in a stand-alone certificate program *as long as* the admission standards for the certificate are met. This certificate could also be part of Stackable Degree, M.S. in Business. The students could complete additional certificates to eventually earn MS in Business that MU already offers.

Eligibility of students: Students with Bachelor's degree in fashion, retailing, and/or related areas, or equivalent professional/industry experiences in the field.

Needs:

The industry is transforming into digital commerce, both B2B and B2C. In the fashion and retail industries, digital technology is known to increase sales, make the cost structures clear and transparent, and make each step of the value chain better, faster, and cheaper (McKinsey & Co., 2020). For example, on-time manufacturing is now possible through digital data. Digitalization promotes innovative ways of recruit, service, and maintain consumer loyalty. Predicting and managing inventory is virtually impossible without digital technology. The fundamental enabler to all this will be data—the transparency, governance, and accuracy of which have never been more important (McKinsey & Co., 2020).

The experts claim that companies that were digitally and analytically mature outperformed competitors that do not have robust digital and analytics capabilities. The COVID-19 crisis has only widened the gap between industry leaders and laggards. Retailers and fashion brands are pressured to transform their businesses to digitalization from planning/merchandising and product development to marketing and e-retailing.

All of these changes suggest that new talents and skills are necessary—particularly at the middle manager level. Professionals with about 10-20 years of industry experiences were never educated on digital commerce nor digitalization of fashion. Although they have valuable industry experiences, they lack the knowledge and skills that they need to digitalize the fashion.

Currently, University of North Texas is the only program (that we know of) that offers graduate certificate in digital retail and merchandising; however, the information about this program is virtually non-existent, not sure what courses are included, nor if these are offered online or not. We believe UNT's program is mostly for their regular MS program but do not want to complete the whole 36- credit hour MS program. Drexel University has a MS program in Retail and Merchandising. However, this requires 2 years to complete with full time course work. Also, this program is not specific to digital merchandising.

Based on the search, we feel confident that our graduate certificate in digital merchandising is the only online graduate certificate, that requires short-term, providing micro-credential certificate that today's workforce desires. With the TAM faculty reputation in research and teaching, this first-of-its-kind program will have no problem recruiting students.

We target this program to industry professionals with about 5 plus years of experiences in the fashion industry. Approximately 1.8 million people are employed in the U.S. fashion industry. Out of those 145,000 people are in apparel wholesaling or merchandising roles. We target apparel wholesale (or brands) or merchandising professionals specifically. Not only the US but also the whole world professionals.

Even if we target just 0.1% of the 145,000 brands and merchandising professionals, our potential students can be 145 people. With appropriated and targeted marketing, we could easily recruit them as these are key skills sets that today's businesses are looking for right now. Our certificate is also accomplishable in a short period of time with relatively inexpensive costs. It is one of the micro-credentials that today's workforce is seeking.

Relationship with current TAM graduate programs

Mizzou TAM is known to be the educational leaders in the field. PhD graduates are faculty members in major universities in the nation. Recent graduates are now faculty members at University of Georgia, West Virginia University, Florida State University, University of Rhode Island, Kent State University, Texas Tech, Oklahoma State, and many more. We provide rigorous curricula in both teaching and research, and we are known to be the producers of the next generation of professors in the field.

With the changes in the industry, Mizzou TAM is now seeking ways to share faculty's expertise in research and teaching with industry professionals who seek additional educational/professional development opportunities in digital merchandising.

The DM certificate will compliment current MS and PhD programs in TAM by provide focused areas of course contents. DM certificate students could use the course credits to purse MS or PhD in the future. DM certificate program can be a feeder for MS and PhD. DM certificate program will further enhance the visibility and brand of MS and PhD programs in TAM as the leader in the field.

Required coursework

The graduate certificate in digital merchandising will require students completing 4 online courses, or 12 credit hours. The courses are:

- Branding, TAM 7300 (3 hrs; Dr. Li Zhao, Assistant Professor in TAM): This course addresses the management of branding product lines produced by textile and apparel firms; strategic implications of the development of brand equity toward increasing customer loyalty.

- Digital merchandising, TAM 7600 (3 hrs; Dr. Caroline Kopot, Assistant Professor in TAM): The course presents a comprehensive overview of the quickly evolving world of digital merchandising across all electronic channels, with an emphasis on textiles and apparel. The students learn the architecture and functionality of websites, mobile apps, and social media, and the successful techniques being utilized to optimize sales and profits. Specific attention will be given to methods of visual product display, feature and attribute descriptions, navigation and filtering options, and overall ease of use from entry through shopping cart in order to build a relationship with the customer. Sales, gross margin, expenses, and net profit will be discussed throughout as the students analyze the decisions that digital merchants are faced with: product category selection, expense of marketing, shipping, and returns, and overall competition for ever demanding customers in a crowded field.

- Digital marketing for fashion, TAM 7000 (3 hrs, Dr. Song-yi Youn, Assistant Professor in TAM): This course develops an understanding of digital marketing strategies and provides executional considerations when fashion companies perform marketing plans within digital channels. Students will utilize analytical and critical thinking skills as they apply the latest technologies to develop integrated marketing strategies across various digital platforms.

- Information visualization and visual analytics, Arch St 7962 (3 hrs, Dr. Bimal Balakrishnan, Associate Professor in Arch St): This course addresses the foundation for information visualization and deals with external representation and interactive manipulation of information, data or artifacts using digital tools to enhance communication, analytical reasoning and decision-making.

All of these courses are already approved and being taught either at the undergraduate level (in 4000 level courses) or at the graduate level. Additional adjustments are necessary to target industry professionals, which is not a huge task and all faculty who are currently teaching these courses agreed to do so. The entire graduate faculty in TAM and Arch St already reviewed this plan, and unanimously approved it as of August 2020.

The course from Arch St offers unique capabilities that TAM alone does not fully possess, which will be highly appreciated by potential students. Two courses will be offered every semester. Students can complete the certificate in 9 months (fall and spring) or 12 months (spring and fall) if they take 2 courses per semester. Students can also complete this in 2 years if they take only 1 class per semester. The following courses will be available/offered to all students.

Fall 2021:	TAM 7300, TAM 7000
Spring 2022:	TAM 7600, Arch St 7962

Management structure:

Director of this program will provide administrative oversight, including but not limited to, accepting participants, maintaining participants' files, and assessing participants' progress toward completion of the certificate program.

- Jung Ha-Brookshire, Professor and Department Chair, 137 Stanley Hall, habrookshirej@missouri.edu, 882-6316

If the program grows above 20, TAM will hire additional faculty (.2 FTE) who will be 100% responsible for this program.

Online class teaching mentor: Dr. Kerri McBee-Black will serve as an online class teaching mentor during the development and initial implementation stages of this certificate program. She has been an e-Mentor on campus for several years at Mizzou and maintains an Online Teaching Certificate and serves as a Quality Matters Online Course Reviewer for the University of Missouri campus.

Advisory committee will provide comments and suggestions for digital merchandising curricula and professional development opportunities.

- Hope Horn, Retired, Former e-Commerce Chief at Brown Shoes company, Developed TAM 4600 as an adjunct faculty at Mizzou TAM, a TAM Industry Advisory Board member
- Jake Hammel, Senior director, Talent & Social at Create & Cultivate, Digital marketing guru in New York, a TAM alum, a TAM Industry Advisory Board member
- Dana Zumbo, Business Development, Zappos Adaptive Team (a request to join has been made).

Participating faculty members:

All TAM faculty are already teaching or have taught these classes at the undergraduate level. Once the program is approved, the department will release one course from their current teaching assignments, to teach these new graduate courses. For example,

- Li Zhao will be teaching TAM 7300 in fall instead of TAM 2400
- Song-yi Youn will be teaching TAM 7000 in fall instead of TAM 3800
- Caroline Kopot will be teaching TAM 7600 in spring instead of TAM 2100
- Bimal Balakrishnan is already teaching Arch St 7962 in spring

Capacity for student advising: We anticipate anywhere between 10 and 20 students when the program starts. The Director of the program will be able to advise all them. The course offering and requirements are fairly simple, so the anticipated amount of time required for advising is not extensive. Mizzou Online staff can also help advising. By year 3, when the total number goes beyond 20, the department will hire .25 FTE advisor.

Annual evaluation plans: Director of the Program will conduct annual evaluation plans with each student as we do for our current graduate students. Each student will be evaluated for academic progress (satisfactory or unsatisfactory) based on grades as well as one-on-one meeting.

Resources:

The Chair of TAM is committed to find/pay for other instructors to cover TAM 2400, 3800 and 2100 (anywhere from $12,000 if adjunct - $22,000 if graduate students). The department has sufficient balance to cover this cost in the endowment fund that is specifically designated for graduate education and faculty professional development. The Chair will utilize that money to cover instructors for these 3 courses. There is no course buy-out is necessary in Arch St, given the course is already being taught.

The program fee is proposed at $677.80 per credit hour, or $282.90 higher than Graduate online tuition fee of $394.90 (please note that we will be seeking the approval from the MU Finance Leadership once the program is approved). If we were to recruit a minimum of 10 students initially, TAM will generate about $61,000 net new revenue. Arch St will get about $20,334. This net new revenue will sufficiently cover the faculty salary to offer 3 in TAM and 1 in Arch St classes going forward. More specifically,

- A differential course fee will be proposed at $677.80/credit hour, or $282.90 higher than Graduate online tuition fee of $394.90. This is the same rate that of Arch St is currently charging for its graduate online program. Supplemental fee for HES is $60.90/credit hour. See projected revenue and cost below. Please note that our numbers are very conservative in estimates. We feel confident that we can meet this goal given the demand in the marketplace. Even if the differential fee is not approved, the department is committed to offer this new program because the revenue is still greater than the cost.

- Instruction costs for (10 students Y1, 15 students Y2, and 20 students Y3-Y5) – No new net cost for teaching the 4 classes will be required. Instead, we will need to hire adjunct or doc students to teach 3 classes that these instructors are currently teaching. That cost is expected from
$12,000-$22,000).

- How many faculty FTE and TA (0.5FTE) needed to support the instructions? – 0.4 FTE of faculty total (.1 for each faculty X 4 courses), and no new TAs are needed as each faculty's current TA can help this work.

- By Year 3, when we have more than 20 students, we will have .25 Academic Advisor with the new revenue generated.

Scenario A: Differential tuition fee of $677.80

	Min Target # of Students/# of SCH	Course Fee per Cr Hr	HES Supplemental Fee per Cr Hr	New Revenue to the University	New cost of Instruction	Net New Revenue to the University
Yr 1	10/120	$677.80	$60.9	$88,644	$22,000	$66,644
Yr 2	20/240	$677.80	$60.9	$177,288	$22,000	$155,288
Yr 3	40/480	$677.80	$60.9	$354,576	$22,000 + $17,000 (.25 Advisor)	$315,576

Scenario B: Regular tuition fee of $394.90

	Min Target # of Students	Course Fee per Cr Hr	HES Supplemental Fee per Cr Hr	New Revenue to the University	New cost of Instruction	Net New Revenue to the University
Yr 1	10/120	$394.90	$60.9	$54,696	$22,000	$32,696
Yr 2	20/240	$394.90	$60.9	$109,392	$22,000	$87,392
Yr 3	40/480	$394.90	$60.9	$218,784	$22,000 + $17,000 (.25 Advisor)	$179,784

Graduate Certificate Plan of Study

Submit to the Graduate School, 210 Jesse Hall.

Student name: _____

Mizzou ID number: _____

Certificate program: Digital Merchandising

Anticipated certificate completion date: _____

_____ *(if applicable)* _____

Academic program: Textile and Apparel Management

Degree (i.e. MS, MA, PhD): _____ Major: _____

Consult the Graduate Catalog for a list of approved graduate certificates.

Proposed Plan of Study: List the course numbers, course titles, number of credit hours and the term in which the courses have been/will be taken. The certificate Plan of Study must be approved by the official certificate coordinator.

Course number	Title	Hours	Semester/Year	Grade
TAM 7000	Branding	3	Fall /21	
TAM 7000	Digital marketng for fashion	3	Fall/21	
TAM 7600	Digital merchandising	3	Spring/22	
Arch St 7962	Information visualization and visual analytics	3	Spring/22	

Total Hours (12 graduate hours minimum) 12

The program of study is approved as stated. Subsequent changes must be reported on a Program of Study Course Substitution form.

_____ _____

Student signature Date Graduate dean's signature Date

_____

Certificate coordinator's signature Date

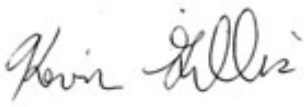
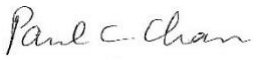
DO NOT WRITE IN THIS BOX (office use only)

Date copies sent to the coordinator: _____

ACCELERATED GRADUATE PROGRAM PROPOSAL COVER SHEET

College or School:	**College of Engineering**
Department:	**Biomedical, Biological & Chemical Engineering**
Program Title:	**Accelerated MS Degree Program in Biological Engineering**
Degree:	**Master's Degree in Biological Engineering**
Implementation Semester:	**Spring 2021**
First Graduation:	**Fall 2022**
Author of Proposal:	**Gang Yao**
Program Contact:	**Gang Yao, YaoG@missouri.edu, 884-7529**

SIGNATURES

Director of Graduate Studies:	**Gang Yao**	
Department Chair:	**Kevin Gillis**	
Dean of School/College:	**Paul Chan**	

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Executive Summary

The Department of Biomedical, Biological & Chemical Engineering (BBCE) proposes to establish an accelerated Master's program that allows a high-preforming student to earn a BS degree in Biomedical Engineering (BME) or Biological Engineering (BE) plus an MS degree in Biological Engineering in five years.

An MS degree enables BME/BE students to access many job opportunities not available to those only with a BS degree. In past, our undergraduate students have been taking advantage of the "dual-enrollment" program offered by the Graduate School, which allows them to take graduate-level courses as an undergraduate. Most of these students eventually enrolled in our MS programs and obtained an MS in BE at a faster pace than regular students. However, the current dual-enrollment program does not have a clear structure to guide interested students. And it only counts 6 hours of the dual-enrollment graduate credits toward the undergraduate degree.

This proposed accelerated BS+MS program will establish a structured curricular path that benefits participating students with a shortened study duration, significant financial savings, and early engaging mentorship. It not only helps to attract our high-achieving undergraduates to join our graduate program here at MU, but also serves as a highlighting feature for recruiting high quality students to our undergraduate programs. Similar 5-year BS+MS programs are already offered by some academic programs here at MU and many BME/BE programs at other peer universities.

The eligible participants for this program will be BME and BE students who have completed at least 90 credit hours with a cumulative GPA of 3.0 and higher. The academic requirements of the accelerated MS program will be the same as our existing MS programs which require a total of 30 credit hours to graduate. Accepted undergraduate students can take 12 hours of graduate level courses that will count toward both the undergraduate and the graduate degrees. Once they obtain 127 hours in BME or 126 in BE, the corresponding bachelor's degree will be conferred and they will become graduate students in our MS programs to complete the remaining 18 hours of graduate credit.

This proposed program will be built on our existing MS programs. All courses needed are currently available with a significant number of them being offered online. Thus, implementing this accelerated MS program will not incur any burden on departmental resources. On the contrary, the additional tuition revenue will improve and strengthen our capacity to better serve our students.

Accelerated MS Degree in Biological Engineering

1. Introduction

The Department of Biomedical, Biological & Chemical Engineering (BBCE) offers Bachelor of Science (BS) in Biological Engineering (BE) and Biomedical Engineering (BME). The department also awards Doctor of Philosophy (PhD) and Master of Science (MS) degrees in BE. There are usually ~50 graduate students enrolled in BE graduate programs each year. During the past three years, we graduated ~5 PhD and ~9 MS students each year in average. An MS degree allows our students to access many job opportunities not available to those only with a BS degree. Most of our MS graduates went to industry, others continued to attend medical schools or PhD programs.

In past, undergraduate students in BME and BE have been taking advantage of the "dual - enrollment" program offered by the Graduate School, which allows them to take graduate courses as an undergraduate. Many such students eventually enrolled in our MS programs and obtained an MS in BE at a faster pace than regular students. However, the current dual- enrollment program does not have a well-structured curricular path to guide interested students. And it only counts 6 hours of the dual-enrollment graduate credits toward the undergraduate degree.

To better serve our high-achieving undergraduates, the BBCE department proposes to establish a formal accelerated MS program that allows a student to earn a BS+MS in BE in five years.
Similar 5-year BS+MS programs are already offered by some academic programs here at MU and many BME/BE programs at other peer universities.

The eligible participants for the proposed accelerated BS+MS program will be our current BE/BME undergraduates who have completed at least 90 credit hours with a cumulative GPA of 3.0 and higher. Once admitted, these students are considered as provisional graduate students. They still pay undergraduate rate for their coursework and are eligible for undergraduate financial aid. They can take up to 12 hours of credits that count toward both the undergraduate and the graduate degrees ("dual-enrollment" credits). Once they obtain 127 hours in BME or 126 in BE, the corresponding bachelor's degree will be conferred and they will become graduate students in our MS programs.

The academic requirements of the proposed accelerated MS program will be the same as our existing MS programs. BBCE offers both thesis (MST) or non-thesis (MSNT) based MS degrees that require a total of 30 credit hours to graduate. Both MST and MSNT students will work closely with their advisors to develop a research project and explore a research topic in depth. MST students spend a significant amount of time working on their research projects such as reading literature, collecting & analyzing data, writing manuscripts and thesis. They can take up to 12 hours of Master's Research. A research thesis is required and must conform to the
Graduate School' specifications. The MSNT degree requires more coursework (≥27 hours).

These courses allow MSNT students to explore a range of topics, and develop new skill sets in the field of bioengineering. In lieu of a thesis, MSNT students are required to conduct an independent project and complete a research report approved by the examination committee.

The Director of Graduate Studies in Biological Engineering will work with the Director of Undergraduate Studies, undergraduate academic advisors, and BBCE faculty to ensure a proper management of this proposed program.

2. Business-Case: Criteria and Justification

2.A. Benefits for Students and for the Program

An MS degree in BE/BME is attractive to many students because it allows them to access many job opportunities not available to those with only a BS degree. This proposed accelerated MS program provides multiple benefits to our high-achieving undergraduate students who are interested in obtaining an MS degree. Its key dual-enrollment component can count 12 credit hours of graduate courses for both the BS and MS degrees. In addition to its tuition saving benefit, such dual-enrollment effectively allows a student to earn an MS degree in 1-year after a 4-year BS degree. Moreover, participating students are still eligible for undergraduate financial aid while taking graduate-level courses as an undergraduate student.

Besides the shortened study duration and significant financial benefits, this proposed BS+MS program provides a structured curriculum and encourages interested students to involve in research earlier, which promotes close and early interactions between students and faculty. Overall, this program provides great incentive for our high-performing undergraduates to join our MS program here at Mizzou. Based on experience learned from other similar programs, many students and their families will consider a 1-year MS degree as a “perk” of the BS programs. Therefore, this accelerated program can also become a highlight point in recruiting quality students to our undergraduate programs, which will subsequently feed more eligible students to our graduate programs.

2.B. Student Demand for Program

Many undergraduate students have been interested in earning an MS degree at accelerated pace. Some have taken advantage of the dual-enrollment program that allows them to take graduate level courses as an undergraduate. In average, about 3 students each year chose to take the dual-enrollment credits even though only 6 hours of dual-enrollment graduate courses count toward their undergraduate degrees and they cannot use undergraduate financial aid to pay for the graduate level courses. Majority of these participating students eventually enrolled in our graduate programs.

This proposed accelerated 4+1 MS program provides a formal and more structured system to advise participating students. This proposed program provides significant incentive to encourage those who meet the criteria to participate and eventually complete an MS degree here at MU. Therefore, we expect this new program will attract more students than the previous “dual-enrollment” program.

In order to estimate the potential enrollment, Table 1 shows the GPA distributions of our current BE/BME undergraduates at the time when they completed 90 credit hours. The data were provided by the MU Students' Services.

Table 1. GPA distribution of BE/BME undergraduates who completed 90 credit hours during the past three years.

Academic Year	2016-2017	2017-2018	2018-2019
GPA≥3.0	43	37	32
GPA≥3.2	33	33	28

The data in Table 1 shows that there are around 30 students who can meet the eligibility requirements. As a conservative estimation, we expect similar enrollment in the first year as in previous "dual-enrollment" program, which is about 10% of our current eligible students. We believe the number will gradually increase to 30% in five years. Using these estimations, Table 2 shows the project enrollment in the proposed program for fall semester of the first five years.

Table 2. Student Enrollment Projections (anticipated total number of students enrolled in program during the fall semester of given year).

Year	1	2	3	4	5
Projected Enrollment	3	5	6	8	10

2.C. Departmental Capacity

This proposed accelerated MS program is built on our exiting MS degree programs in Biological Engineering. We expect only a moderate increase in graduate enrollment which will not affect the departmental capacity for teaching and advising. On the other hand, although this program is mainly designed to benefit our high-preforming undergraduate students, the additional tuition revenue will improve and strengthen our department's capacity to better serve our students.

2.C.1. *Impact on Resources*

This proposed program will be easily managed with existing departmental resources. First, no new course development is needed. We currently offer more than 40 graduate level courses in Biological Engineering. The majority of our graduate courses are taught in small class sizes (5~15 enrollments). Therefore, faculty teaching load will not be affected by the addition of this accelerated MS program. Secondly, the department has 22 core faculty members and 30 affiliated faculty members who are actively advising our graduate students in Biological Engineering. The anticipated addition of new accelerated MS students will not have any significant impact on faculty advising.

In case the program becomes exceedingly successful and student enrollment increases more than expected, the department can use the additional revenue generated to provide more resources to support this program, for example, by hiring a NTT faculty to teach and advise this program.

2.C.2. *Revenue*

The main purpose of this new program is to help our current high-preforming undergraduate students to earn an MS degree at an accelerated pace. However, any increase in graduate student enrollment will also bring in additional revenue to the department.

According to the Graduate School's guideline on Accelerated Graduate Degree Programs, a participating student is still charged at the undergraduate rate for the 12 credit hours of dual- enrollment graduate courses. Therefore, this program does not affect the tuition and fees a participating student pays as an undergraduate. For the graduate portion of the program, each student will pay graduate tuition/fees for the remaining 18 credit hours. Therefore, the revenue from each enrolled student is: $394.90×18=$7,108.20 in tuition and $218.9×18=$3,940.2 in engineering course fees, which totals at $11,048.40. This is "net" new revenue, as many of these high-preforming students would otherwise not pursue their graduate education here at MU or immediately after their bachelor's degree.

2.C.3. *Net Revenue*

As discussed previously, this proposed program does not incur additional cost or need additional resources to the department. We expect the majority of the students in the accelerated MS program would focus on completing course requirements during their 1-year period as a graduate student, instead of seeking additional duties that may stretch their study period. However, we acknowledge that once these students become graduate students, they would be eligible to apply for assistantships in forms of Graduate Research Assistant (GRA) or Graduate Teaching Assistant (GTA). GRAs are offered by individual faculty members using funding from their research sponsors, which are expected to also cover the tuition costs. The department does cover the tuition for GTAs. However, the number of the GTAs we appoint depends on the undergraduate enrollment, not the number of eligible graduate students.

Therefore, the addition of these new graduate students will not cause any tuition loss to the department. The tuition and course fees paid by these students should be considered as "net" revenue for our department. Table 3 summarizes the estimated net revenue for the first five years of the program based on the enrollment projections listed in Table 2.

Table 3. Net revenue projections based on enrollment projection listed in Table 2.

Year	**1**	**2**	**3**	**4**	**5**
Net Revenue	$33,145.20	$55,242.00	$66,290.40	$88,387.20	$100,484.00

2.D. Business and Marketing Plan: Recruiting and Retaining Students

This proposed program is designed for our current undergraduate students in BME and BE. The original "dual-enrollment" option has already been included in our undergraduate student handbooks. The Director of Undergraduate Studies and academic advisors identify eligible students and inform them about the program. Those efforts will continue under this new accelerated program. Therefore, we do not anticipate additional marketing cost for the accelerated program. This formal accelerated MS program will be highlighted in our exiting undergraduate marketing materials and introduced during perspective students and families'visits.

Students entering the accelerated program will receive advising from both undergraduate and graduate advisors. At the time of acceptance, a faculty advisor will be assigned to supervise the student's enrollment and undergraduate research. Faculty members are identified based on student's interest and chosen emphasis area. They will continue to serve as the graduate advisor after the bachelor's degree is conferred and the student becomes an official graduate student. This early and continuous advising will help to bond students with their faculty advisors, which benefits student retention.

3. Program Characteristics

3.A. Program Outcomes

The primary goal of our graduate program is to ensure graduate students receive an optimal education in biological engineering to be successful in their chosen career. This proposed accelerated MS program will achieve the same goal. Graduate students gain advanced subject- specific knowledge by taking supporting courses, while at the same time, perform mentored, but successively more independent, research studies. All graduate students in Biological Engineering are expected to:

- possess advanced knowledge in their chosen emphasis areas;
- be able to design, develop, and conduct complex studies with confidence;
- be able to work efficiently with people in different fields if part of an interdisciplinary team;
- effectively communicate scientific results orally and in writing.

3.B. Program Structure

The BBCE currently offers both thesis (MST) or non-thesis (MSNT) based MS degrees in Biological Engineering. Both require a total of 30 graduate credit hours beyond the bachelor's degree and a research project. MST students can take 6 to 12 hours of Master's Research (BIOL_EN 8990) and are required to complete a Master's thesis conforming to the Graduate School' specifications. MSNT students must take a minimal of 27 hours of graduate courses (excluding research and problems course) and complete a project report approved by the examination committee. In both programs, a minimum of 15 hours must be from courses at the 8000 level or above.

Students admitted to the accelerated MS program will take 12 hours of graduate courses as part of their undergraduate degree (as a provisional graduate student). These courses can be selected based on the student's chosen tracks (emphasis or proficiency areas) from cross-level listed Technical Elective Courses (at 7000 level). After becoming a graduate student, they will complete the remaining requirement of 18 credit hours. Most of the courses taken as a graduate student will be at 8000 level or above.

To broaden our graduate students' perspectives, our graduate programs require a student to take courses from at least two different "proficiency areas" including bioprocessing engineering, bioenvironmental engineering, bioelectronics and instrumentation, biomaterials, biomedical Innovation, biophotonics and bioimaging, and biosensing. A detailed list of available courses is provided as part of the Program Structure Form below.

Once the student receives the bachelor's degree and become a graduate student, they will have the same rights and responsibilities of all graduate students at the University of Missouri. They are eligible to apply all the financial support available, including fellowships and assistantships offered at the department, college, and campus levels.

PROGRAM STRUCTURE FORM

(1) *Total credits required for graduation (must be at least 138 total credit hours):*

a. Total undergraduate credits: 127 for BS in BME, 126 for BS in BE

b.Total of dual-enrollment credits: 12

c. Total graduate credits: 30

(2) *Residency requirements, if any: N/A*

(3) *Example schedules to complete the MS*

Table 4 shows an example schedule to complete the accelerated MS program. The proposed accelerated program is based upon existing graduate degree programs. All courses listed here are currently offered.

Table 4. An example schedule to complete the accelerated MS program.

	MS-Thesis	**MS-Non thesis**
Year 1 (Provisional Graduate Student)	• undergraduate courses • a 7000+ level BE tech elective (3) • a 7000+ level BE tech elective (3) • a 7000+ level BE tech elective (3) • a 7000 level statistics course (3)	• undergraduate courses • a 7000+ level BE tech elective (3) • a 7000+ level BE tech elective (3) • a 7000+ level BE tech elective (3) • a 7000 level statistics course (3)
Year 2 (Graduate Student)	• BE 8402 Research Methods (2) • BE 8087 Graduate Seminar (1) • BE 8180 Numerical Methods (3) • BE 8000 level elective #1 (3) • BE 8000 level elective #2 (3) • BE 8990 MS Research (6)	• BE 8180 Numerical Methods (3) • another 7000+ level courses (3) • BE 8000 level elective #1 (3) • BE 8000 level elective #2 (3) • BE 8000 level elective #3 (3) • BE 8085 Problems (3)
Total	30	30

Note: ≥15 hours must be from 8000 level and above. Coursework has to be from at least two different proficiency areas.

List of Technical Elective Courses by Proficiency Area

(A student needs to take at least one course from a minimum of two different areas)

- Bioprocess Engineering

BIOL_EN 7315 – Introduction to Bioprocess Engineering
BIOL_EN 7316 – Biomass Refining Operations
BIOL_EN 7160 – Food Process Engineering
BIOL_EN 8280 – Advanced Biological Transport Processes
BIOL_EN 7001 – Biomanufacturing Technologies BIOL_EN
8001 – Advanced Bioprocessing & Biocatalyst

- Bioenvironmental Engineering

BIOL_EN 7150 – Soil and Water Conservation Engineering
BIOL_EN 7250 – Irrigation and Drainage Engineering BIOL_EN
7350 – Watershed Modeling Using GIS
BIOL_EN 7450 – Environmental Hydrology BIOL_EN
7560 – Observing the Earth from Space BIOL_EN
8250 – Water Management Theory

- Bioelectronics and

Instrumentation BIOL_EN 7070 –
Bioelectricity
BIOL_EN 7075 – Brain Signals and Brain Machine Interfaces (online)
BIOL_EN 7310 – Feedback Control Systems
BIOL_EN 7380 – Applied Electronic Instrumentation
BIOL_EN 7540 – Neural Models and Machine Learning
BIOL_EN 7590 – Computational Neuroscience
BIOL_EN 8380 – Modeling and Identification of Engineering Systems

- Biomaterials

BIOL_EN 7170 – Biomaterials Interfaces of Implantable Devices
BIOL_EN 7370 – Orthopaedic Biomechanics (online)
BIOL_EN 7480 – Physics and Chemistry of Materials (online) BIOL_EN
8370 – Materials Characterization Techniques (online) BIOL_EN 8670
– Orthopaedic Failure Modes and Defect Analysis BIOL_EN 8870 –
Molecular and Cell Mechanics
BIOL_EN 8001 – Tissue Engineering

- Biomedical Innovation

BIOL_EN 8000 – Scientific Discovery Leading to Life Science Innovations (online)
BIOL_EN 8004 – Regulatory Issues in Clinical Research and Clinical Trials (online)
BIOL_EN 8100 – Design and Development of Biomedical Innovations (online) BIOL_EN
8200 – Commercialization of Life Science Innovations (online)

- Biophotonics and Bioimaging

BIOL_EN 7420 – Introduction to Biomedical Imaging (online)
BIOL_EN 7570 – Fluorescent Imaging
BIOL_EN 7770 – Biomedical Optics (online)
BIOL_EN 7970 – Nuclear Magnetic Resonance and Magnetic Resonance Imaging (online) BIOL_EN
8270 – Principles and Applications of Fluorescence
BIOL_EN 8570 – Microscopic Imaging
BIOL_EN 8970 – Nuclear Magnetic Resonance and Magnetic Resonance Imaging (online)

- Biosensing

BIOL_EN 7470 – Biomolecular Engineering and Nanobiotechnology BIOL_EN
7670 – Photonics and Nanotechnologies in Optical Biosensors BIOL_EN 8170
– Sensors and Biosensors
BIOL_EN 8470 – Ultrasensitive Bio-detection
BIOL_EN 7001 – Wearable Biomedical Devices
BIOL_EN 8001 – Bioelectronics & Biosensors

(4). *Requirement for thesis or other capstone experience:*

All MS students have to complete an independent research project supervised by their faculty advisors. A master's thesis is required for MST students. It must conform to the Graduate School's thesis specifications. A project report is required for MSNT students and has to be approved by the examination committee. During their last semester in the program, students must defend their thesis or project report in front of an examination committee composed of their graduate advisor and at least two other faculty members.

(5). *Any additional features of the program:*

A large number of graduate courses in biological engineering have been developed into online offerings. In addition to our on-campus MS programs, we also offer a 100% online non-thesis MS degree. All online courses are available to both remote and on-campus students, which provides flexibility for students to complete their MS degrees.

3.C. Program Goals and Assessment

The biological engineering graduate programs will be reviewed year-round at faculty meetings to review graduate course offerings, graduate student admission, and academic requirements. To ensure the quality of the MS graduates, all graduate students will be required to maintain a minimum GPA of 3.0 throughout the program. The student's advisor and examination committee will examine the independent research project and report carefully to assess the student's understanding of the subject area and ability to communicate effectively.

3.D. Student Requirements and Admissions

Current undergraduate students in Biological Engineering and Biomedical Engineering who have completed at least 90 hours (including all general education and academic program requirements) with a cumulative GPA of 3.0 and above are eligible to apply.

The general admission requirements and deadlines are the same as in our regular graduate programs. However, as this program is designed to attract high-achieving undergraduate students, the department will provide additional incentives in admission including:

(1) waived application fee,
(2) waived GRE scores, and
(3) a minimum of one recommendation letter from a BBCE faculty member.

All admitted students are required to participate in undergraduate research by enrolling in BIOL EN 4990 or 4995H. A faculty member is designated at the time of acceptance to advise the student's study and research.

3.E. Faculty and Administration

The Director of Graduate Studies will be responsible for this proposed accelerated MS program. They will work with the Director of Undergraduate Studies, academic advisors, and biological engineering graduate faculty to ensure the success of this propose program. All courses will be taught by existing instructors who are either BBCE core or affiliated faculty members. All graduate faculty in Biological Engineering are active researchers conducting interdisciplinary research. Many of them have joint/adjunct appointments with other academic programs in engineering, medicine, CAFNR, and Arts & Science. Such a diverse yet synergetic faculty body is unique at MU and provides an excellent environment to educate and train the next generation scientists and engineers with knowledge and skills crossing traditional boundaries.

Appendix A

Accelerated Graduate Program in Biological Engineering Student Agreement Contract
Department of Biomedical, Biological & Chemical Engineering

Accelerated graduate programs blend the 4th year of the undergraduate degree and the 1st year of the master's degree. These programs have been created for high-achieving and high-quality students who have the ability to complete a bachelor's and a master's at an accelerated pace. If you are accepted by both the Graduate School at the University of Missouri and the Department of Biomedical, Biological & Chemical Engineering, you will be admitted as a provisional graduate student to the Department of Biomedical, Biological & Chemical Engineering's Accelerated Graduate Program. Once you obtain 120 hours, you will become a **graduate student**, which gives you the rights and responsibilities of all graduate students at the University of Missouri.

Students being considered for an accelerated graduate program must have a **cumulative** GPA of ≥3.2 and have completed at least 90 hours which includes all general education and academic program requirements. Please attach a degree audit to this document.

The Department of Biomedical, Biological & Chemical Engineering has determined that your bachelor's degree will be awarded when:

- ❒ the requirements of the bachelor's degree have been met
- ❒ the requirements of the master's degree have been met.

With regard to financial aid, you may wish to consult MU's Office of Student Financial Aid to determine your options. Once you become a Graduate Student at the University of Missouri, you **are not** eligible for Federal Pell Grants; however, you are eligible for Federal Financial Aid. Additionally, you are eligible for fellowships, and teaching/research assistantships through the Department of Biomedical, Biological & Chemical Engineering. Fellowships and assistantships may allow you to receive a tuition coverage.

I attest that I agree to the conditions of the Accelerated Graduate Program:

_____ _____
Applicant Date

_____ _____
Undergraduate Adviser Date

_____ _____
Director of Undergraduate Studies Date

_____ _____
Department Chair/Director of Grad Studies Date

_____ _____ _____
Graduate School Received Date Approved by the Graduate School Date

GRADUATE CERTIFICATE PROGRAM PROPOSAL COVERSHEET

Graduate Faculty Senate Approval Form

Name of Proposed Graduate Certificate Program

Data Analytics Engineering

Proposal Contact Person

Name: Yi Shang Academic Title: Professor

Campus Address: 207 Naka Hall

E-mail Address: shangy@missouri.edu Phone: 573-884-7794

Yi Shang 11/19/2019

Signature Date

Approval Signatures

		Printed Name	Signature	Date
Graduate Studies Director(s)*	1.	Yi Shang	Yi Shang	11/19/2019
	2.			
Department Chair(s)*	1.	Syed Islam		11/19/2019
	2.			
Academic Unit Dean(s)*	1.			
	2.			
Graduate School Dean				
Graduate Faculty Senate President				
Provost				
Chancellor				
UM Vice President For Academic Affairs				

Proposal Submission Check List

- ☐ Coversheet with necessary signatures
- ☐ Clear statement of the educational objective
- ☐ Indication certificate is stand-alone, for degree-seeking or both Explanation of a demonstrated need
- ☐ Assessment of impact on existing graduate degree programs Course work list
- ☐ Sample plan of study and the proposed completion timeline Explanation of the management structure
- ☐ A blank Plan of Study Form
- ☐ Send this packet in c/o Ruth Erwin to the Graduate School, 210 Jesse Hall

*Add additional signature pages if necessary

Revised 11/07

Gainful Employment Reporting and Disclosure Template

Part 1: Department of Education Mandated Submission Template: Complete the highlighted selections below by typing in the *"Click here to enter text"* boxes.

1. **Institution Name:** University of Missouri-Columbia

2. **OPEID:** 002516

3. **Program Name/CIP Code:** Graduate Certificate in:
Data Analytics Engineering

4. How the institution determined need for the program:

As companies try to collect and mine data for business-enhancing insights, the demand for data-related jobs will only increase. In 2011, a report from McKinsey suggested a national shortage of as many as 190,000 people with "deep analytical skills" by the end of 2018. Now we're midway through 2019, and according to data from Burning Glass's Nova platform, which analyzes millions of active job postings, "data engineer" and "data scientist" remains the top tech jobs. The January report from Indeed, one of the top job sites, showed a 29% increase in demand for data engineers and scientists year-over-year and a 344% increase since 2013 -- a dramatic upswing. Similarly, data from technology job site Dice showed the number of data science job postings on its platform -- as a proportion of total posted jobs -- has increased about 32% year over year, and the site considers data science a "high-demand skill." Dice noted that the job postings are from companies in a wide variety of industries, not just tech.

Demand for data engineers and data scientists will only grow, as organizations increasingly rely on data-driven insights. The rise of AI and machine learning is also a factor in the dramatic increase in demand for data engineers. The EECS department has a large group of outstanding faculty with very strong well-funded research programs related to Data Engineering and Data Science. An extensive set of high quality courses in these areas are being offered by the department. In recent years, an increasing number of graduate students have been attracted to the CS and ECE MS and PhD programs due to the strength of the department in these areas.

At MU, the existing Data Science & Analytics (DSA) program offers an MS in DSA and a Graduate Certificate in DSA. Both are online programs with online courses only, and are mainly for non-resident working professionals. DSA plans to offer on-campus versions of the MS and Graduate Certificate based on the current online courses plus some on-campus problem sessions. The DSA courses are mainly taught by NTT faculty for students from various disciplines without much computer science background and knowledge in programming, algorithms, and computer systems.

In contrast, this certificate program is based on existing EECS courses related to data engineering fundamentals, techniques and methodologies, taught by tenure-track/tenured faculty, and targeted for students with strong programming, algorithm, and computing background. Its goal is to produce graduates that are proficient in programming, algorithms, and distributed and cloud systems for the analysis of various types of data.

This certificate program will draw student from many disciplines who are interested in advanced data analytics engineering skills.

The program will strengthen interdisciplinary education and research at MU, enhance MU's standing among peer research institutions, ability to recruit more high-quality graduate students, and collaboration with industries.

5. How the program was designed to meet local market needs:

Data engineers design, manage, and optimize the flow of data within an organization. In an age of big data, it is one of the most important and in-demand jobs. Data science is an interdisciplinary area of scientific processes, methods, systems, and algorithms to obtain knowledge or insights from data. The field combines data analysis, statistics, and machine learning and their associated methods to gain an understanding and evaluate data. Data engineers and data scientists are the main positions in Data Science and are among the most sought-after positions in America.

While there is frequent collaboration between data scientists and data engineers, they are different positions that prioritize different skill sets. Data engineers have advanced programming skills and an understanding of distributed systems and data pipelines for developing and managing distributed systems for the analysis of large volumes of data. They are tasked with designing, building, processing, testing, integrating, managing, and optimizing data from a variety of sources.

In contrast, data scientists focus on applying advanced statistics and mathematical analysis to find new insights from the data that was generated, cleaned and prepared for them by data engineers. Data scientists regularly interact with the data infrastructure, but they don't build or maintain it.

The goal of this graduate certificate is to prepare students and professionals to understand the fundamentals and advanced skills in data analytics engineering. It enables the graduating students to address the growing need for data engineering and data science professionals who are trained in advanced data analytics and can collect, process, and transform large streams of data into understandable and actionable information for the purpose of making decisions.

The EECS department has a large group of outstanding faculty with very strong well-funded research programs related to Data Engineering and Data Science. An extensive set of high quality courses in these areas are being offered by the department. In recent years, an increasing number of graduate students have been attracted to the CS and ECE MS and PhD programs due to the strength of the department in these areas.

The impact on existing DSA MS and Graduate Certificate program is minimal because the target students and teaching focus are quite different. The proposed program focuses more on fundamentals and in-depth techniques of programing, computing systems, and algorithms for information and data processing, whereas the DSA program focuses more on using existing tools to analyze and understand data in various disciplines. The proposed program is based on high-quality existing CS and ECE graduate courses taught by regular EECS faculty.

6. Narrative description of any wage analysis completed by the institution:

There are thousands of Data Engineering and Data Science jobs posted on job websites, such as Indeed.com, LinkedIn.com, and ZipRecruiter.com. The jobs are well paid. For example, according to Glassdoor.com, the salary range of Data Engineering in St. Louis, Missouri area is $72k-$136k per year.

7. Graduate Certificate Program Review and Approval Process:

Graduate Certificates offered by the University of Missouri- Columbia (MU) verify the successful completion of a specified group of graduate courses designed to provide proficiency in a given discipline or a set of related disciplines. The didactic material for a graduate certificate may represent a more practice-oriented subset of an existing graduate discipline. Graduate Certificate programs are developed by MU faculty experts within the academic disciplines and each certificate must adhere to the MU Graduate Faculty Senate's requirements; certificate proposals are required to demonstrate a need for such a program (e.g. market and educational needs) and offer a clear and appropriate educational objective.

MU's Graduate Faculty Senate, in conjunction with the Vice Provost for Advanced Studies and Dean of the School, completes the initial review of all Graduate Certificates. Once approved by Graduate Faculty Senate, Graduate Certificates are reviewed by the highest levels of MU's academic administration - the Office of the Provost and the Office of the Chancellor. If approved by these two offices, Graduate Certificates are subject to review by the University of Missouri System's Office of the Vice President for Academic Affairs. If approved by the UM System's Vice President for Academic Affairs, Graduate Certificates are subjected to the final review of the Missouri Department of Higher Education. If approved by the Missouri Department of Higher Education, Graduate Certificates are submitted individually to the U.S. Department of Education for approval of federal financial aid eligibility.

Since Graduate Certificates are derived from currently offered degree programs and received appropriate approval from the Missouri Department of Higher Education, it is our understanding from our communication with Dr. Karen Solomon at the Higher Learning Commission (HLC) that "if the certificates are derived from currently offered degree programs then there does not to be a Commission review." Hence, the letter provided from the HLC in June 2008 concerning Certificates still applies and is included.

8. Date of first day of class:

January 20, 2021

9. Normal time to complete the program in weeks:

Two semesters, 32 weeks.

Part 2: Gainfiul Employment Reporting Requirements: Please provide the information below. MU is required by the U.S. Department of Education to report this infomration.

Certificate description:

Data science is an interdisciplinary area of scientific processes, methods, systems, and algorithms to obtain knowledge or insights from data. Data engineers design, manage, and optimize the flow of data within an organization. The goal of this graduate certificate is to prepare students and professionals to understand the fundamentals and advanced skills in data analytics engineering. It enables the graduating students to address the growing need for data engineering and data science professionals who are trained in advanced data analytics and can collect, process, and transform large streams of data into understandable and actionable information for the purpose of making decisions.

The 12 credit hour Graduate Certificate will be offered as a stand-alone certificate.

List of courses in the certificate program (12 credit hours with 3.0 or above GPA are required for completion).

- Required (6 credit hours)
  - CMP_SC 7380 - Database Management Systems I
  - CMP_SC 8370 - Data Mining and Knowledge Discovery
- Electives (Students select two of the following courses)
  - CMP_SC 7350 - Big Data Analytics
  - CMP_SC 7530 - Cloud Computing
  - CMP_SC 7650/ECE 7655 - Digital Image Processing
  - CMP_SC/ECE 7720 - Introduction to Machine Learning and Pattern Recognition
  - CMP_SC 8530 - Cloud Computing II
  - CMP_SC 8630 - Data Visualization
  - CMP_SC 8650 - Advanced Image Processing
  - CMP_SC 8690 - Computer Vision
  - CMP_SC/ECE 8725 - Supervised Learning
  - CMP_SC/ECE 8735 - Unsupervised Learning
  - CMP_SC 8740 - Advanced Natural Language Processing
  - CMP_SC 8790 - Filtering, Tracking and Data Fusion
  - ECE 8810 - Advanced Digital Signal Processing
  - CMP_SC 8860 - Parallel and Distributed Processing
  - ECE 8860 - Probability and Stochastic Processes for Engineers

Number of semesters required to complete: The typical student would take 2 to 3 courses a semester (not including summer) and finish in 2 semesters.

Certificate web site:
https://engineering.missouri.edu/academics/eecs/eecs-degrees/

Contact information: Yi Shang
Email: shangy@missouri.edu
Phone: 573-884-7794
Address: 207 Naka Hall

Tuition for completing this program within normal time:
~$5,000

Associated fees:
0

Typical costs for books and supplies:
$400

Related occupational titles and codes:
As part of the federal disclosure, MU is required to report prospective occupations for certificate holders. Titles can be found in the US Department of Labor's database, O*Net OnLine.

- Go to http://www.onetonline.org/ .
- Click **Find Occupations**.
- Type a keyword in the search box.
- Hit go. Scan the list for feasible titles.
- Click on a title to review its summary.
- If it matches your certificate, copy the job title, occupational code, and the URL link to the summary page.

Please list **10** related occupations below:

Code	Occupation	Summary Link
15-1111.00	Computer and Information Research Scientists	https://www.onetonline.org/link/summary/15-1111.00
33-3021.06	Intelligence Analysts	https://www.onetonline.org/link/summary/33-3021.06
15-1199.04	Geospatial Information Scientists and Technologists	https://www.onetonline.org/link/summary/15-1199.04
15-1132.00	Software Developers, Applications	https://www.onetonline.org/link/summary/15-1132.00
11-3021.00	Computer and Information Systems Managers	https://www.onetonline.org/link/summary/11-3021.00
13-1161.00	Market Research Analysts and Marketing Specialists	https://www.onetonline.org/link/summary/13-1161.00
19-2099.01	Remote Sensing Scientists and Technologists	https://www.onetonline.org/link/summary/19-2099.01
15-1199.02	Computer Systems Engineers/Architects	https://www.onetonline.org/link/summary/15-1199.02
15-1131.00	Computer Programmers	https://www.onetonline.org/link/summary/15-1131.00
15-1199.08	Business Intelligence Analysts	https://www.onetonline.org/link/summary/15-1199.08

Graduate Certificate Plan of Study

Submit to the Graduate School, 210 Jesse Hall.

Student name: _____

Mizzou ID number: _____

Certificate program: _____

Anticipated certificate completion date: _____

(if applicable)

~~Academic program: _____ _____~~

Degree (i.e. MS, MA, PhD): Major: _____

_____

Consult the Graduate Catalog for a list of approved graduate certificates.

Proposed Plan of Study: List the course numbers, course titles, number of credit hours and the term in which the courses have been/will be taken. The certificate Plan of Study must be approved by the official certificate coordinator.

Course number	Title	Hours	Semester/Year	Grade

Total Hours (12 graduate hours minimum) _____

The program of study is approved as stated. Subsequent changes must be reported on a Program of Study Course Substitution form.

_____ _____

Student signature Date Graduate dean's signature Date

_____

Certificate coordinator's signature Date

DO NOT WRITE IN THIS BOX (office use only)	Date copies sent to the coordinator: _____

University of Missouri
Department of EECS

Graduate Certificate in Data Analytics Engineering

Approved by EECS Faculty on 11/19/2019

Educational Objective

Data engineers design, manage, and optimize the flow of data within an organization. In an age of big data and AI, it is one of the most important and in-demand jobs. Data science is an interdisciplinary area of scientific processes, methods, systems, and algorithms to obtain knowledge or insights from data. The field combines data analysis, statistics, and machine learning and their associated methods to gain an understanding and evaluate data. Data engineers and data scientists are the main positions in Data Science and are among the most sought-after positions in America.

While there is frequent collaboration between data scientists and data engineers, they are different positions that prioritize different skill sets. Data engineers have advanced programming skills and an understanding of distributed systems and data pipelines for developing and managing distributed systems for the analysis of large volumes of data. They are tasked with designing, building, processing, testing, integrating, managing, and optimizing data from a variety of sources.

In contrast, data scientists focus on applying advanced statistics and mathematical analysis to find new insights from the data that was generated, cleaned and prepared for them by data engineers. Data scientists regularly interact with the data infrastructure, but they don't build or maintain it.

The purpose of this graduate certificate is to prepare students and professionals to understand the fundamentals and advanced skills in data analytics engineering. It enables the graduating students to address the growing need for data engineering and data science professionals who are trained in advanced data analytics and can collect, process, and transform large streams of data into understandable and actionable information for the purpose of making decisions.

Certificate Type

The 12 credit hour Graduate Certificate will be offered as a stand-alone certificate.

Date of first day of class

Spring semester, 2021

Demonstrated Need and Market Analysis

As companies try to collect and mine data for business-enhancing insights, the demand for data-related jobs will only increase. In 2011, a report from McKinsey suggested a national shortage of as many as 190,000 people with "deep analytical skills" by the end of 2018. Now we're midway through 2019, and according to data from Burning Glass's Nova platform, which analyzes millions of active job postings,

“data engineer” and “data scientist” remains the top tech jobs. The January report from Indeed, one of the top job sites, showed a 29% increase in demand for data engineers and scientists year-over-year and a 344% increase since 2013 -- a dramatic upswing. Similarly, data from technology job site Dice showed the number of data science job postings on its platform -- as a proportion of total posted jobs -- has increased about 32% year over year, and the site considers data science a "high-demand skill." Dice noted that the job postings are from companies in a wide variety of industries, not just tech.

Demand for data engineers and data scientists will only grow, as organizations increasingly rely on data-driven insights. The rise of AI and machine learning is also a factor in the dramatic increase in demand for data engineers.

The EECS department has a large group of outstanding faculty with very strong well-funded research programs related to Data Engineering and Data Science. An extensive set of high quality courses in these areas are being offered by the department. In recent years, an increasing number of graduate students have been attracted to the CS and ECE MS and PhD programs due to the strength of the department in these areas.

At MU, the existing Data Science & Analytics (DSA) program offers an MS in DSA and a Graduate Certificate in DSA. Both are online programs with online courses only, and are mainly for non-resident working professionals. DSA plans to offer on-campus versions of the MS and Graduate Certificate based on the current online courses plus some on-campus problem sessions. The DSA courses are mainly taught by NTT faculty for students from various disciplines without much computer science background and knowledge in programming, algorithms, and computer systems.

In contrast, this certificate program is based on existing EECS courses related to data engineering fundamentals, techniques and methodologies, taught by tenure-track/tenured faculty, and targeted for students with strong programming, algorithm, and computing background. Its target is to produce graduates that are proficient in programming, algorithms, and distributed and cloud systems for the analysis of various types of data.

This certificate program will draw student from many disciplines who are interested in advanced data analytics engineering skills.

The program will strengthen interdisciplinary education and research at MU, enhance MU’s standing among peer research institutions, ability to recruit more high-quality graduate students, and collaboration with industries.

Impact on Existing Programs

The impact on existing DSA MS and Graduate Certificate program is minimal because the target students and teaching focus are quite different. The proposed program focuses more on fundamentals and in-depth techniques of programing, computing systems, and algorithms for information and data processing, whereas the DSA program focuses more on using existing tools to analyze and understand data in various disciplines. The proposed program is based on high-quality existing CS and ECE graduate courses taught by regular EECS faculty.

Course Work

List of courses in the proposed program (12 credit hours with 3.0 or above GPA are required for completion).

- Required (6 credit hours)
  - CMP_SC 7380 - Database Management Systems I
  - CMP_SC 8370 - Data Mining and Knowledge Discovery
- Electives
  - CMP_SC 7350 - Big Data Analytics
  - CMP_SC 7530 - Cloud Computing
  - CMP_SC 7650/ECE 7655 - Digital Image Processing
  - CMP_SC/ECE 7720 - Introduction to Machine Learning and Pattern Recognition
  - CMP_SC 8530 - Cloud Computing II
  - CMP_SC 8630 - Data Visualization
  - CMP_SC 8650 - Advanced Image Processing
  - CMP_SC 8690 - Computer Vision
  - CMP_SC/ECE 8725 - Supervised Learning
  - CMP_SC/ECE 8735 - Unsupervised Learning
  - CMP_SC 8740 - Advanced Natural Language Processing
  - CMP_SC 8790 - Filtering, Tracking and Data Fusion
  - ECE 8810 - Advanced Digital Signal Processing
  - CMP_SC 8860 - Parallel and Distributed Processing
  - ECE 8860 - Probability and Stochastic Processes for Engineers
  - ECE 8770/CMP_SC 8870 Modeling and Management of Uncertainty

Number of semesters required to complete: The typical student would take 2 to 3 courses a semester (not including summer) and finish in 2 semesters.

Management Structure

Designated Director:

Yi Shang, PhD, Professor, 207 Naka Hall, shangy@missouri.edu, 573-884-7794 Advisory Committee:
A committee of 3 faculty members from the Data Analytics Engineering area will serve as the review committee for the forms and procedures on a rotating basis.

Implementation and Evaluation

Advising: Yi Shang will serve as the initial contact person for the certificate and the advisory committee will approve course changes.

Evaluation: Evaluation will focus on two primary measures. First, program enrollment growth will indicate market need for this program. Second, the College of Engineering office of assessment conducts satisfaction surveys for all graduating students.

Resources Available: All faculty who are currently responsible for the courses included in the certification program will continue to instruct these courses as part of their regular load. An administrative staff in the College of Engineering will assist in managing certificate applications, admissions, and completion.

GRADUATE CERTIFICATE PROGRAM PROPOSAL
Template (modify as appropriate)

Graduate Curriculum Committee Approval Form

Name of Proposed Graduate Certificate Program

Graduate Certificate Program in Neural Engineering – Signals, Systems & Machine Learning (GRAD)

Proposal Contact Person

Name: Satish S. Nair and Dominic Ho Academic Title: Both Professors of EECS
Campus Address: 229 Naka Hall
E-mail Address: nairs@missouri.edu; hod@missouri.edu Phone: 882-2964; 882-8023

Clear statement of the educational objective

The Graduate Certificate in 'Neural Engineering – Signals, Systems & Machine Learning (GRAD)' will enable the student to gain both fundamental and applied understanding of brain signals and systems, and machine learning schemes in this rapidly growing component of neural big-data research. The program includes the study of basic concepts related to modeling the nonlinear electrical circuits in the brain which use concepts from signal processing, systems modeling and control disciplines. The students will gain expertise in understanding the fundamentals of signals, systems and machine learning tools for 'reverse engineering the brain', and also for the design of neural prostheses, and brain machine interfaces.

Indicate whether the proposed certificate is stand-alone, for degree-dependent or both

_x_ Stand-alone

__ Degree-dependent

__ Both

Indicate intended method of delivery for proposed certificate

_x_ On-ground

__ Online

__ Both

Explanation of a demonstrated need

The area of neuroscience has seen an unprecedented 592% increase in PSAT major selections among 9-11th graders (2007-2013) and a 100% increase in Ph.D. degrees awarded (2003-13)†. This surge in interest has resulted in the initiation of undergraduate majors in neuroscience at four-year institutions and at universities such as MIT, Harvard, UCLA, and University of Chicago. Indeed, a National Research Council report, *Research at the Intersection of the Physical and Life Sciences* [9], identified 'Understanding the Brain' as one of the top five grand challenges for research that will significantly benefit society, and to this end recommended development of introductory undergraduate and graduate courses at the interface of the appropriate disciplines. This, together with the recognition of 'reverse engineer the brain' as one of the 14 Grand Challenges for Engineering in the 21st century [10] and the substantial funding investment by the federal BRAIN initiative [11], represents a tremendous opportunity for engineers to collaborate with neuroscientists to tackle some of the neuro-challenges for the next century at theoretical, computational, experimental, and workforce readiness levels.

† Latimer B, Bergin DB, Guntu V, Schulz DJ, Nair SS (2019), Integrating model-based approaches into a neuroscience curriculum – An interdisciplinary neuroscience course in engineering, *IEEE Transactions on Education* 62(1) 48-56

At MU, the College of Engineering partnered with the College of Arts & Science to institute an interdisciplinary Minor in Computational Neuroscience that has been jointly administered since 2012 by Drs. Satish Nair (Engineering) and Dr. David Schulz (Biology). The minor has been very popular with students from both colleges and has even had enrollment from CAFNR students. The total enrollment to date is 52.

We have two undergraduate certificates in the submission stages presently, Neural Engineering – Signals and Neural Engineering- Systems. The purpose of this graduate certificate in Neural Engineering – Signals & Systems is to provide the same option to graduate students at an advanced level, and train them to work in neuroscience-related careers, both in industry and academia. A transcripted graduate certificate in Neural Engineering-Signals & Systems will provide students with the opportunity to pursue educational objectives beyond those normally associated with their academic major in engineering.

Audience

The proposed graduate certificate in Neural Engineering-Signals & Systems provides specialization that both academia and industry would value in graduates, including

- Individuals seeking entry-level career opportunities in biomedical technologies, e.g., Medtronics, Inc.
- Individuals seeking either graduate school opportunities in neuroscience and neural engineering, one of the fastest growing PhD areas, or to the medical school where such technologies are becoming common-place now.

A minimum GPA of 3.0 is required for admission.

Demonstration that the courses will be offered regularly
The courses will be offered each year using the following rotational plan:

Core courses (select 6 credits – any two from the three below):
1. ECE/CS 7540 Neural Models and Machine Learning (elective, offered every Spring)
2. ECE/BE 7310 Feedback Control Systems – offered every Spring OR
   ECE 7830 Introduction to Digital Signal Processing – offered every Fall
3. ECE/BE/
BME /CS 7590 Computational Neuroscience (required, offered regularly every Fall)

Support courses (select 6 credit hours; Should include one neuroscience course):
One of ECE 7XXX from the ones not taken from the above
ECE 8810 Advanced Digital Signal Processing
ECE 8860 Probability and Stochastic Processes for Engineers
ECE/CS 8570 Neural Dynamics and Communication
ECE/CS 8580 Machine Learning in Neuroscience

List of Additional Course Requirements and / or Course prerequisites:
Core courses need to be taken before or parallel to the elective courses.

List of courses that define the program / sample program of study.

Complete __6_ hours of required Core course				
Dept	**Course #**	**Description**	**Cr Hr**	**Online (Y/N)**
ECE/CS	7540	Neural Models and Machine Learning	3	N
ECE ECE	7310 7830	Feedback Control Systems OR Introduction to Digital Signal Processing	3 3	N N
ECE/CS	7590	Computational Neuroscience (Required)	4	N
Examples of suggested support courses: must choose _6_ semester hours from this list of courses. Should include at least one neuroscience course:				
ECE	7XXX	Any course not taken from the set above	3	N
ECE	8810	Advanced Digital Signal Processing	3	N
ECE	8860	Probability and Stochastic Processes for Engineers	3	N
ECE/CS	8570	Neural Dynamics and Communication	3	N
ECE/CS	8580	Machine Learning in Neuroscience	3	N

Accounting of Advising and Support Services

Sample Graduate Certificate Plan of Study

Student name:_____
Mizzou ID number:_____
Certificate program_____
Anticipated certificate completion date:_____

_____(if applicable)_____

1. Academic program:_____
2. Major_____

Consult the Graduate Catalog for a list of approved certificates.

Proposed Plan of Study: List the course numbers, course titles, number of credit hours and the term in which the courses have been/will be taken. The certificate Plan of Study must be approved by the official certificate coordinator.

Course #	Course Title	Cr Hrs	Semester	AY

Total Hours (12 graduate hours minimum) _

The program of study is approved as stated. Subsequent changes must be reported on a Program of Study Course Substitution form.

_____ _____
Student signature Date Graduate dean's signature Date

_____
Certificate coordinator's signature Date

Date copies sent to the coordinator: _____