

Brothers, Sheila C

From: Schroeder, Margaret <m.mohr@uky.edu>
Sent: Tuesday, January 31, 2017 12:14 PM
To: Brothers, Sheila C; McCormick, Katherine
Cc: Badurdeen, Fazleena F
Subject: GC in Manufacturing Systems
Attachments: MFS Grad Certificate_CompleteFinal.pdf

Proposed New Graduate Certificate: Manufacturing Systems

This is a recommendation that the University Senate approve the establishment of a new Graduate Certificate: Manufacturing Systems, in the Department of Mechanical Engineering within the College of Engineering.

Rationale:

The Department of Mechanical Engineering at the University of Kentucky proposes a four-course (12 credit hours) Graduate Certificate entitled "Manufacturing Systems ". Online, Classroom, or independent study courses taken in pursuit of the proposed certificate will provide students with experience in the application of engineering principles to manufacturing systems. It is designed for graduates with Bachelor's degrees in engineering and select other fields who meet certain prerequisites, who wish to extend their education to include the topics in manufacturing processes and systems. Recent national initiatives to refuel a 'new era of sustainable economic growth in America through Advanced Manufacturing' (Dow Chemical Report) brings to the forefront the need to develop a more competent & multidisciplinary future workforce of manufacturing engineers. This certificate program, aimed at working professionals as well as full-time students, is to meet this very need by preparing students for successful careers and professional development in manufacturing processes and systems' and to develop students with the knowledge, skills and attitude to make a significant contribution to sustainable development. Such offerings would attract professionals who experience difficulty attending classes on-campus, and provide opportunity for a level of advanced knowledge to those who lack the time and resources to complete an advanced degree.

The revised proposal is attached.

Best-
Margaret

[Margaret J. Mohr-Schroeder, PhD](#) | Associate Professor of STEM Education - Mathematics | [COE Faculty Council Vice Chair](#) | [SAPC University Senate Committee Chair](#) | [University Senator/Senate Council Member](#) | [Secondary Mathematics Undergraduate Program Chair](#) | | [Department of STEM Education](#) | [University of Kentucky](#) | www.margaretmohrschroeder.com | [Schedule a Meeting with Me](#)

NEW GRADUATE CERTIFICATE

A graduate certificate shall have a clear and focused academic topic or competency as its subject, meet a clearly defined educational need of a constituency group, such as required continuing-education or accreditation for a particular profession, respond to a specific state mandate or provide a basic competency in an emerging (preferably interdisciplinary) topic. Certificates are minimally nine graduate credit hours but typically no more than 15. Completed forms must receive appropriate department/school approval and sent to the college for review.

Once approved at the college level, your college will send the proposal to the Graduate Council for review. Once approved at the Graduate Council, the Graduate Council will send the proposal to the Senate Council office for additional review via a committee and then to the Senate Council. Once the Senate Council has approved the proposal, it is moved to the University Senate. Once approved by that body, the University Senate will send the proposal to the Registrar to be included in the Bulletin. The contact person listed on the form will be informed throughout this process.

By default, graduate certificates shall be approved for a period of six (6) years. Re-approvals are also for six years.

1. GENERAL INFORMATION			
1a	Date of contact with Institutional Effectiveness ¹ :	01/19/2016	
	<input checked="" type="checkbox"/> Appended to the end of this form is a PDF of the reply from Institutional Effectiveness.		
1b	Home college: <i>Engineering</i>		
1c	Home educational unit (department, school, college ²): <i>Mechanical Engineering</i>		
1d	Proposed certificate name: <i>Manufacturing Systems</i>		
1e	CIP Code (provided by Institutional Effectiveness):	<i>14.3601, Manufacturing Engineering</i>	
1f	Requested effective date:	<input checked="" type="checkbox"/> Fall semester following approval.	OR <input type="checkbox"/> Specific Date ³ : <i>Fall 20</i>
1g	Contact person name: <i>Fazleena Badurdeen</i>	Email: <i>badurdeen@uky.edu</i>	Phone: <i>3-3252</i>
2. OVERVIEW			
2a	Provide a brief description of the proposed new graduate certificate. (300 word limit)		
	<i>The Department of Mechanical Engineering at the University of Kentucky proposes a four-course (12 credit hours) Graduate Certificate entitled "Manufacturing Systems". Online, Classroom, or independent study courses taken in pursuit of the proposed certificate will provide students with experience in the application of engineering principles to manufacturing systems. It is designed for graduates with Bachelor's degrees in engineering and select other fields who meet certain prerequisites, who wish to extend their education to include the topics in manufacturing processes and systems.</i>		

¹ You can reach Institutional Effectiveness by phone or email (257-2873 or institutionaleffectiveness@uky.edu).

² Only cross-disciplinary graduate certificates may be homed at the college level.

³ Certificates are typically made effective for the semester following approval. No program will be made effective unless all approvals, up through and including University Senate approval, are received.

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2b	This proposed graduate certificate (check all that apply):
	<input checked="" type="checkbox"/> Has a clear and focused academic competency as its subject.
	<input checked="" type="checkbox"/> Meets a clearly defined educational need of a constituency group (e.g. continuing education or licensing)
	<input type="checkbox"/> Responds to a specific state mandate.
	<input checked="" type="checkbox"/> Provides a basic competency in an emerging, preferably interdisciplinary, topic.
2c	Affiliation. Is the graduate certificate affiliated with a degree program? (related to 3c) Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
	If "yes," include a brief statement of how it will complement the program. If "no," incorporate a statement as to how it will provide an opportunity for a student to gain knowledge or skills not already available at UK. (300 word limit)
	<i>The proposed certificate program complements the existing Masters and Doctoral programs in the Department of Mechanical Engineering (ME) on the educational, research, and departmental levels. Candidates for the proposed certificate will contribute to the educational mission of the department. They may have different educational backgrounds and experiences than typical students, and since all students (proposed certificate candidates and candidates in other programs) will take classes together, it is anticipated that peer-based student learning will be enhanced due to the expected increased academic heterogeneity of the resulting student mix. The Department, College of Engineering, and University will benefit from the: a) increased enrollments due to the enhanced visibility of Manufacturing Systems Engineering as a viable career alternative, and b) increased enrollment of women and minorities among the student population. With the online offerings, increased visibility of the department and programs will result.</i>
2d	Duplication. Are there similar regional or national offerings? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
	If "Yes," explain how the proposed certificate will or will not compete with similar regional or national offerings.
2e	Rationale and Demand. State the rationale for the new graduate certificate and explain the need for it (e.g. market demand, student requests, state mandate, interdisciplinary topic). (400 word limit)
	<i>Recent national initiatives to refuel a 'new era of sustainable economic growth in America through Advanced Manufacturing' (Dow Chemical Report) brings to the forefront the need to develop a more competent & multidisciplinary future workforce of manufacturing engineers. This certificate program, aimed at working professionals as well as full-time students, is to meet this very need by 'preparing students for successful careers and professional development in manufacturing processes and systems' and to develop students with 'the knowledge, skills and attitude to make a significant contribution to sustainable development...'. The certificate program at UK has an excellent opportunity to cater to the national, and internationally emerging, demand for manufacturing engineering education by increasing accessibility through online offerings; such offerings would attract professionals who experience difficulty attending classes on-campus, and provide opportunity for a level of advanced knowledge to those who lack the time and resources to complete an advanced degree.</i>
2f	Target student population. Check the box(es) that apply to the target student population.
	<input checked="" type="checkbox"/> Currently enrolled graduate students.
	<input checked="" type="checkbox"/> Post-baccalaureate students.
2g	Describe the demographics of the intended audience. (150 word limit)
	<i>Prospective candidates for the proposed certificate program include those who:</i> a) <i>Are currently working full-time in engineering or manufacturing careers, and who wish to expand their</i>

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<i>knowledge and expertise in manufacturing without committing to a master's degree program</i>					
b) <i>Are current graduate students in related fields who wish to expand their emphasis in manufacturing</i>					
2h Projected enrollment. What are the enrollment projections for the first three years?					
	<i>Year 1</i>	<i>Year 2 (Yr. 1 continuing + new entering)</i>	<i>Year 3 (Yrs. 1 and 2 continuing + new entering)</i>		
<i>Number of Students</i>	5	10	15		
2i Distance learning (DL). Initially, will any portion of the graduate certificate be offered via DL?				Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
If "Yes," please indicate below the percentage of the certificate that will be offered via DL.					
1% - 24% <input type="checkbox"/>	25% - 49% <input type="checkbox"/>	50% - 74% <input type="checkbox"/>	75 - 99% <input type="checkbox"/>	100% <input checked="" type="checkbox"/>	
If "Yes," describe the DL course(s) in detail, including the number of required DL courses. (300 word limit)					
<i>Students can select from a number of courses to be offered online, as outlined in the proposal document. The university has funded the conversion of four courses in the Manufacturing Systems Engineering (MFS) program to online format through the eLII program, and the College of Engineering has funded conversion of an additional eight MFS courses. These courses form the backbone of the offerings in the certificate program, as well as in the Masters in Manufacturing Systems Engineering. In addition to the online courses, students will also have the option to come on campus take any of the face-to-face courses offered.</i>					
3. ADMINISTRATION AND RESOURCES					
3a Administration. Describe how the proposed graduate certificate will be administered, including admissions, student advising, retention, etc. (150 word limit)					
<i>The certificate director, with advice from the Chair of Mechanical Engineering and Director of Graduate Studies (DGS) for the Manufacturing Systems Engineering, will administer the proposed certificate program. The certificate director will prepare advertising materials and actively market the proposed certificate. The director will review applications to the program, and with consultation from the chair and DGS as needed, will make admission decisions. Admitted students will receive individualized advising from the proposed certificate director regarding course selection. Faculty who teach students in the proposed certificate program will submit relevant grades and other performance metrics of these students to the certificate director for monitoring and, if needed, retention-oriented academic advising. Students who withdraw from the program will be counseled by the certificate director regarding cause; remediation efforts will be made if applicable.</i>					
3b Faculty of Record and Certificate Director. (related to 2c) The faculty of record consists of the graduate certificate director and other faculty who will be responsible for planning and participating in the certificate program. The director must be a member of the Graduate Faculty of the University and is appointed by the dean of the Graduate School. The faculty of record must be comprised of three or more faculty. At least three members of the graduate certificate's faculty of record must be members of the Graduate Faculty.					
The graduate certificate is affiliated with a degree program.				Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
If "Yes," list the name of the affiliated degree program below. If "No," describe below the process for identifying the faculty of record and the certificate director, including selection criteria, term of service, and method for adding and removing members. (150 word limit)					

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Manufacturing Systems Engineering		
3c	Course utilization. Will this graduate certificate include courses from another unit(s)?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
<p>If "Yes," two pieces of supporting documentation are required.</p> <p><input type="checkbox"/> Check to confirm that appended to the end of this form is a letter of support from the other units' chair/director⁴ from which individual courses will be used. The letter must include demonstration of true collaboration between multiple units⁵ and impact on the course's use on the home educational unit.</p> <p><input type="checkbox"/> Check to confirm that appended to the end of this form is verification that the chair/director of the other unit has consent from the faculty members of the unit. This typically takes the form of meeting minutes.</p>		
3d	Financial Resources. What are the (non-course) resource implications for the proposed graduate certificate, including any projected budget needs? (300 word limit)	
<i>No significant expenditure of funds is anticipated to implement the proposed certificate program. Courses included in the proposed certificate program are approved and currently offered. No new courses will be developed for this program.</i>		
3e	Other Resources. Will the proposed certificate utilize resources (e.g. departmentally controlled equipment or lab space) from additional units/programs?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
If "Yes," identify the other resources that will be shared. (150 word limit)		
<p>If "Yes," two pieces of supporting documentation are required.</p> <p><input type="checkbox"/> Check to confirm that appended to the end of this form is a letter of support from the appropriate chair/director⁴ of the unit whose "other resources" will be used.</p> <p><input type="checkbox"/> Check to confirm that appended to the end of this form is verification that the chair/director of the other unit has consent from the faculty members of the unit. This typically takes the form of meeting minutes.</p>		
4. IMPACT		
4a	Other related programs. Are there any related UK programs and certificates?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
If "Yes," describe how the new certificate will complement these existing UK offerings. (250 word limit)		
<p>If "Yes," two pieces of supporting documentation are required.</p> <p><input type="checkbox"/> Check to confirm that appended to the end of this form is a letter of support from each potentially-affected academic unit administrators.</p> <p><input type="checkbox"/> Check to confirm that appended to the end of this form is verification that the chair/director has input from the faculty members of the unit. This typically takes the form of meeting minutes.</p>		
5. ADMISSIONS CRITERIA AND CURRICULUM STRUCTURE		

⁴ A dean may submit a letter only when there is no educational unit below the college level, i.e. there is no department/school.

⁵ Show evidence of detailed collaborative consultation with such units early in the process.

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5a **Admissions criteria.** List the admissions criteria for the proposed graduate certificate. (150 word limit)
Prospective students for the proposed graduate certificate program must: 1) have a bachelor's degree in engineering from an ABET-accredited post-secondary school (or equivalent) or a bachelor's degree in technology management, business, chemistry, mathematics, physics, or other related areas, 2) earn a GPA of 3.0 or greater at the institution granting the bachelor's degree, and 3) demonstrate (via official transcript) successful completion (grade B or better) in each of 2 courses (minimum total 6 credit-hours) of college mathematics (consisting of differential and integral calculus). All three criteria must be met to be eligible for admission into the proposed graduate certificate program.

5b **Core courses.** List the required core courses below.

Prefix & Number	Course Title	Credit Hrs	Course Status ⁶
✓ MFS 505	<i>Modeling and Analysis of Manufacturing Processes</i>	3	No Change
✓ MFS 605	<i>Systems for Factory Automation and Control</i>	3	No Change
✓ MFS 606	<i>Global Issues in Manufacturing</i>	3	No Change
✓ MFS 613	<i>Sustainability, Ethics and Leadership in Manufacturing Organizations</i>	3	No Change
			Select one....
<i>Total Credit Hours of Core Courses:</i>			

5c **Elective courses.** List the electives below.

Prefix & Number	Course Title	Credit Hrs	Course Status ⁷
✓ MFS 501	<i>Mechanical Design with Finite Element Methods</i>	3	No Change
✓ MFS 503	<i>Lean Manufacturing Principles & Practices</i>	3	No Change
✓ MFS 507	<i>Design for Manufacturing</i>	3	No Change
✓ MFS 512	<i>Manufacturing Systems</i>	3	No Change
✓ MFS 513	<i>Mechanical Vibrations</i>	3	No Change
✓ MFS 556	<i>Introduction to Composite Materials</i>	3	No Change

5d Are there any other requirements for the graduate certificate? If "Yes," note below. (150 word limit) Yes No

⁶ Use the drop-down list to indicate if the course is a new course ("new"), an existing course that will change ("change"), or if the course is an existing course that will not change ("no change").
⁷ Use the drop-down list to indicate if the course is a new course ("new"), an existing course that will change ("change"), or if the course is an existing course that will not change ("no change").

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Students are required to complete twelve credit hours of coursework for the graduate certificate. This requires completing two of the four listed core courses (form format not flexible to show this) and two additional electives (only a partial list of electives shown in table--form format not flexible to show all courses). Complete list of elective courses shown in Graduate Certificate Proposal document attached.

5e	Is there any other narrative about the graduate certificate that should be included in the Bulletin? If "Yes," please note below. (300 word limit)	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
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*The following is the preferred description that should be included in the Bulletin:
 "The Graduate Certificate in Manufacturing Systems offers opportunities for students to expand their knowledge of manufacturing processes and systems without formally committing to a master's program in this field, yet retain the option to apply certificate-earned credits toward the Master's or PhD degree."*

6. ASSESSMENT

6a	Student learning outcomes. Please provide the student learning outcomes for the graduate certificate. List the knowledge, competencies, and skills (learning outcomes) students will be able to do upon completion. (Use action verbs, not simply "understand.") (250 word limit)
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The two specific learning outcomes for the certificate are:

- *Apply basic engineering knowledge to analyze manufacturing performance - Students will have the ability to apply knowledge of mathematics, physical science, and manufacturing engineering principles to analyze technical literature and write technical reports related to manufacturing systems, processes, products and interrelations between these and their social, economic, and environmental context.*
- *Demonstrate the application of manufacturing principles to design products, processes and systems - Students will have the ability to demonstrate the application of relevant manufacturing principles to design more sustainable products, processes, and systems.*

6b	Student learning outcome (SLO) assessment. How and when will student learning outcomes be assessed? Please map proposed measures to the SLOs they are intended to assess. Do not use grades or indirect measures (e.g. focus groups, surveys) as the sole method. Measures likely include artifacts such as course-embedded assessment (e.g., portfolios, research papers or oral presentations); and course-embedded test items (embedded test questions, licensure/certification testing, nationally or state-normed exams). (300 word limit)
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The assessment of learning outcomes for the certificate program will be conducted by using information gathered for student performance in the respective courses. The graduate certificate proposed requires two core courses (see proposal document) and two elective courses. An artifact map will be used to identify specific artifacts to evaluate each of the learning outcomes. All the core courses have a final project and/or final written report. These projects/reports require the analysis of literature, evaluation of product/process/system performance and/or the application of manufacturing principles to design/improve products/processes/systems. These projects/written reports as well as other specific assignments and/or questions from the examinations will be used as artifacts to evaluate the learning outcomes.

6c	Certificate outcome assessment⁸. Describe evaluation procedures for the proposed graduate certificate. Include how the faculty of record will determine whether the program is a success or a failure. List the benchmarks, the assessment tools, and the plan of action if the program does not meet its objectives. (250 word limit)
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The certificate outcome assessment will include evaluation of recruitment, enrolment, retention, student performance and student satisfaction as described in the proposal document (attached). The specific metrics to be

⁸ This is a plan of how the certificate will be assessed, which is different from assessing student learning outcomes.

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used for each of these criteria, the potential sources to gather data and desired benchmarks for each are also shown.

7. OTHER INFORMATION

7a Is there any other information about the graduate certificate to add? (150 word limit)

This is a novel certificate program that offers benefits to all stakeholders, especially students, the College, and the University. Also, since the courses are offered online, the graduate certificate will provide an opportunity to full-time employed professionals who are seeking to advance their knowledge of manufacturing systems but are unable to come on campus.

8. APPROVALS/REVIEWS

Information below does not supersede the requirement for individual letters of support from educational unit administrators and verification of faculty support (typically takes the form of meeting minutes).

	Reviewing Group Name	Date Approved	Contact Person Name/Phone/Email
8a	<i>(Within College) In addition to the information below, attach documentation of department and college approval. This typically takes the form of meeting minutes but may also be an email from the unit head reporting department- and college-level votes.</i>		
	<i>Mech. Eng.</i>	<i>12/02/2015</i>	<i>Fazleena Badurdeen / 3-3252 / badurdeen@uky.edu</i>
	<i>College of Eng.</i>	<i>12/16/2015</i>	<i>/ /</i>
			<i>/ /</i>
			<i>/ /</i>

8b (Collaborating and/or Affected Units)

			<i>/ /</i>
			<i>/ /</i>
			<i>/ /</i>
			<i>/ /</i>
			<i>/ /</i>
			<i>/ /</i>
			<i>/ /</i>
			<i>/ /</i>
			<i>/ /</i>
			<i>/ /</i>

8c (Senate Academic Council) **Date Approved** **Contact Person Name**

	Health Care Colleges Council (if applicable)		
	Graduate Council		

UNIVERSITY OF KENTUCKY

Department of Mechanical Engineering

Proposal for Graduate Certificate in Manufacturing Systems

Introduction: This proposal is for the establishment of a Graduate Certificate in Manufacturing Systems. It will be composed of a minimum of 12 credit hours and represents a collaborative effort between the Department of Mechanical Engineering and various other departments within the College of Engineering (particularly Electrical and Computer Engineering, and Chemical and Materials Engineering) at UK. Students will be able to complete the certificate in an online delivery mode or on campus.

Courses to be taken in pursuit of this certificate are those which are already approved. No new courses are required for implementation of this certificate.

Need: Recent national initiatives to refuel a ‘new era of sustainable economic growth in America through Advanced Manufacturing’ (Dow Chemical Report) brings to the forefront the need to develop a more competent & multidisciplinary future workforce of manufacturing engineers. This certificate program, aimed at working professionals as well as full-time students, is to meet this very need by ‘preparing students for successful careers and professional development in manufacturing processes and systems’ and to develop students with ‘the knowledge, skills and attitude to make a significant contribution to sustainable development...’. In addition, the national emphasis on development of multiple NNMI National Networks for Manufacturing Innovation is evidence of the emphasis on national initiatives for manufacturing. “The National Network for Manufacturing Innovation (NNMI) provides a manufacturing research infrastructure where U.S. industry and academia collaborate to solve industry-relevant problems. (<http://www.manufacturing.gov/nnmi.html>) The NNMI is a network of Institutes for Manufacturing Innovation that each has a unique focus, but a common goal to create, showcase, and deploy new capabilities and new manufacturing processes.”

The certificate program at UK has an excellent opportunity to cater to the emerging national and international demand for manufacturing engineering education by increasing accessibility through online offerings; such offerings would attract professionals who experience difficulty attending classes on-campus, and provide opportunity for a level of advanced knowledge to those who lack the time and resources to complete an advanced degree. The program will also offer an entry path for individuals to continue toward the Master’s degree by starting in the certificate program.

Outcomes:

The two specific student learning outcomes for the certificate are:

- Apply basic engineering knowledge to analyze manufacturing performance - Students will have the ability to apply knowledge of mathematics, physical science, and manufacturing engineering principles to analyze technical literature and write technical reports related to manufacturing systems, processes, products and interrelations between these and their social, economic, and environmental context.
- Demonstrate the application of manufacturing principles to design products, processes and systems - Students will have the ability to demonstrate the application of relevant manufacturing principles to design more sustainable products, processes, and systems.

The Department, College of Engineering, and University will benefit from the:

- Increased enrollments due to the enhanced visibility of Manufacturing Systems Engineering as a viable career alternative,
- Increased enrollment of women and minorities among the student population. With the online offerings, increased visibility of the department and programs will result.

Admission Requirements: Admission to eligibility for a Graduate Certificate follows the same minimum requirements as application to admission to the Graduate School in post-baccalaureate status. Any student currently enrolled, or accepted, in the Graduate School as a graduate student, or in post-baccalaureate or university scholar status**, can be considered for admission. Program specific admission requirements are:

- 1) Have a bachelor's degree in engineering from an ABET-accredited post-secondary school (or equivalent) or a bachelor's degree in technology management, business, chemistry, mathematics, physics, or other related areas,
- 2) Earn a GPA of 3.0 or greater at the institution granting the bachelor's degree,
- 3) Demonstrate (via official transcript) successful completion (grade B or better) in each of 2 courses (minimum total 6 credit-hours) of college mathematics (consisting of differential and integral calculus).

All three criteria must be met to be eligible for admission into the proposed graduate certificate program.

** Students in this category must have senior standing, have completed all University studies requirements (a minimum of 90 hours, 3.5 GPA in major, 3.2 GPA overall).

Course Requirements: Course work applied to satisfy the minimum 12 credit-hour requirement will be selected from two following categories:

Core Courses* (Select two)

MFS 505	Modeling of Manufacturing Processes
MFS 605	Systems for Factory Information and Control
MFS 606	Global Issues in Manufacturing
MFS 613	Sustainability, Ethics, and Leadership in Manufacturing Organizations

Elective Courses* (Select two)

MFS 501	Mechanical Design with Finite Element Methods
MFS 503	Lean Manufacturing Principles and Practices
MFS 507	Design for Manufacturing
MFS 512	Manufacturing Systems
MFS 513	Mechanical Vibrations
ME 514	Computational Techniques in Mechanical System Analysis
ME 515	Rotordynamics of Turbomachinery
MFS 526	Operations Management in Lean Manufacturing
ME 556	Introduction to Composite Materials
MFS 609	Leadership for a Lean System (In the process of being changed to MFS 509)
ME 647	Systems Optimization
MFS 780	Special Topics in Manufacturing Systems Engineering
MFS 599	Topics in Manufacturing Systems Engineering
MFS 699	Topics in Manufacturing Systems Engineering

In addition to those listed above, one other course may be selected with approval of the Director, to satisfy the elective course requirement.

[*All these are existing courses, approved for delivery].

Graduate Certificate Requirements: As required by the Graduate School, a student must maintain a minimum GPA of 3.0 in the set of courses required for completion of the Graduate Certificate.

Award of Certificate: When a student enrolled in the UK Graduate School has successfully completed the last required course for the Graduate Certificate and has satisfied the above-stated GPA requirements, the Director shall send a completed, signed Graduate Certificate Completion Form to the Dean of the Graduate School verifying that the student has fulfilled all

requirements for the certificate and requesting award thereof, and officially notify the University Registrar of award of the certificate for posting to the student's permanent transcript.

Evaluation of Certificate Program:

Student Learning Outcome Evaluation: The assessment of learning outcomes for the certificate program will be conducted by using information gathered for student performance in the respective courses. The graduate certificate proposed requires two core courses (see proposal document) and two elective courses. An artifact map will be used to identify specific artifacts to evaluate each of the learning outcomes. All the core courses have a final project and/or final written report. These projects/reports require the analysis of literature, evaluation of product/process/system performance and/or the application of manufacturing principles to design/improve products/processes/systems. These projects/written reports as well as other specific assignments and/or questions from the examinations will be used as artifacts to evaluate the learning outcomes.

Program Outcome Evaluation: The certificate outcome assessment will include evaluation of recruitment, enrolment, retention, student performance and student satisfaction. The specific metrics to be used for each of these criteria, the potential sources to gather data and desired benchmarks for each are also shown in the table below.

	Measure	Data Source	Target
Recruitment	Number of recruitment events	Website visit log, mail log, travel log, telephone log,	<ul style="list-style-type: none"> • > 500 visits/yr. to Certificate links at website • participation in >2 promotional events such as graduate fairs and conferences
Applicants	Number of applicants to program	Applicant Log maintained in Department of Mechanical Engineering	> 10 applicants to Certificate program/yr.
Enrollment	Number of students admitted to certificate program	Department of Mechanical Engineering	> 75% of applicants admitted enroll in the Certificate program
Retention	Number of students receiving certificate	Department of Mechanical Engineering	> 90% of enrolled students successfully completing Certificate
Student Satisfaction	Teacher Course Evaluation Scores	Teacher Course Evaluation Forms	Students ratings for Certificate courses > 3.0 on a 4-point scale
Student Performance	Student grades	UK Transcripts	Mean GPA of Certificate graduates > 3.5 GPA

Director: The Director of the Graduate Certificate will be appointed by the Dean of the Graduate school, on recommendation of the Chair of Mechanical Engineering (from among the Manufacturing Systems Engineering faculty in the Mechanical Engineering Department), after consultation with the Graduate Studies Committee of Manufacturing Systems Engineering.

Faculty Associates: Associates will be drawn from several departments reflecting the interdisciplinary nature of this endeavor. As an initial complement, the Associates will be comprised of the faculty in Table 1. *indicates graduate faculty appointment in Manufacturing Systems Engineering as well.

Table 1: Faculty Associates

Faculty Member	Rank	Primary Appointment	Graduate Faculty Status	Field of Expertise
I.S. Jawahir*	Professor	Mechanical Engineering	Full	Computer Integrated Manufacturing, Manufacturing Process
Fazleena Badurdeen*	Associate Professor	Mechanical Engineering	Full	Sustainable manufacturing systems and supply chains, Modeling, Optimization
Keith E. Rouch*	Professor	Mechanical Engineering	Full	Dynamics, Finite Elements, Vibrations
John R. Baker	Associate Professor	Mechanical Engineering	Full	Vibrations, Finite Element Methods, Stability in Machining
Wei Li*	Assistant Professor	Mechanical Engineering	Associate	Production Scheduling, Adaptive Production Control, Optimization, Manufacturing Systems
L. Scott Stephens	Professor	Mechanical Engineering	Full	Bearing and Sealing Systems, Controls, Machine Design, Magnetic Suspensions
Abbot Maginnis	Adjunct Assistant Professor	Mechanical Engineering	Associate	Lean Manufacturing
Larry Holloway*	Professor	Electrical and Computer Engineering	Full	Discrete event control systems, embedded systems, Energy, fault detection, fault diagnosis, fault monitoring, manufacturing

				automation, Manufacturing Systems, power, power systems, production control
Yu Ming Zhang*	Professor	Electrical and Computer Engineering	Full	Applied machine vision, control systems, Manufacturing processes, robotic welding
Jeffrey Ashley	Senior Lecturer	Electrical and Computer Engineering		
Yang-Tse Cheng*	Professor	Chemical and Materials Engineering	Full	Biomedical Devices, Conservation, Energy, Nanostructured Materials, Sustainable Manufacturing
Jeffrey Seay	Associate Professor	Chemical and Materials Engineering	Full	Biofuels, Computer Aided Process Engineering, Energy, Green Engineering, Process Design, Process Safety, Sustainability
Charles Lu	Associate Professor	Mechanical Engineering	Full	composites, elastomers, finite element modeling, Materials, micromechanics, nanomechanics, polymers, Solid Mechanics, vibration
Dusan Sekulic*	Professor	Mechanical Engineering	Full	Heat Exchanger Theory and Design, Thermodynamics, Transport phenomena for materials processing

Appendix A. Description of Courses

Core Courses (Select two)

MFS 505: MODELING OF MANUFACTURING PROCESSES AND MACHINES. (3)

This course involves a study of major manufacturing processes (bulk forming, sheet metal working and machining processes) and related tooling and machines/equipment, with emphasis on mathematical and computer-based models, and will include two labs experiments. Lecture, two hours; laboratory, one hour. (Same as ME 505) [Course offered online starting Spring 2015]

MFS 605: Systems for Factory Automation and Control (3)

Systems approach to manufacturing. Hardware and software for real time control and reporting. Sensor and actuators, controllers, network, database, hierarchical and distributed control, CAD/CAM systems, flexible manufacturing systems, group technology, modeling and simulation of factoring operations. Lecture, two hours; laboratory, two hours. (Same as EE 605). [Tentative online delivery starting Fall 2016].

MFS 606: Global Issues in Manufacturing (3)

The need to increase quality, productivity, efficiency and sustainability in manufacturing operations spanning the product, process and systems (manufacturing systems as well as supply chain) domains is essential for companies to be successful. The increased globalization of markets and manufacturing operations, declining natural resources and negative consequences of some manufacturing practices as well as increased legislation in many regions has led to many new challenges that companies must overcome to be successful in competitive markets. This seminar course will introduce students to a variety of global issues in manufacturing through presentations by leading national and international experts in these domains. In addition, University of Kentucky faculty engaged in cutting-edge research in some of these areas will discuss innovative approaches that are being developed and applied to address those issues. (Same as EE/ME 606) [Course offered online starting Fall 2015].

MFS 613 Sustainability, Ethics, and Leadership in Manufacturing Organizations (3)

This course is intended to provide future manufacturing managers and leaders a basic understanding of important theories and practices necessary to successfully manage and lead teams to achieve manufacturing organizational objectives. The course is organized into several modules. The first module will focus on developing an understanding and capability to approach ethical and sustainability concerns confronted by manufacturing organizations. This will include coverage of tools to help identify and address societal and environmental obligations of manufacturing organizations and issues confronting them that span multiple cultures and nations. Because people are one of the most important resources in any organization, the second and third modules will address organizational behavior (OB) and individual effectiveness. OB theories and practices that can be used to increase the capability to observe, understand and manage people's behavior will be covered. The last module considers safety and ergonomics as they relate to manufacturing organizations. Coverage will include tools and techniques that can be used to analyze the manufacturing workplaces and ensure its ergonomic design

as well as an overview of the current state of occupational safety and health regulations. (same as ME 613) [Course offered online starting Fall 2016]

Elective Courses (Select two)

MFS 501 MECHANICAL DESIGN WITH FINITE ELEMENT METHODS. (3)

Mechanical design techniques based on the finite element method, using machine design background as the starting point. Techniques for modeling machine elements will be shown in relation to the basic FEM theory. Emphasis will be on quantifying loads, the resulting stress and deflection, and relating them to design allowables, leading to an acceptable design solution. (same as ME 501) [Course offered online starting Fall 2015]

MFS 503 LEAN MANUFACTURING PRINCIPLES AND PRACTICES. (3)

This course will introduce students to the fundamental principles and practices required to implement lean manufacturing. Topics covered include structured problem solving, standardized work, value stream mapping, 5S and visual control as well as flow and pull production. In addition to the lectures, simulations/experiments/games will be used to help learn the application of the tools supported by industry case studies. An application project is also included to study real-life manufacturing or service environment to assess the current state, identify improvement opportunities and develop countermeasures for implementation. (Same as ME 503) [Course offered online starting Fall 2015]

MFS 507 DESIGN FOR MANUFACTURING. (3)

The topics covered in this course will include product design for sustainability, including life-cycle product design, fundamentals of concurrent engineering, product specification, standardization, functional requirements and datum features, selection of materials and manufacturing processes, cost analysis, case studies on designing for quality, economy, manufacturability, productivity and sustainability. (Same as ME 507) [Course to be offered online starting Spring 2017].

MFS 512 MANUFACTURING SYSTEMS. (3)

This course introduces students to the fundamentals of design, planning and control of manufacturing systems. Concepts of design for manufacturing and assembly, process planning and operations design, production planning and control, facilities layout design, production scheduling as well as group technology, etc., will be addressed. (Same as ME 512) [To be offered online delivery starting Spring 2017].

MFS 513 MECHANICAL VIBRATIONS. (3)

The analysis of vibrational motion of structural and mechanical systems. Single-degree-of-freedom systems; free vibrations; nonperiodic excitation; harmonic excitation. Modal analysis of multiple-degree-of-freedom systems. Vibration of continuous bodies, including strings and bars (axial, torsional and flexural modes) and energy methods. (Same as ME 513) [Course offered online Fall 2016]

ME 514 COMPUTATIONAL TECHNIQUES IN MECHANICAL SYSTEM ANALYSIS. (3)

Computer-based methods of analyzing mechanical systems are studied. The studies include the numerical solution techniques on which the analyses are based. Linear and nonlinear static and dynamic systems are analyzed. Finite element and other engineering software packages are used. [Course offered online starting Spring 2017]

ME 515 Rotordynamics of Turbomachinery (3)

Review of dynamic characteristics unique to high speed rotating shafts in turbomachinery. Equations of motion for a rotor, including gyroscopic effects; computational methods, including finite element; effects of bearings and nonlinearities, stability; application to design situations in high-speed equipment, including aerospace, energy generation, and other industrial applications.

MFS 526 Operations Management in Lean Manufacturing (3)

This course employs a mixture of in-class presentations, hands-on activities and selected outside assignments to teach and demonstrate the development of a lean management system. Students develop a lean operations environment within a simulated factory environment using fundamental lean tools and concepts. As the operational environment evolves, key management principles will be explored and more advanced topics such as Flow, Pull and Material & Information Mapping will be presented. The people side of lean will also be explored, culminating in the development of a true lean operating system capable of sustaining Continuous Improvement.

ME 556 INTRODUCTION TO COMPOSITE MATERIALS (3).

Applications, materials selection and design of materials. Relation between properties of constituent materials and those of composite. Processing methods for materials and for some structures. Lab focuses on preparation and testing of composite materials and their constituents. [To be offered online Spring 2017]

MFS 609 Leadership for a Lean System* (3)

Leadership competencies presented in this course are: Design of infrastructure; Toyota model for developing leaders; Importance of matrix structures; Organization behavior dimensions; Human resource management strategy; Procurement systems dynamics; Operations dynamics; distribution logistics; and customer relations. Course presentation will utilize lecture and case study. Pre-req: MFS 503. (*This will be replaced by MFS 509; course change application under review).

ME 647 SYSTEM OPTIMIZATION I (3).

Introduction to linear and nonlinear optimization and their use in engineering design. Emphasis on numerical approaches and use of optimization methods for engineering systems (e.g. biological, mechanical, structural). (Same as BAE 647.)

MFS 780 Special Problems in Manufacturing Systems Engineering (3)

Course consists of specialized individual work in manufacturing systems engineering. Laboratory, nine hours. May be repeated to a maximum of nine credits. Tentative online delivery starting Spring 2016.

MFS 599 Topics in Manufacturing Systems Engineering (need description)

A detailed investigation of a topic of current significance in manufacturing systems engineering such as: computer-aided manufacturing, special topics in robotics, and lean/agile manufacturing. May be repeated under different subtitles to a maximum of six credits. A particular topic may be offered at most twice under the MFS 699 number.

MFS 699 Topics in Manufacturing Systems Engineering (Selected Topics) (1-3)

A detailed investigation of a topic of current significance in manufacturing systems engineering such as: computer-aided manufacturing, special topics in robotics, and lean/agile manufacturing. May be repeated under different subtitles to a maximum of six credits. A particular topic may be offered at most twice under the MFS 699 number.

Badurdeen, Fazleena F

From: Alexander-Snow, Mia
Sent: Monday, February 01, 2016 5:48 PM
To: Badurdeen, Fazleena F
Cc: Carvalho, Susan E; Stone, Galen
Subject: RE: Proposal for Graduate Certificate in Manufacturing Systems--Online Certificate Program

Hello Fazleena

Thank you for the reminder.

As presented, the proposed proposal: graduate certificate program in **Manufacturing Systems (14.3601)** does not require additional documentation for SACSCOC, the university's regional accreditor. The proposal provides a comprehensive evaluation plan for assessing student learning and program outcomes. You may move forward in accordance with college and university-level approval processes. Your certificate program will be utilizing existing resources and previously approved existing courses. Please note that as a 100% online program, there will be additional documentation required for showing

Given that this will be a totally online program, please be sure to work with Galen Stone (galen.stone@uky.edu), the university's coordinator for distance education to ensure the proposed certificate program will satisfy distance education standards and requirements.

Best,
Mia

Mia Alexander-Snow, PhD
Director, Planning and Institutional Effectiveness
Phone: 859-257-2873
Fax: 859-323-8688

Visit the Institutional Effectiveness Website: <http://www.uky.edu/ie>

Follow us at: <https://www.facebook.com/universityofky>



The University of Kentucky

From: Badurdeen, Fazleena F
Sent: Monday, February 01, 2016 1:15 PM
To: Alexander-Snow, Mia
Subject: FW: Proposal for Graduate Certificate in Manufacturing Systems

Hello, Mia.

I wasn't sure if this email of mine got lost on your inbox. So, sending it again to get your feedback.

Thanks and Best Regards,
Fazleena

Fazleena Badurdeen, Ph.D.
Associate Professor of Mechanical Engineering
Director for Graduate Studies – Manufacturing Systems Engineering MS Program
Institute for Sustainable Manufacturing
414L, CRMS Building
University of Kentucky
Lexington KY 40506
Phone: (859) 323-3252
Fax: (859) 257-1071



From: Badurdeen, Fazleena F
Sent: Tuesday, January 19, 2016 9:14 AM
To: Alexander-Snow, Mia
Subject: FW: Proposal for Graduate Certificate in Manufacturing Systems

Dear Mia,

Hope all is well at your end and that you are off to a great year!

We are in the process of submitting an application for a new graduate certificate. I had prepared the proposal in a form that was available at that time. However, our college administration informed me just before the break that there is a new form which has to be completed.

The new form, almost complete, is attached. However, the first box in this form asks for 'Date of contact with Institutional Effectiveness' and to append the email from IE. I'm not sure what is required when preparing such proposals or what it entailed as no guidelines can be found. Hoping you can help me out?

I have also attached a proposal document that outlines a little more details about the proposed graduate certificate as well.

Let me know if we need to have a meeting to discuss anything in here.

Thanks and Best Regards,
Fazleena

Fazleena Badurdeen, Ph.D.
Associate Professor of Mechanical Engineering
Director of Graduate Studies, Manufacturing Systems Engineering
414L CRMS Building
University of Kentucky
Lexington, KY 40506, USA

From: [Renfro, Michael](#)
To: [Brandenburg, Barbara J](#)
Cc: [Badurdeen, Fazleena F](#)
Subject: RE: New Cmte Item (SAPC)_Proposed New Graduate Certificate in Manufacturing Systems
Date: Wednesday, January 11, 2017 4:31:15 PM

BJ,

We voted on the graduate certificate in MFS at our December 2, 2015 ME faculty meeting. It was approved (all in favor, none opposed).

Mike

From: Brandenburg, Barbara J
Sent: Wednesday, January 11, 2017 3:49 PM
To: Renfro, Michael <michael.renfro@uky.edu>
Cc: Badurdeen, Fazleena F <badurdeen@uky.edu>
Subject: FW: New Cmte Item (SAPC)_Proposed New Graduate Certificate in Manufacturing Systems

Dr. Renfro,

Dr. Badurdeen was asked for the below information for the new grad certificate in MFS and she called me since I am the one who works on the course and curriculum changes. I misunderstood the first item needed Will you send me an email with the below information? I have the email where I sent it to the faculty and Dr. Badurdeen has provided the third item needed.

1) Meeting minutes showing the approval of the certificate in your department or an email from your chair stating when the meeting took place and that it was voted upon and the results of the vote.

As soon as I get this from you, I will forward it on.

Thanks,

BJ

BJ Brandenburg
College of Engineering
Director of Student Records
373 Ralph G. Anderson Building
University of Kentucky
Lexington, KY 40506-0503
Tel: (859) 257-7978
Fax: (859) 257-5727

From: [Brandenburg, Barbara J](#)
To: [LIST All Engineering Faculty](#)
Subject: FW: Course and curriculum changes
Date: Monday, March 21, 2016 1:45:00 PM
Attachments: [MFS Grad Certificate Proposal 03-07-2016 .docx](#)

All,

Please review the attached MFS Grad Certificate Proposal. It was inadvertently left off the email I sent last week.

I am asking for an expedited timeframe on the above proposal as it was supposed to be sent out last week.

Please respond with any concerns by Tuesday, March 29, 2016.

BJ

BJ Brandenburg
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