BOARD OF TRUSTEES
UNIVERSITY OF THE DISTRICT OF COLUMBIA
UDC Resolution No. 2016-

SUBJECT: Approval of Master of Science in Mechanical Engineering (MSME) Degree Program in the School of Engineering & Applied Sciences (SEAS)

WHEREAS, pursuant to D.C. Official Code § 38-1202.06(3), the Board of Trustees is authorized to establish or approve policies and procedures governing admissions, curricula, programs, graduation, the awarding of degrees, and general policy for the components of the University; and

WHEREAS, pursuant to DCMR § 08-B308.1, new associate, baccalaureate, and graduate degree programs may be added to the University curricula upon recommendation by the Academic Senate and the President and after approval by the Board; and

WHEREAS, SEAS has been offering an accredited bachelor's degree in Mechanical Engineering, a discipline that applies the principles of engineering, physics and materials science for analysis, design, manufacturing, and maintenance of mechanical systems and is the branch of engineering that involves the production and usage of heat and mechanical power for the design, production, and operation of machines and tools, and is a discipline in engineering that encompasses many specialties, such as renewable energy technologies, advanced manufacturing, product design, automobile engineering, robotics, aerospace engineering, and fast evolving nanotechnology, in addition to the connection mechanical engineering may have with the field of Biomedical engineering (e.g., rehabilitation engineering, biomechanics, bio-related mechatronics, bio-related nanotechnology and physiological modeling of biological systems); and

WHEREAS, the proposed graduate program, Master of Science in Mechanical Engineering (MSME), is designed to meet the needs of Mechanical Engineering undergraduate students (starting with those at UDC), working professionals in the greater Washington DC Metropolitan area, as well as international students, by providing an economical and continuous path for obtaining a master's of science (MS) degree in various sub-disciplines of Mechanical Engineering; to also prepare the Mechanical Engineering program to meet the academic requirements of a master's degree for professional licensure; and to provide opportunities for graduate students to assist faculty members in research and funded grant activities; and to increase employability and make UDC graduates better prepared for the demands of expanding and advancing fields within or related to Mechanical Engineering;

WHEREAS, the proposed curriculum presents a standard Mechanical Engineering curriculum that all MSME students will be expected to take, it also offers multiple tracks that will require MSME graduate students to choose technical electives and conduct thesis research in a focus area under the supervision of their advisors, with the objectives of: providing graduate students with up-to-date advanced training in selected, marketable specialties of Mechanical Engineering and other mechanical engineering-related/inter-disciplinary fields; preparing students to develop innovative technologies; providing students with graduate research opportunities to solve real-world problems in mechanical engineering; preparing students for entry into research-based doctoral studies in the discipline; preparing graduate students for leadership positions in their professional field in both public and private sectors; and academically preparing Mechanical Engineering students to meet the requirements of the engineering profession and their societies (American Society of Mechanical Engineers, and National Society of Professional Engineers); and

WHEREAS, the Administration proposes to establish a Master Degree in Mechanical Engineering (MSME), based in the School of Engineering and Advanced Sciences, and the proposed program has been approved by all required levels of faculty and administration;

NOW THEREFORE, BE IT RESOLVED that the University of the District of Columbia is hereby authorized to implement the MS in Mechanical Engineering (MSME) Degree Program in accordance with the attached proposal, *provided that* the funds required to implement the program shall not be obligated until they have been identified and reprogrammed within existing University resources.

Submitted by Academic and Student Affairs Committee July 12, 2016

Approved by the Board of Trustees

July 26, 2016

Elaine A. Crider
Chairperson of the Board

UNIVERSITY OF THE DISTRICT OF COLUMBIA
1851

FISCAL IMPACT STATEMENT

TO: The Board of Trustees

FROM: Managing Director of Finance

DATE: July 8, 2016

SUBJECT: Master of Science in Mechanical Engineering Program Proposal

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Conclusion

It is concluded that there is sufficient funding to support the implementation of the Master of Science in Mechanical Engineering (MSME) Degree Program in the School of Engineering & Applied Sciences (SEAS).

Background

Pursuant to D.C. Code § 38-1202.06 (3), the Board of Trustees has the authority to approve establish or approve policies and procedures governing admissions, curricula, programs, graduation, the awarding of degrees, and general policy for the components of the University.

Mechanical Engineering is projected to be one of the fastest growing occupations (based on U.S. Bureau of Labor Statistics) and, therefore, a high-demand profession in our region and nationally. The proposed graduate program, Master of Science in Mechanical Engineering (MSME), is designed to meet the needs of Mechanical Engineering undergraduate students (starting with those at UDC), working professionals in the greater Washington, DC Metropolitan area, as well as international students, by providing an economical and continuous path for obtaining a master's of science (MS) degree in various sub-disciplines of Mechanical Engineering.

Financial Impact

The proposed new academic program will be supported by existing faculty resources within the School of Engineering & Applied Sciences. In addition to the use of existing faculty resources to fund costs in years 1-3 of a 5 year plan, the program anticipates enrollment will increase gradually from the first year of implementation with 12 students and with an average annual increase of 25%. With projected increasing enrollment and current undergraduate teaching load, two additional faculty members will be required by year 5 to provide instructional support for the Bachelors of Science in Mechanical Engineering and Masters of Science in Mechanical Engineering programs.

The Office of the Provost must monitor program milestones on an annual basis to determine continual viability of the program. There are some risks with this proposal; however, with proper

administrative oversight during the first three years of the program's implementation such risk can be mitigated.

Proposal for a New Graduate Program at UDC

Graduate Program in Mechanical Engineering
Master of Science in Mechanical Engineering (MSME)

Department of Mechanical Engineering
School of Engineering and Applied Sciences
University of the District of Columbia
Washington DC

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A. Review Type Requested – New Program

The Department of Mechanical Engineering (ME) of the School of Engineering and Applied Sciences (SEAS) at the University of the District of Columbia proposes the establishment of a new graduate degree program in the Mechanical Engineering: **Master of Science in Mechanical Engineering (MSME).**

B. Program Description

Since 1988, SEAS has been offering an ABET accredited bachelor's degree in Mechanical Engineering. Mechanical Engineering is a discipline of engineering that applies the principles of engineering, physics and materials science for analysis, design, manufacturing, and maintenance of mechanical systems. It is the branch of engineering that involves the production and usage of heat and mechanical power for the design, production, and operation of machines and tools. Mechanical Engineering encompasses many specialties that can include renewable energy technologies, advanced manufacturing, product design, automobile engineering, robotics, aerospace engineering, and fast evolving nanotechnology. Mechanical engineers may also work in the field of Biomedical engineering (e.g., rehabilitation engineering, biomechanics, bio-related mechatronics, bio-related nanotechnology and physiological modeling of biological systems).

The proposed graduate program, Master of Science in Mechanical Engineering (MSME), is designed to meet the needs of Mechanical Engineering undergraduate students (such as those at UDC) aimed at continuing post-bachelor's to pursue a graduate degree, working professionals in the greater Washington DC Metropolitan area, as well as international students interested in pursuing a graduate degree. The proposed graduate program aims to do the following:

(i) To provide UDC soon-to-be graduates of the bachelor's of science (BS) in Mechanical Engineering program a continuous path for obtaining a master's of science (MS) degree in various sub-disciplines of Mechanical Engineering

(ii) To prepare the Mechanical Engineering program to meet the academic requirements of a master's degree for professional licensure

(iii) To enhance the existing 4-year BS Mechanical Engineering undergraduate program and

(iv) To provide opportunities for graduate students to assist faculty members in research and funded grant activities.

The proposed MSME program will offer a high-level graduate program with strong foundations in theory and applications necessary to equip students with the interdisciplinary skills required to grasp and develop new technologies and trends in the Mechanical Engineering field. In order to increase employability and make UDC students more responsive to the demands of growing and advancing fields within or related to Mechanical Engineering, areas of focus of the MSME program will include the following: (i) advanced manufacturing, (ii) renewable energy, (iii) biomedical engineering,

and (iv) nanotechnology. The MSME will prepare students with the knowledge and tools needed to advance into leadership roles (either in industry or research settings) that will shape the future of this dynamic field.

The main educational objectives of MSME degree program are as follows:

(i) To provide graduate students with up-to-date advanced training in selected marketable specialties of Mechanical Engineering and other Mechanical Engineering related inter-disciplinary fields

(ii) To prepare students through inter-disciplinary research to develop innovative technologies

(iii) To provide graduate students with research opportunities to solve real-world problems in Mechanical Engineering and prepare students for entry into research-based doctoral studies in the discipline

(iv) To prepare graduate students for leadership positions in their professional field in both public and private sectors

(v) To prepare Mechanical Engineering students academically to meet the requirements of the engineering profession and their societies (American Society of Mechanical Engineers, and National Society of Professional Engineers)

The current proposal includes a standard Mechanical Engineering curriculum that all MSME students will be expected to take. It also offers multiple tracks that require the MSME graduate students to choose technical electives and conduct thesis research in their focus area under the supervision of their advisors. The MSME requires a minimum of 30 credit hours of graduate-level work. Currently, the program offers a thesis option only, however, a non-thesis option may be added as the program matures.

Program Administration

The Chair of the Department of Mechanical Engineering will be responsible for the implementation and administration of the new MSME degree program in Mechanical Engineering. All requirements in the program will be in compliance with the graduate studies requirements of the academic policies of the University.

This MSME program will benefit from current faculty research in the ME department. Dr. Pawan Tyagi is currently engaged in grant-funded research on nanomaterials-based devices, advance manufacturing, and biomedical devices. He is leading effort to establish a Nanotechnology Application Laboratory at UDC campus to conduct and promote multidisciplinary research. Dr. Kate Klein's research is in the area of advanced meteorology techniques, nanomaterials, and nanoscale fabrication. Dr. Klein is also an expert in materials science and has established the Material Characterization and Microscopy Laboratory at UDC to support cutting edge research and engage undergraduate and graduate students. Dr. Jiajun Xu has expertise in advanced thermal management research using nanomaterials. He has a strong publication record in this area. He is currently developing a state-of-the-art heat transfer laboratory in the ME

department. Dr. Xu is also an expert in the area of 3D modelling and simulation. His expertise will be key to implementing the various tracks such as advanced manufacturing, nanoscale devices, and biomedical engineering planned for prospective MSME students. Dr. Lara Thompson is an expert in biomedical engineering. She is actively pursuing research in the area of ambulatory devices and auditory mechanisms. In addition, Dr. Devdas Shetty has been actively researching in the areas of advanced manufacturing, biomedical research, and mechatronics. Dr. Shetty has led efforts to develop a state-of-the-art mechatronics laboratory at UDC to support research in systems automation and control.

The MSME Degree Program Committee, referred to as the Graduate Committee, will be composed of faculty members in the Department of Mechanical Engineering with a Ph.D. degree and/or faculty from SEAS with a Ph.D. degree. The members of the graduate committee will be responsible for curriculum development and periodic review of the MSME degree program in Mechanical Engineering.

The Graduate Committee will formulate academic policy, guidelines, and requirements consistent with the graduate council and university policies. The course development and day-to-day operations of the MSME degree program will be the responsibility of the Graduate Committee. The Graduate Committee members will elect the Chair of the committee annually at the beginning of the fall semester.

The course work for each area of emphasis consists of a set of required courses and a set of elective courses in the areas of Mechanical Engineering, Mathematics, and other related fields. To integrate the technological advancement in the Mechanical Engineering discipline into the curriculum, members of the Graduate Committee may propose new courses or changes in course content of any existing course. Proposals for adding new courses or curriculum changes to reflect the changing industry trends will be reviewed and recommended by the Graduate Committee. Recommendations for the addition of a new course or change of course content will then be presented to the entire ME department faculty for formal review and approval. Formal university procedure for approving the addition of new courses or changing the contents of existing courses will be followed. After formal university review and approval, the course additions/changes will be entered into the University's course catalog.

Advising

Each student admitted into the program needs to select an advisor in his/her area of interest. An interim advisor will be assigned to each student until he/she chooses an advisor. Each student is responsible for discussing any special needs they may have with his/her advisor. Each student and his/her advisor must also select an Advisory Committee that is composed of at least 3 members of the full-time faculty, the majority of whom must be members of the Department of Mechanical Engineering. The advisor serves as the chairman of the student's Advisory Committee. The Advisory Committee for each student must be formally approved by the Dean of the graduate school. The selection of the Advisory Committee for each student must be completed before the end of the second semester of his/her graduate studies. The academic advisor of each student is responsible for approving the course planning guide for that student, monitoring his/her work progress, and approving the successful completion of his/her studies culminating in a Master's in Mechanical Engineering.

B1. Admission Standards

To be considered for admission into the program, a student must satisfy the university-wide requirements for admission to graduate programs as established by the Office of Graduate Studies (Graduate School) at the University. However, the Mechanical Engineering Graduate Committee may require higher and/or appropriate academic standards for admitting students to the department's graduate program. In general, the applicant must have completed a Bachelor's degree in Mechanical Engineering, or a closely-related field. The applicant must submit all documents required by the Graduate School to the Office of Admission. In addition, each applicant should also submit:

- Graduate Record Examination (GRE) basic test scores (required for all the applicants);
- A letter of intent describing his/her graduate studies goals and objectives;
- Three letters of reference from qualified scientists, engineers or supervisors that can certify his/her ability to pursue studies at the Master of Science level.

International students must also submit TOEFL [Test of English as a Foreign Language] scores as part of their application. Complete applications satisfying the university's general graduate admission criteria will be sent to the department for consideration for admission to the graduate program. It is the policy of the graduate admissions committee in the ME department to carefully consider every applicant's previous academic and professional qualifications, test scores and achievements before an admission decision is made.

B2. MSME General Degree Requirements

1. Educational requirements for admission to program: Baccalaureate Degrees in Mechanical Engineering, Engineering Science, Industrial Engineering or closely related field.
2. Maximum of three graduate-level course units may be transferred from another institution to apply toward the MSME degree. Transferred courses must logically fit into the student's graduate program. The student's graduate advisor decides which courses are acceptable. Approval of transfer credit is required. These two courses should not have been used in fulfillment of any other degree(s).
3. At least half of the coursework credits, excluding thesis or technical report credits, must be taken with other than a single professor.
4. Any coursework more than six years old at the time of the MS thesis defense will not be used to fulfill any of the MSME degree requirements.
5. All graduate credits must have letter grades of A, B, or C, or a pass grade of S (Satisfactory) vs. fail grade of US (Unsatisfactory) for research related credits. No more than two graduate courses with letter grade C will be accepted.
6. A minimum grade point average (GPA) of 3.0 is required to remain in good standing and to graduate.

B3. Thesis Degree Requirements

1. Plan of Study - the student must meet with his/her advisor to formulate a plan of study. The plan of study must be submitted to the student's Advisory Committee after completing at least 9 but no more than 15 semester credits.

2. Satisfactory completion of 30 credit hours of approved graduate credits: 6 credit hours of common courses, 15-18 credit hours of technical elective courses and 6-9 credit hours of thesis research.
3. At least 18 credits of course work, excluding thesis, must be at or above the 500 level. However, undergraduate courses will not count towards the master degree requirements.
4. Thesis Defense - a copy of the thesis should be distributed to each member of the Advisory Committee and to the Graduate School at least two weeks prior to the defense. The advisor and the Graduate School will make a public announcement of the defense to allow attendance by interested faculty, students, and the University Community.
5. Upon application for the thesis defense, students are required to submit a technical paper or abstract, based on their thesis research, in a form suitable for submission to a regional technical conference.

B4. Curriculum

The university catalog contains statements of regulations that apply to all graduate students. Of particular interest are the sections on admissions and degree programs and requirements. Statements referring to foreign language requirements do not apply to students in the MSME program. The MSME program has several tracks and all MSME students, without exception, complete one track. Thus, considerable breadth in the student's program is possible. All course selections must be part of an approved program of study. The course requirements are summarized as **Common courses** (6 credit hours), **Technical Elective Courses** (18 credit hours), **Master's Thesis** (6 credit hours):

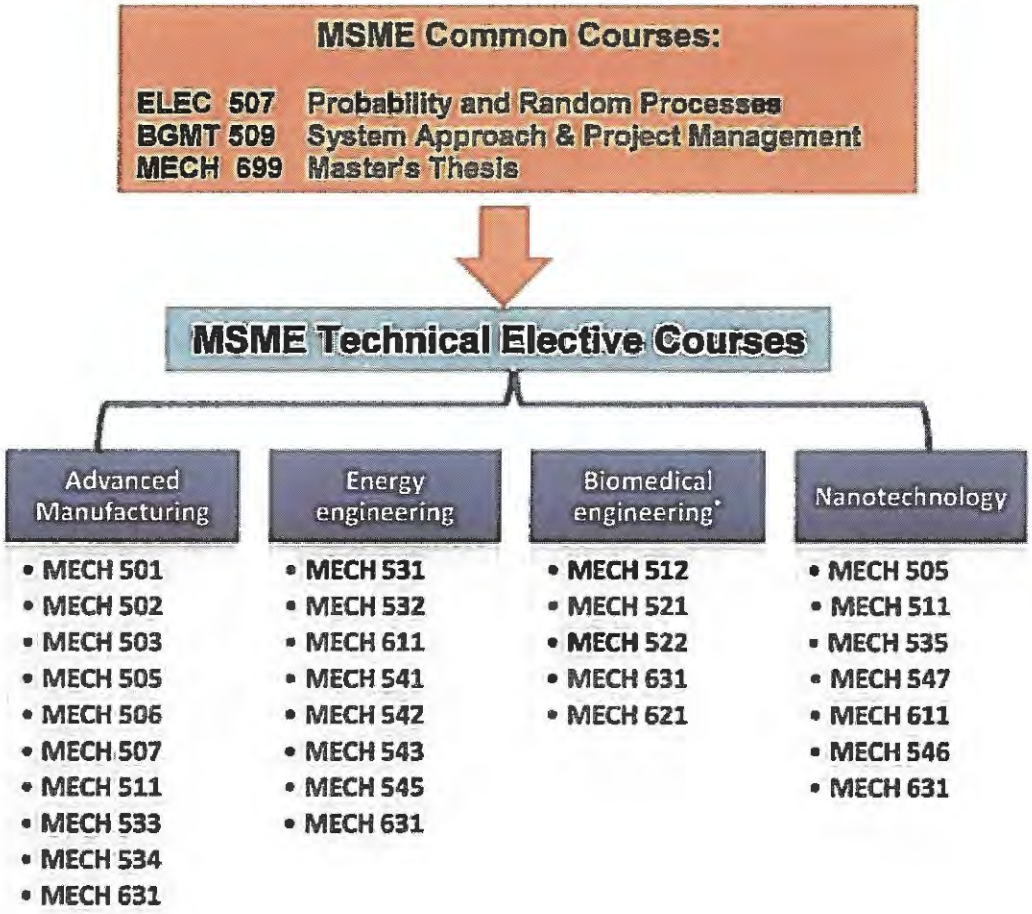
MSME	
Category	Credit hours
Common Courses	06
Technical Elective Courses	15-18
Master's Thesis	06-09
Total	**30**

The course requirements for MSME students:

*I) **Three common courses:***
   a. ELEC – 507 Probability and Random Processes
   b. BGMT – 509 System Approach and Project Management
   c. MECH - 699 Master's Thesis

ii) ***Technical electives:*** Technical electives must be approved by the student's Academic Advisor. (The Master's thesis must count for a minimum of 6 credit hours. However, a maximum 9 credit hours may be taken in which case one of the technical electives will be waived.)

The following is a flowchart of required and suggested technical elective courses the prospective MSME student may take. The four proposed MSME tracks and their associated Technical Elective Courses were selected based on ME faculty members' expertise; however, the implementation of each track is subject to SEAS Dean's approval. An initial estimation of 5 to 10 qualified and highly motivated students is expected for the first year of the MSME program and as such, Advanced Manufacturing and/or Nanotechnology Tracks are on the priority list of tracks to be initially offered.



*Other graduate-level courses offered outside of the Mechanical Engineering Department such as Image Processing, Bioinformatics, Speech-based computing, and others) may be aligned with the Biomedical Engineering concentration.

List of all courses:

ELEC 507 3 Probability and Random Processes

BGMT 509	**3**	**System Approach and Project Management**
MECH 699	**3**	**Master's Thesis**
MECH 501	3	Mechatronics System Design
MECH 502	3	Product Design
MECH 503	3	Finite Element Analysis
MECH 505	3	Advanced Manufacturing
MECH 506	3	Principles of Six Sigma
MECH 507	3	Supply Chain Engineering
MECH 511	3	Advanced Materials
MECH 512	3	Advanced Mechatronics
MECH 521	3	Rehabilitation Engineering
MECH 522	3	Physiological Systems Analysis
MECH 531	3	Intermediate Heat and Mass Transfer
MECH 532	3	Engineering Numerical Modeling Methods
MECH 533	3	Engineering optimization
MECH 534	3	Failure Mechanism and Reliability
MECH 535	3	Nano-to-Macro Transport Processes
MECH 541	3	Photovoltaic cells and solar thermal systems
MECH 542	3	Fuel cell science and Technology
MECH 543	3	Wind turbine science and technology
MECH 545	3	Design of energy systems
MECH 546	3	Nanoscale Materials and Devices
MECH 611	3	Mechanical Fundamentals and Design of Electronic Systems
MECH 621	3	Special Topics in Biomedical Engineering
MECH 631	3	Special Topics in Mechanical Engineering

C. Program Feasibility

C.1 Demonstration of need (including internal and external supporting data)

The Department of Mechanical has a critical need to establish a Master of Science in Mechanical Engineering (MSME) degree program for the following reasons:

- Employment projections continue to show an increase in science, technology, engineering and mathematics fields (STEM); especially in Washington, D.C. region. Employment projections in STEM fields appear promising. The U.S. Department of Labor has predicted a 29 percent increase in STEM jobs, adding about 2.1 million new jobs between 2010 and 2020. Washington, D.C. region has more than two times the concentration of STEM jobs than the national average.
- According to the U.S. Bureau of Labor Statistics 2012-22 (http://www.bls.gov/emp/ep_table_102.htm), Mechanical engineers are expected to have employment growth of 5% over the projection decade. The Mechanical Engineering employment growth is attributed to population growth and related need to improve the Nation's competitiveness and spur modern innovation. The growing demand for Mechanical engineers in both public and private sectors is not limited to those with a bachelor's degree but also those with a specialized

master's degree. The proposed graduate program will address the creation of opportunities for current and future Mechanical Engineering students and professionals within the Washington DC metropolitan area as well as national and international students. There are a number of engineering graduates, mainly mechanical engineers, who have a desire to further their education in Mechanical Engineering by adding more specialization to their general undergraduate studies. Most of the local universities (George Washington University (GWU), Howard University (HU), Catholic University of America (CUA), University of Maryland (UMD), and George Mason University (GMU)) offer traditional graduate programs in various sub-disciplines of Mechanical Engineering. Based upon the statistics from "*Profiles of Engineering and Engineering Technology Colleges*" published by ASEE, GWU graduated 15, HU graduated 2, CUA graduated 1 and UMD graduated 65 MSME students in 2012-2013 academic year. So there is an emerging demand for MSME program within the Washington DC metropolitan area. In addition to that, the comparative cost of these graduate programs has been a hindrance for underrepresented minorities to pursue advanced degrees and our lower tuition costs compared to other local institutes would attract students to our MSME program.

- In the Metropolitan Washington, DC region of over 4 million people, the role of the profession of Mechanical engineer and related industry is ranked close to the professions of law, finance, information technology and service oriented business as driving engines of the region's economy. As the nation's only urban land grant university, a graduate program in Mechanical Engineering, along with existing nationally accredited BS in Mechanical Engineering program, would immeasurably improve UDC's capacity to fully exercise its responsibilities as a major institutional partner in the promotion of research innovation, in increasing economic development, and improving quality of life for residence for those in Washington, DC.
- The availability of graduate programs in the ME department will enhance existing undergraduate BS programs at UDC, increase the visibility of the department and improve its academic ranking in the nation. This will help attract highly qualified faculty and a larger number of undergraduate students to the department and School of Engineering and Applied Sciences.
- The establishment of the MSME program will allow UDC to become more competitive with grant funding requiring components of graduate student research, which in turn can only improve UDC's laboratory facilities and research portfolio.

C.2 Congruence with academic unit objectives and university mission

The University of District of Columbia Strategic Plan is structured around goals that lie in the intersecting arenas of learning, scholarship and community service. The proposed graduate program will support goals in each of these arenas and intersections. In the arena of learning it will promote advanced Mechanical Engineering education and its integration into the curricula, and it will help students develop critical thinking and

advanced professional skills that will make them more competitive in career placement. In the arena of scholarship it will help students develop skills to support faculty in meeting the goals of using advanced science, engineering and technology innovation in various dimensions of scholarship. In the arena of service it will, by supporting outreach activities and serving minority Mechanical Engineering students, address the needs of DC residents. It will rise to meet the obligations of only urban land-grant university of the nation.

The proposed graduate program will also meet the SEAS's goals of providing graduate program in all of the engineering programs and creating opportunities for research activities in Mechanical Engineering. It will provide synergistic effect on the other programs within the school as well as other programs of the University.

In addition to meeting University and SEAS goals related to interdisciplinary collaboration, and scholarship, the graduate program will also meet more specific department goals. To this end, it will support the goal of integrating instructional, research and outreach efforts. Since engineering entails analysis and solution of real-world problems, the program will promote the departmental goal of focusing its scholarship "on the real-world, problem-solving needs of sustainable technological innovations."

C.3 Avoidance of duplication or overlap with existing courses or programs

The Master of Science in Mechanical Engineering program will not duplicate any other program or courses currently offered at UDC.

C.4 Relationships with Other UDC Programs

The proposed MSME program will complement and help strengthen other graduate programs not only within the SEAS but also other programs in the university, through collaboration in multidisciplinary research activities. The MSME program will have the same synergistic relationships with other UDC programs as have always existed between the undergraduate Mechanical Engineering programs and UDC programs in engineering, computer science, electrical engineering and environmental sciences. The interdisciplinary nature of the Mechanical Engineering will enhance the collaborative research activities with other disciplines.

C.5 Standards of relevant accrediting agencies and/or professional societies

The undergraduate Mechanical Engineering program of the ME department is accredited by ABET, Inc. ABET accredits either the undergraduate or the graduate program of any particular department. In our case, no outside accreditation is required for the graduate program. American Society of Mechanical Engineers is the professional association of Mechanical Engineering profession. It provides general directions to the program.

C.6 Students immediately affected if relevant and/or projected enrollment

Most of the UDC Mechanical Engineering students currently enrolled in the 4-year BS Mechanical Engineering undergraduate program, and other engineering undergraduate programs, will be positively affected. Also affected, are the majority of undergraduate program graduates over the past decade those who are employed in various public and private sectors within the Metropolitan DC area. It is expected that the UDC Mechanical

Engineering alumni and international students will make up a significant portion of the potential MSME program applicant pool.

An implemented MSME professional degree program at UDC would hold tremendous market attraction to persons seeking a quality, economical alternative to existing Mechanical Engineering graduate programs offered in Washington DC area. Most of the Washington area graduate programs including those at Howard University, Catholic University, George Washington University, University of Maryland at College Park, and Morgan State University in Baltimore attract a significant number of students who would find an economical program at UDC. Since most of these programs are prohibitively expensive in comparison to UDC, UDC may be a more favorable alternative to those hoping to pursue an MSME.

In summary, enrollment in the UDC Master of Mechanical Engineering program would be drawn from several sources:

a. Currently enrolled UDC undergraduate Mechanical Engineering students
b. UDC Mechanical graduates of the BS program Graduate Students transferring from other universities
c. Other engineering bachelor's degree holders seeking a career change
d. International students who are interested to purse graduate program in Mechanical Engineering
e. DC local workforce wishing to have an advanced degree or continuing education opportunity

An initial entering class of 5 to 10 qualified and highly motivated students drawn from the above pool of potential applicants can be considered as a highly realistic enrollment target for the first year of the MSME program. The impact of a SEAS Mechanical Engineering master's program will have a dramatic effect on undergraduate recruitment. The eventual enrollment of 50 new undergraduate and 15 graduate Mechanical Engineering students each year becomes a highly credible target over the next ten years. We also expect faculty to increase their scholarship and to provide research assistantships to the students.

C.7 Effect on Student Development and Employment

The advanced specialized studies in Mechanical Engineering would also have a significant positive effect on the development and employability of students. The addition of the graduate professional degree and university commitment to research and innovation will represent a strong, positive signal to current and future undergraduate and graduate students. Student morale will increase significantly. Prospective employees will be favorably impressed, thereby raising the bargaining position of graduates in the market place. In addition, a graduate program would improve faculty productivity and the probability of winning competitive research grants.

C.8 Adequacy and appropriate qualification of current faculty and support staff

The program will initially depend upon the appropriately qualified faculty members in the primary area of this program. The faculty of the ME department has the highest qualifications needed for their profession. However, adjunct faculty may be hired both to

take advantage of the specialized expertise found in the Washington metropolitan area and to expose our students to professionals working in the field, and expose potential employers to our future graduates. One additional full-time permanent faculty member may be required when the program matures and other tracks are needed in the future.

C.9 Adequacy of current facilities (offices, classrooms, labs, etc.)

The current department facilities (academic space) shared by SEAS and other program square footage (dispersed through buildings 32 and 42) will be adequate to support the program in first year. However, space will be needed for lecture room, research laboratory and graduate student offices as the program matures.

C.10 Adequacy of supplies and equipment; identify additional needs, if any

The expected increase in enrollment will require the acquisition of additional software licenses, laboratory equipment, more office supplies and teaching and research materials.

C.11 Estimated costs, available funds and probable funding sources

This budget presented in this section is preliminary since the actual fiscal impact statement will be prepared by the Budget Office. The rationale for the use of adjunct faculty is described previously in Section C.8. In addition The Department of Mechanical Engineering expects external funding, from the federal, and District agencies as well as industries, after the successful implementation of the MSME program. Current initiatives of the department, primarily in Mechanical Engineering, include (i) advance manufacturing from 2012-2014 under DOE-NNSA funded project and (ii) micro-nanofabrication laboratory sponsored by air force office of scientific research to promote multidisciplinary research. The Mechanical Engineering faculty is involved in these proposals.

As student enrollment increases the requirement of additional full-time faculty is needed for the Mechanical Engineering program. Moreover, institutional resources including financial support in the first three years may be needed to help jumpstart the program. Part of this funding will be used to fund research activities, support research and teaching assistants in the program, and possibly hire adjunct faculty members.

Currently, there are several recently awarded grants that will be used to support the MSME program:

1. The MSME program with a focus on Advanced Manufacturing will be supported by a Department of Energy grant. This grant will be available from 2014-2017 and may continue afterwards. We will use this funding to equip our laboratories with 3D printers, advance manufacturing equipment, and providing funding for student research and projects. This grant will also enable students from MSME program to do internships in the area of advance manufacturing at the Kansas City Plant in Missouri and the Y-12 plant in Tennessee.

2. The Nanotechnology, as well as Biomedical and Renewable Energy Engineering paths of the MSME program, will be supported by the newly developed, state-of-the-art Nanotechnology Application Laboratory the Microscopy and Device Characterization Laboratory at UDC. Equipment for these laboratories has been funded by the Air Force Office of Sponsored Research (AFOSR), the National Science Foundation, and the Department of Energy.
3. The MSME program with a focus on Renewable Energy will be supported by an ongoing National Science Foundation (NSF) grant (2014-2017). This grant focuses on integrating renewable energy education with the smart grid.
4. Additional funding from the NSF and various government agencies will be targeted (including those set aside for HBCUs) to support Research Assistants in Nanotechnology and Advanced Manufacturing.

Moreover, in order to make this program sustainable, it is proposed that the MSME will start with one or two tracks in the fall of 2015 (likely in Advanced Manufacturing or Nanotechnology) and other tracks will be introduced subject to the availability of resources and/or extramural funding.

C.12 Adequacy of supportive library and technical resources

The supportive library and technical resources are adequate to start the program. However, it may be required the UDC subscription to some of the digital libraries for various discipline specific journals and books. We will work collaboratively with the LRD on these acquisitions.

APPENDIX –A

Detailed Catalog Descriptions for Courses in the Program

Course Name & Number	Course Description
ELEC – 507 Probability and Random Processes (3 crd.)	This course deals with foundations for the engineering analysis of random processes: Review of probability theory, Introduction to stochastic processes, Continuous time and discrete time processes, Mean functions, correlation functions, covariance functions, noise, Strict- and wide-sense stationarity, ergodicity, Gaussian processes, power spectral densities, mean square estimation, Markov processes. Prerequisite: Graduate standing and understanding of probability at the level of 3531-307 or consent of instructor.
BGMT-509 The System Approach – Project Management (3 crd.)	This course examines management, the systems concept and matrix management; project planning, organization, staffing, direction, and control; project management authority; project budgeting and cost analysis; project implementation and evaluation.
MECH 699 Master's Thesis (6~9 crd)	A supervised research project for thesis option equivalent to two regular three-credit courses. Topics to be determined by student and supervisor.
MECH 501 Mechatronics System Design (3 crd)	Principles of transducers and sensors and how to interface them with a process in a computer environment. Discussion topics about types of transducers and different sensors include operating principles, modeling, design considerations, and applications. Computer interfacing work includes signal conversion, interface components, and real-time applications of microcomputer systems to problems in manufacturing. Component integration and design considerations are addressed by case histories presented by the instructor. Student design projects involve problems from industry that require computer interfacing and experimental techniques. Topics include principles of transducers and sensors, signal processing, data acquisition, and computer interfacing using case studies.
MECH 502 Product Design (3crd)	Principles of Design for Manufacturing, Integrated Product and Process Design, Part geometry and its effect on assembly. Several tools and methods for design for assembly and disassembly, product rating for assembly based on geometry or assembly motions, manufacturability evaluation methods. Emphasis on optimization tools, FMEA, root cause analysis and lean manufacturing on product design. Strategy for organizing design for manufacturing techniques in industry.
MECH 503 Finite Element	Principles and applications of finite element methods. The principle

Analysis (3 crd)	of virtual work is used to develop finite element equations for the representation and analysis of engineering structures. Hand calculations and computer modeling are used to analyze two- and three-dimensional constructs.
MECH 511 Advanced Materials (3 crd)	Introduction to properties and processes of production of high strength and/or high modulus of elasticity materials including composites, fibers, ceramics, polymers, and elastomers; principles of materials selection using modern software tools; survey of design, analysis, fabrication, and testing.
MECH 505 Advanced Manufacturing (3 crd)	Mechanics and thermal models of machining, machining economics and optimization. Stability analysis of machine tools. Specialized machine process such as EDM, ECM, laser, CVD and PVD processes.
MECH 521 Rehabilitation Engineering (3 crd)	This course is aimed to educate students on project definition, and the design, development and technology transfer of potential biomedical products (in particular, those used for patient rehabilitation). During lectures, case study examples will be provided. Students will learn best practices for bioengineering device development including: product development via design and process control, intellectual property and innovation in biomedical engineering (including patents), and clinical regulatory issues, including clinical trial design.
MECH 522 Physiological Systems Analysis (3crd)	This course provides a survey of systems theory with applications and case studies from bioengineering and physiology (e.g., nerve function, muscle dynamics, cardiovascular regulation, physiologic feedback control systems, properties of muscle, cardiovascular function). Analyses within the course includes: differential equations, linear and nonlinear systems, stability, time and frequency domain methods, feedback control, and biological oscillations. Case studies readings and analysis of actual physiologic data will comprise the lab portion of this course.
MECH 531 Intermediate Heat and Mass Transfer (3crd)	This course covers problems of heat and mass transfer in greater depth and complexity than is done in those courses and incorporates many subjects that are not included or are treated lightly in undergraduate heat transfer courses; analysis is given greater emphasis than the use of correlations.
MECH 532 Engineering Numerical Modeling Methods (3crd)	Numerical methods for solving problems arising in heat and mass transfer, fluid mechanics, energy engineering, biomedical and molecular simulation. Topics: numerical linear algebra, solution of nonlinear algebraic equations and ordinary differential equations, solution of partial differential equations (e.g. Navier-Stokes), numerical methods in molecular simulation (dynamics, geometry

	optimization). All methods are presented within the context of Mechanical Engineering problems.
MECH 533 Engineering optimization (3crd)	This graduate course presents applied aspects of computational models and methods for single- and multi-objective design optimization with a focus on continuous variables. The course will involve an overview of design optimization models and methods and usage of Matlab and Excel optimization tools in homework and project assignments.
MECH 534 Failure Mechanism and Reliability (3crd)	Reliability is the ability of a product to properly function within specified performance limits, for a specified period of time, under the life cycle application conditions. By understanding reliability principles, the students have the fundamentals and skills in the field of reliability as it directly pertains to the design and the manufacture of electrical, mechanical, and electro mechanical products. The following topics will be covered: 1. Reliability concepts including failure distributions, reliability metrics, and redundancy as well as risk assessment, mitigation and management. 2.Techniques to design and manufacture electronic products with improved reliability, based on the study of Root-cause failure mechanisms. 3. Techniques to assess failures along with methods to conduct failure analysis. 4. Skills to develop a reliability program. 5. Methods to design and implement accelerated testing. 6. Methods to understand the reliability issues associated with warranties, safety, regulatory requirements, and the law
MECH 535 Nano-to-Macro Transport Processes (3crd)	Parallel treatments of photons, electrons, phonons, and molecules as energy carriers, aiming at fundamental understanding and descriptive tools for energy and heat transport processes from nanoscale continuously to macroscale. Topics include the energy levels, the statistical behavior and internal energy, energy transport in the forms of waves and particles, scattering and heat generation processes, Boltzmann equation and derivation of classical laws, deviation from classical laws at nanoscale and their appropriate descriptions, with applications in nano- and microtechnology
MECH 631 Mechanical Fundamentals and Design of Electronic Systems (3crd)	An Understanding Of The Fundamental Mechanical Principles Used In Design of Electronic Devices And Their Integration Into Electronic Systems Will be Provided. Focus Will Be Placed On The Effect Of Materials compatibility, Thermal Stress, Mechanical Stress, And Environmental exposure On Product Performance, Durability And Cost. Both Electronic devices And Package Assemblies Will Be Considered. Analysis Of Package assemblies To Understand Thermal And Mechanical Stress Effects Will Be emphasized Through Student Projects.

MECH 512 Advanced Mechatronics (3crd)	System design methods applied to intelligent electromechanical devices. Analysis of dynamic response, performance and reliability. Mechatronic design is able to optimize in a systematic manner the available methodologies to produce quality products in a timely manner. The course addresses the ideas of optimized design, modeling parameters of sensors and actuators and computer interfacing. Industrial case studies are discussed. The unifying factor of this course is the integration of various disciplines into a successful mechatronics design
MECH 506 Principles of Six Sigma (3crd)	Implementing the Six Sigma philosophy and methodology. Several tools and methods including process flow diagrams, cause and effect diagrams, failure mode and effects analysis, gage R&R, capability studies, and design of experiments. Strategy for organizing six sigma techniques in industry.
MECH 507 Supply Chain Engineering (3crd)	The course introduces the student to supply chains starting from the movement of raw materials and components into an organization, through internal processing of materials into finished goods, to the delivery of finished goods to the end-customer. The course introduces the key tactics such as risk pooling and inventory placement, integrated planning/collaboration and information sharing. The class also presents new opportunities and issues introduced by the Internet and e-commerce, discusses models and software tools for logistics network design, capacity planning and integration with product development. All models and methods for supply chain analysis and optimization are presented via lectures, case studies and class projects.
MECH 546 Nanoscale Materials and Devices (3crd)	This course teaches the fundamental difference between the properties of nanomaterials and macroscopic materials. A number of experiential activities use current technology to produce a number of materials, such as nanowires, using bottom up and top down approaches. One important component of this course teaches the ability to integrate nanomaterials into device forms. A number of characterization tools such as the Scanning Electron Microscope (SEM), and atomic force microscope (AFM) are covered as tools for nanometer scale metrology. Students will be participating in a number of experimental modules to learn about elements of I nanotechnology. They will learn to use the cleanroom and methods of photolithography, thin film deposition, and device fabrication.
MECH 547 Materials Characterization Methods (3crd)	Students will become familiar with important analytical techniques used to characterize materials such as x-ray diffraction, electron and ion microscopy, atomic force microscopy, and chemical spectroscopies.

MECH 541 Photovoltaic cells and Solar thermal systems (3crd)	This course focuses on science and technology of solar energy harvesting. One important module of this course teaches about the solar radiation and how to get maximum solar radiation at a given point. Next this course will delve into science and technology of solar thermal water and air heating systems. This course place special emphasis on photovoltaics cells (PV). This course will teach science and technology of PV cells. Various complimentary systems required to channel energy from PV cells to electrical appliances will be discussed. This course will also introduce key technological developments that are useful in making solar energy harvesting economical. This course will benefit from UDC experimental resources such as Zero energy home, solar thermal water heater trainer, vacuum tube solar thermal water heater, current-voltage meter to study the solar cell efficiency etc.
MECH 542 Fuel Cell Science and Technology (3crd)	This course show how Fuel cells can power hydrogen car, make a home self-reliant in energy, and power big stores and hotels with very high efficiency. This course provides in depth understanding of fundamentals of different types of fuel cells e.g. Polymer exchange membrane fuel cells, Solid oxide fuel cells, etc. This course covers the thermodynamic principles behind voltage generation and definition of fuel cell efficiency. Science behind generating high current in fuel cell is covered under dedicated module. This course will utilize UDC state of the art experimental facilities, including Potentiostate, LabVolt fuel cell trainer; Fuel cell powered automobile, hydrogen charging station, to provide experiential learning.
MECH 545 Design of energy system (3crd)	This course analyzes the entirety of energy systems with a focus on mechanisms by which energy is produced, transported and transformed. Energy system involved, solar thermal water heating, nuclear fuel based electricity generation, refrigeration systems, geothermal heating and cooling systems will be discussed. A number of Mechanical Engineering concepts such as fluid flow through pipes, heat exchangers, and prime movers will be discussed. Students in this course will be asked to utilize heating cooling system and power plant at UDC campus. Student will also experimentally analyze solar thermal water heater systems and geothermal cooling and heating systems. This course will also include several modeling assignments about the design of pipes, heat exchangers etc. to design an energy system.
MECH 543 Wind Turbine Science and Technology (3crd)	This course teaches the science and technology for converting wind energy into electricity. This course will start with an introduction of wind resources and knowledge about selecting site for the wind turbine installation. One module of this course focus on the Horizontal axis and vertical axis wind turbines. Bernoulli principle will be utilized to explain the science of blade rotation. Different components such as yaw control, pitch control, air foil design etc will be covered, This course will immensely benefit from two 900 W horizontal axis wind turbine, vertical axis wind turbine, configurable wind turbine with various blade types. Students will

	be having a strong experiential learning course.
MECH 611 Special Topics in Mechanical Engineering (3crd)	Exploration of special topics in concurrent engineering, such as intelligent design and manufacturing. Detailed examination of feature-based design and roles of quantitative reasoning, flexible-based design and roles of quantitative reasoning, flexible fixture systems, knowledge-based process planning for mechanical and electronic components, control of manufacturing systems, tools for building expert systems, neural networks to solve manufacturing problems.
MECH 621 Special Topics in Biomedical Engineering (3crd)	The purpose of this course is to expose students to an array of topics related to BME via guest speaker lectures, case studies, and interactive small group discussions. Each semester's series is scoped toward a different topic in BME, resulting in a cycle that covers: medical ethics, research conduct, written and oral technical communication, and other medical-related topics and issues. Knowledgeable faculty and professionals in the field are BME are invited to present interactive and informative workshops to expose the student to potential topics of interest.

MASTER'S OF SCIENCE IN MECHANICAL ENGINEERING

DATA FOR FINANCIAL IMPACT STATEMENT

1. EXPENSES

This fiscal statement has been prepared as a part of proposed graduate program in the Mechanical Engineering. As per Bureau of Labor Statistics, there is an increased demand for mechanical engineers coming decade (21.1% growth). Currently school of engineering and applied sciences (SEAS) offers Bachelors of Science in Mechanical Engineering (BSME) and Bachelors of Science in Biomedical Engineering (BSBME) has been approved. This proposal has been prepared to offer Masters of Science in Mechanical Engineering (MSME). The mechanical engineering department has five full time faculty members.

In the first 3 years, the current fulltime faculty along with 2 adjunct faculty will be sufficient to meet the instructional and research demand of the program. With increasing enrollment and current undergraduate teaching load, two additional faculty members will be required by Year 5 to provide instructional support for the BSME and MSME programs.

Following table presents total incremental expense for the new MSME program for next 5 years.

Expenses	2016-17	2017-18	2018-19	2019-20	2020-21
PS (Full Time)	$0	$0	$98,880	$101,846	$226,277
PS (Adjunct)	$12,000	$12,000	$12,000	$12,000	$12,000
Total PS	$12,000	$12,000	$110,880	$113,846	$238,277
NPS	$10,000	$10,000	$10,000	$14,000	$14,000
Total Incremental Expenses	**$22,000**	**$22,000**	**$120,880**	**$127,846**	**$252,277**

Note: The faculty salary is calculated with benefits and first two years of summer salary

The total budgetary incremental expense requirements are presented in the last row of the above table from Years 1 to 5.

POTENTIAL REVENUE

Following table presents the potential revenue generated from the MSME graduate program.

Revenue	2016-17	2017-18	2018-19	2019-20	2020-21
Grant Revenue (Projected)	$75,000	$75,000	$75,000	$150,000	$150,000
# of Students	12	14	20	24	30
Tuition	$77,784	$93,470	$137,535	$169,993	$218,866
Total revenue	**$152,796**	**$168,484**	**$212,555**	**$320,017**	**$368,896**

We project that the implementation of graduate program will increase the grant activities and there will be potential revenue from the indirect costs. We anticipate that the enrollment will increase gradually from the first year of implementation with 12 students and with an average annual increase of 25%. By Year 5, the MSME enrollment would be 30. We also anticipate half of the MSME students will be from the Metropolitan DC region and half of the students are non-residents and the tuition revenues have been estimated accordingly. During next five years, it is projected that the number of undergraduate and graduate students in the department of mechanical engineering program would be 100.

Beginning in AY 2020/21, the total number of fulltime faculty, subject to overall enrollment in both BSME, BSBME and the proposed MSME program, is estimated at seven.

2. NET BENEFITS TO UDC

The proposed graduate program, Master of Science in Mechanical Engineering (MSME), is designed to meet the needs of aspiring mechanical engineering graduates, working professionals in the greater Washington DC Metropolitan area, and other national and international students. The proposed graduate program will

(i) *Provide UDC graduates a continuous path for obtaining advanced education in various sub-disciplines of mechanical engineering.*
(ii) *Enhance the existing 4-year BS Mechanical Engineering undergraduate program,*
(iii) *To provide opportunities for graduate students to assist faculty members in research and funded proposal activities,*
(iv) *Enhance research capacity and productivity, and grant production, and*
(v) *This proposed program will provide opportunity for District residents to get education from Associate to Masters degree education in mechanical engineering.*

The net revenue to the University of the District of Columbia for the MSME program is provided below:

Academic Year	2016-17	2017-18	2018-19	2019-20	2020-21
Net Revenue to UDC	$130,796	$146,484	$91,675	$192,171	$116,620

Total Net Revenue: $677,746 in the first five years of implementation of the MSME program.