MARYLAND HIGHER EDUCATION COMMMISSION
ACADEMIC PROGRAM PROPOSAL

PROPOSAL FOR:

__X__ **NEW INSTRUCTIONAL PROGRAM**

_____ **SUBSTANTIAL EXPANSION/MAJOR MODIFICATION**

_____ **COOPERATIVE DEGREE PROGRAM**

__X__ **WITHIN EXISTING RESOURCES or ____ REQUIRING NEW RESOURCES**

(For each proposed program, attach a separate cover page. For example, two cover pages would accompany a proposal for a degree program and a certificate program.)

Howard Community College
Institution Submitting Proposal

Fall 2018
Projected Implementation Date

Lower Division Certificate
Award to be Offered

Additive Manufacturing Technology
Title of Proposed Program

5399-01
Suggested HEGIS Code

15.0613
Suggested CIP Code

Science, Engineering, and Technology
Department of Proposed Program

Patti Turner
Name of Department Head

Dr. Jean Svacina
Contact Name

jsvacina@howardcc.edu
Contact E-Mail Address

443-518-4807
Contact Phone Number

Kathleen Hetherington 3/13/18
Signature and Date

President/Chief Executive Approval

Date

Date Endorsed/Approved by Governing Board

Proposal for New Certificate in Additive Manufacturing Technology

A. Centrality to institutional mission statement and planning priorities:

Howard Community College (HCC) is committed to providing educational programs that meet the diverse needs of the community and central Maryland region. The foundation for these programs is a commitment to the HCC education ideal of creating a dynamic and effective learning environment for students.

Central to all academic programs at HCC is their adherence to the college's mission statement of "providing pathways to success." The additive manufacturing technology certificate incorporates the strategic goals of the college including student success, lifelong learning, organizational excellence, and building community. The certificate is intended for students who are interested in pursuing career opportunities directly related to additive manufacturing technologies, including 3D printing. The certificate will adhere to the college's core values of innovation, nurturing, sustainability, partnerships, integrity, respect, excellence, and service.

1. Provide a description of the program, including each area of concentration (if applicable), and how it relates to the institution's approved mission.

The purpose of the additive manufacturing technology certificate is to prepare students for career entry or career advancement in additive manufacturing technology. Manufacturing is becoming increasingly technology dependent, requiring highly skilled workers familiar with digital tools. Many of the recent advances in manufacturing involve additive methods, as opposed to traditional subtractive methods. The curriculum emphasizes foundational skills in additive manufacturing technology, computer-aided design, technical physical science, and entrepreneurship, and incorporates practical, collaborative learning experiences. Students will develop analytical skills and communication skills, while applying creativity to the use of additive manufacturing and design tools. Students who complete the certificate will have access to employment in a variety of technology sectors including engineering, manufacturing, design, marketing, and sales.

2. Explain how the proposed program supports the institution's strategic goals and provide evidence that affirms it is an institutional priority.

One of HCC's strategic goals is Student Success and Lifelong Learning. This certificate differs from other programs in that it focuses on immediate workforce needs at a strategic level. Through class offerings and collaborative learning experiences, students will cultivate the critical thinking and analytical abilities that are necessary in science, technology, engineering, and mathematics (STEM) fields. Implementation of this certificate will enable HCC to improve its alignment with labor market demands. In 2014, the Maryland General Assembly passed legislation to create the Regional Additive Manufacturing Partnership of Maryland (RAMP-MD). This organization strives to assist businesses with the implementation of additive manufacturing technologies, which includes "educating a supporting workforce." Graduates of this certificate program will help to address workforce demands and support the growth of the additive manufacturing technology industry in the region.

B. Critical and compelling regional or Statewide need as identified in the State Plan.

1. Demonstrate demand and need for the program in terms of meeting present and future needs of the region and the State in general based on one or more of the following:

- **The need for the advancement and evolution of knowledge;**

- **Societal needs, including expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education;**
- **The need to strengthen and expand the capacity of historically black institutions to provide high quality and unique educational programs.**

2. **Provide evidence that the perceived need is consistent with the Maryland State Plan for Postsecondary Education (pdf)**

The increasing importance of next-generation manufacturing technologies has become a national economic priority. In April 2016, President Obama released a report on advanced manufacturing developed by the Subcommittee for Advanced Manufacturing of the National Science and Technology Council. In this report, the federal government commits its support to the advancement of technology development in key areas, including additive manufacturing. The report recognizes "the critical role of education and workforce training in building and sustaining tomorrow's advanced manufacturing industries" (p. 44).

The aforementioned presidential report also highlights the America Makes initiative and the associated Additive Manufacturing Technology Roadmap. This Roadmap includes five focus areas, two of which are directly related to offering academic programs. The Roadmap first identifies the need for "Knowledge & Awareness," defined as "[increasing] the 3D printing and additive manufacturing literacy of current users, students at all levels, academics," etc., through curriculum development and other means. The Roadmap also identifies the need for "Competency & Skills," defined as "[increasing] the proficiency of current users, students at all levels, academics, the general public, and companies potentially interested in adopting the technology by using 3D printing and additive manufacturing technologies as a creative or problem-solving tool." The Roadmap recommends "classroom-based learning" and "instructor-led labs" to facilitate this competency improvement.

Within our state, the importance of advanced manufacturing technology cannot be understated. According to the Maryland Department of Commerce, sixty percent of Maryland's manufacturers are considered "advanced," meaning they "produce high-mix, low volume, high technology products." These types of manufacturers frequently employ additive manufacturing technologies to achieve customized parts and take advantage of advanced materials. The Maryland Manufacturing Extension Partnership (MEP) and Regional Manufacturing Institute (RMI) of Maryland exist to support local manufacturers, seeking to make Maryland a national leader in manufacturing. The Maryland MEP notes on their website that "finding, training, and retaining skilled workers is one of the top issues facing manufacturers." RMI has launched a campaign to improve the image of manufacturing careers, hoping to attract millennials to the field. HCC's new certificate will support these regional efforts by addressing workforce deficiencies and changing the way that students view manufacturing.

C. Quantifiable & reliable evidence and documentation of market supply & demand in the regions and the state.

The Maryland State Plan for Postsecondary Education (MSPPE) identifies seven "significant issues" facing post-secondary education in the near future, one of which is the need to "become more adept at attracting, retaining, and graduating a more diverse population of students" in STEM fields (Maryland State Plan 2014, p. 12). The challenge for educational institutions is to provide increased opportunities for students to receive STEM education, preparing them for STEM-related occupations that are critical to economic growth in the state and region. The proposed additive manufacturing technology certificate will help to

address this challenge, as it will increase the number of students in Howard County with a STEM credential.

The MSPPE describes six broad "State Plan Goals" to guide postsecondary educational initiatives. Goal Five, Economic Growth and Vitality, is a statewide effort to "stimulate economic growth, innovation, and vitality by supporting a knowledge-based economy, especially through increasing education and training" (MD State Plan 2014, p. 51). As described in the Plan, Maryland's economy demands a highly skilled workforce trained in emerging technologies. Specifically, training for STEM occupations is an urgent and growing need in Maryland. A certificate in additive manufacturing technology will contribute to workforce development by preparing students for employment in "next generation" manufacturing occupations. This certificate will also provide an opportunity for people working in traditional manufacturing jobs, whose skills have not kept up with technological innovations, to enhance their employability in the evolving field of manufacturing.

D. Reasonableness of program duplication.

There are no duplicate certificate programs in Additive Manufacturing Technology in HCC's geographical area, which includes Anne Arundel Community College, Carroll Community College, the Community College of Baltimore County, Frederick Community College, Montgomery College, and Prince Georges Community College.

The Community College of Baltimore County's associate of applied science degree in Design, Fabrication and Advanced Manufacturing overlaps slightly with HCC's proposed Additive Manufacturing Technology certificate, but as an A.A.S. degree, it is broader in scope.

E. Relevance to high-demand programs at Historically Black Institutions (HBIs)

HCC is not designated as a historically black institution.

F. Relevance to the identity of Historically Black Institutions (HBIs)

Not applicable.

G. Adequacy of curriculum design and delivery to related learning outcomes consistent with Regulation .10 of this chapter:

1. Provide a list of courses with title, semester credit hours and course descriptions, along with a description of program requirements.

Additive Manufacturing Technology
Certificate (Career)
Application Code **330**

For curriculum information, contact the Science, Engineering, and Technology Division – Room SET 430, 443-518-1600.

This certificate equips students with creative and technical skills to enter the workforce in a business or industry utilizing additive manufacturing technology. Students will explore a variety of manufacturing technologies, including 3D printing. Students will design, model, and produce parts, gaining hands-on experience with the latest technologies in this field. Fabrication technologies will be studied for uses ranging from rapid prototyping to traditional large-scale production. This certificate

will help students prepare for the Society of Manufacturing Engineers' nationally recognized Additive Manufacturing Fundamentals Certificate exam.

		Credits
CADD 101	Introduction to Computer Aided Drafting and Design	3
CADD 103	Intermediate CAD	3
ENGT 101	Introduction to Additive Manufacturing Technology	3
ENGT 102	Engineering Materials for Rapid Prototyping	3
ENGT 201	3D Scanning and Printing	3
ENGT 202	3D Printing Design and Fabrication	4
HUMN 115	Entrepreneurship and Creativity	3
PHYS 101	Technical Physical Science	4
	Total	26

Course Descriptions:

CADD 101 Introduction to Computer Aided Design and Drafting (3 credits)
This course introduces students to the Computer-Aided Design system. Students will learn how to adapt basic technical drafting and three-dimensional design techniques to computer-generated drawings of the various design disciplines. Students will receive hands-on training and will develop the techniques that are essential in today's job market.

CADD 103 Intermediate CAD (3 credits)
Students will learn how to adapt the principles of descriptive geometry when applied to "real world" applications, involving using the CAD system to create Isometric and 3-D drawings. Students will have the opportunity to work on drawings used in various technical fields, such as mechanical engineering, architecture and electronics. Students will learn current production techniques to automate the drawing process and how to develop intelligent technical documents.

ENGT 101 Introduction to Additive Manufacturing Technology (3 credits)
This course is an introduction to additive manufacturing from an engineering technology perspective. This is the first course in the additive manufacturing certificate program, providing a broad framework of knowledge for further studies. Students will study the history, processes, equipment, industrial and commercial uses, and current trends in additive manufacturing technology.

ENGT 102 Engineering Materials for Rapid Prototyping (3 credits)
This course provides a foundational understanding of engineered materials common in additive manufacturing processes. Students will study the structure, behavior, and properties of plastics, ceramics, metals, and composites, along with the impact of process parameters of material properties. An emphasis will be placed on material selection in the design process for 3D printed components. Material testing will be performed for some physical properties.

ENGT 201 3D Scanning and Printing (3 credits)
In this course, students will learn the basic principles of 3D scanning and printing. This course will introduce students to the tools and techniques required to use 3D scanners for inspection, reverse engineering, and other applications. Students will also gain hands-on experience operating scanners, processing scan data with software tools, and converting scan data to printable 3D models. Students will explore the entire cycle from an original artifact to a scan-based model to a reproduction part.

ENGT 202 3D Printing Design and Fabrication (4 credits)
In this course, students will learn the basic principles of 3D printing and fabrication. This course will introduce students to the design practices, tools, and techniques required to produce production-quality

parts using multiple types of 3D printers. Students will also learn real-world fabrication methods and processes using industry-specific software.

HUMN 115 Entrepreneurship and Creativity (3 credits)
This course is designed to introduce students to the concept of sustainable entrepreneurship, a management process that can be applied across careers and work settings. It focuses on building entrepreneurship attitudes and behaviors that will lead to creative solutions within community and organizational environments. Course topics include the history of entrepreneurship, the role of entrepreneurs and intrapreneurs in the 21st century global economy, and the identification of entrepreneurial opportunities. The elements of creative problem solving, the development of a business concept/model, the examination of feasibility studies, and the social/moral/ethical implications of entrepreneurship are incorporated. The course is directed toward forging views of entrepreneurship and intrapreneurship as they operate in today's world.

PHYS 101 Technical Physical Science (4 credits)
This physical science course covers basic introductory physics and chemistry and is designed for Allied Health program majors (RadTech and Cardiovascular), technology majors (BMET, Computer Support, and Electronics) and other non-science majors. It consists of basic scientific mathematics and an integrated sequence of physical science and chemical principles. This course will enable students to become aware of, to identify, and to evaluate situations and/or problems in contemporary physical science that include science measurement and dimensional plus statistical analysis techniques. Special emphasis is placed upon learning physics principles and solving mathematical problems in density/specific gravity, gas laws, solutions, pressure, fluids, basic electricity, magnetism, sound and light waves, and the atomic structure of matter. The laboratory program will allow the student to develop an understanding of the fundamental principles of the above mentioned areas, including problem solving, and their application to physical phenomenon observed.

2. Describe the educational objectives and intended student learning outcomes.

Students who complete the Additive Manufacturing Technology certificate should be able to:

1. Design and model components according to best practices for additive manufacturing.
2. Select the appropriate manufacturing process and material for a given part and application.
3. Operate, troubleshoot, and perform basic repairs on additive manufacturing equipment.
4. Describe the role of additive manufacturing in product development and production in various industries.
5. Understand the ethical and legal considerations associated with additive manufacturing and intellectual property.

3. Discuss how general education requirements will be met, if applicable.

There are no general education requirements for this certificate.

4. Identify any specialized accreditation or graduation certification requirements for this program and its students

Students must pass the required courses and maintain a minimum GPA of 2.0 to earn the certificate. There are no specialized accreditation or graduation certification requirements.

5. If contracting with another institution or non-collegiate organization, provide a copy of the written contract.

Not applicable.

H. Adequacy of Articulation

Not applicable.

I. Adequacy of faculty resources (as outlined in COMAR 13B.02.03.11)

Provide a brief narrative demonstrating the quality of program faculty. Include a summary list of faculty with appointment type, terminal degree title and field, academic title/rank, status (full-time, part-time, adjunct) and the course(s) each faulty member will teach.

Howard Community College takes pride in teaching excellence, with instruction from highly qualified and dedicated faculty. Courses in this certificate will be taught by a combination of full-time and adjunct faculty, each with a combination of theoretical content knowledge, industry experience, and practical hands-on experience using additive manufacturing equipment to produce parts. The full-time faculty are listed below:

Name	Terminal Degree/Field	Academic Rank	Courses	Relevant Skills
David Hinton	B.S., Business Information Technology	Professor; Director of Technology	ENGT 101 (Intro to Additive Manufacturing) ENGT 201 (3D Scanning and Printing) ENGT 202 (3D Printing Design and Fabrication)	Computer-aided design, 3D printing, construction and architectural drafting
Mark Edelen	M.S., Mechanical Engineering	Associate Professor; Chair, Engineering & Technology	ENGT 102 (Engineering Materials for Rapid Prototyping) ENGT 201 (3D Scanning and Printing) ENGT 202 (3D Printing Design and Fabrication)	Design for manufacture; structural analysis; material property testing; computer-aided design, 3D printing
Elizabeth Noble	M.S., Management	Professor; Associate Dean, Business & Computer Systems	HUMN 115 (Entrepreneurship and Creativity)	Certified Integral Coach
David Rader	B.S., Engineering	Professor	PHYS 101 (Technical Physical Science)	Chemistry and physics for technology programs

J. Adequacy of library resources (as outlined in COMAR 13B.02.03.12)

Describe the library resources available and/or the measures to be taken to ensure resources ae adequate to support the proposed program. If the program is to be implemented within existing institutional resources, include a supportive statement by the President for library resources to meet the program's needs.

The James Clark, Jr. Library offers a wide array of print and online resources that are adequate for the proposed program. From the library's website, individuals can search the online catalog for approximately 68,000 items, including books, e-books, and audiovisual titles. Library resources may be used or borrowed by current HCC students, faculty, and staff using their HCC ID card. The library also provides access to e-

journals through online database subscriptions. Off-campus access to databases, e-journals, e-books, and online course reserves is available to the college community via a current HCC login and password.

Research assistance is available at the library service desk, by appointment, and via email. Classes and online learning objects for information literacy instruction are regularly offered. Open seven days a week in the fall and spring semesters, the library is outfitted with group study rooms, quiet zones, silent areas, and seating areas for comfortable reading. Computers are available for research and writing and there is wireless connection and power outlets for mobile devices.

Program faculty may recommend materials for the library collection. First priority will be given to those materials that support the instructional program. Orders for previewing of high-cost video and multimedia items may be arranged through the library. Specialized materials not available in the library and not appropriate for purchase for the College's collection may be requested by faculty through interlibrary loan.

K. Adequacy of physical resources (as outlined in COMAR 13B.02.03.13)
Provide an assurance that physical facilities, infrastructure and instruction equipment are adequate to initiate the program, particularly as related to spaces for classrooms, staff and faculty offices, and laboratories for studies in the technologies and sciences. If the program is to be implemented within existing institutional resources, include a supportive statement by the President for adequate equipment and facilities to meet the program's needs.

The existing facilities will be more than adequate to support all aspects of this program. Students in the Additive Manufacturing Program will take courses including lecture and lab components. The lecture class size ranges from 10 to 48 students and there is a variety of classroom configurations that the classes can be taught in. Every HCC classroom has an instructor station with a networked computer, data projector and document camera. Additionally, some of the classrooms have SMART podia, Epson BrightLink® projectors, smart boards, laptop carts, mobile white boards and flexible furniture. Faculty who teach in classrooms that are more traditional can request that laptop computers be delivered to classrooms for student use. Lab facilities relevant to this program include a CAD lab, BMET/Electronics lab, and Engineering lab. All of these lab facilities, along with the equipment contained therein, are within the new SET building. This state-of-the-art facility was completed in summer 2017, featuring labs equipped with the latest technology for instruction and for student learning. The CAD lab features high-end desktop computers outfitted with a variety of computer-aided design software packages, including those supporting 3D printing and scanning. The CAD lab also houses multiple Creaform 3D scanners and a 3D printer for rapid prototyping. In the BMET/Electronics lab, students have access to electronics test equipment and a desktop injection molding equipment. In the Engineering lab, additive manufacturing students will use a variety of 3D printers throughout the program curriculum; printers range from consumer to professional-grade, exposing students to various technologies and levels of system complexity.

L. Adequacy of financial resources (as outlined in COMAR 12B.02.03.14)

1. Complete Table 1: Resources and Table 2. Expenditures.
Finance data for the first five years of program implementation are to be entered. Figures should be presented for five years and then totaled by category for each year.

TABLE 1: RESOURCES:

Resource Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Reallocated Funds	0	0	0	0	0
2. Tuition/Fee Revenue (c + g below)	0	0	0	0	0
a. Number of F/T Students	0	0	0	0	0
b. Annual Tuition/ Fee Rate	$3264/$614	$3312//$623	$3360/$632	$3408^641	$3456/$$650
c. Total F/T Revenue (a x b)	0	0	0	0	0
d. Number of P/T Students	10	20	25	35	45
e. Credit Hour Rate	$136/25.60	$138/25.96	$140/26.34	$142/$26.72	$144/$27.10
f. Annual Credit Hour Rate	13	13	13	13	13
g. Total P/T Revenue (d x e x f)	$21,008	$42,629	$54,060	$76,767	$100,098
3. Grants, Contracts & Other External Sources	0	0	0	0	0
4. Other Sources	$2150	$5000	$6425	$8925	$11,710
TOTAL (Add 1 – 4)	$23,158	$47,629	$60,485	$85,692	$111,808

All tuition and fees are based on in-county tuition rates.

TABLE 2: EXPENDITURES:

Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Faculty (b + c below)	$15,578	$33,767	$34,442	$35,130	$35,833
a. # FTE	0.16	0.34	0.34	0.34	0.34
b. Total Salary	$12,963	$28,098	$28,660	$29,233	$29,818
c. Total Benefits	$2,615	$5,669	$5,782	$5,897	$6,015
2. Admin. Staff (b + c below)	0	0	0	0	0
a. # FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total Benefits	0	0	0	0	0
3. Support Staff (b + c below)	0	0	0	0	0
a. # FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total Benefits	0	0	0	0	0
4. Equipment	$5000	$5000	0	0	0
5. Library	0	0	0	0	0
6. New or Renovated Space	0	0	0	0	0
7. Other Expenses	$500	$500	$500	$500	$500
TOTAL (Add 1 – 7)	$21,078	$39,267	$34,942	$35,630	$36,333

- The program will be implemented with existing full-time faculty, administrative support, and laboratory support. Students in the program will be added to existing courses except for new ENGT courses (six credits in year one and seven credits in year two of the certificate). Salaries for full-time faculty are included in the expenditures table as a percentage of their salary and benefits based on the number of new credits taught in the program per year. Faculty will be responsible for teaching six credits of new courses in year one (students are in the first year of the program) and thirteen credits of new courses each of the remaining years. Salaries and benefit costs are projected to increase by 2% annually.
- Minimal equipment purchases (#4) are anticipated in year one and year two. The new SET building at HCC has all of the large equipment items needed to implement this program.
- Other Expenses (#7) includes consumable materials. These projected costs are covered by student lab fees (see Resources item #4, "Other Sources', above).

2. Provide a narrative rational for each of the resource category. If resources have been or will be reallocated to support the proposed program, briefly discuss the source of those funds.

The resources reflect revenue from tuition and lab fees paid by students in the program. Tuition and fees are projected to increase by $2 per credit annually.

M. Adequacy of provisions for evaluations of programs (as outlined in COMAR 13B.02.03.15).

Discuss procedures for evaluating courses, faculty and student learning outcomes.

This certificate will be part of the ongoing assessment process HCC has in place. Courses are assessed on an ongoing basis. Programs are assessed as a whole every five years. Faculty are evaluated on an annual basis, as part of HCC's routine process.

N. Consistency with the State's minority student achievement goals (as outlined in COMAR 13B.02.03.05 and in the State Plan for Postsecondary Education).

Discuss how the proposed program addresses minority student access & success, and the institution's cultural diversity goals and initiatives.

Howard Community College values diversity and recognizes the critical role of an educational institution in preparing its students, faculty, and staff to become contributing members of the global community. HCC's Diversity Committee promotes conversation, exchange, and an increased awareness of diversity issues affecting the college community. HCC acknowledges that diversity is more than a concept or philosophy; it is a way of being. Diversity is recognizing, appreciating, respecting, listening to and learning from the unique talents and contributions of all people.

Faculty and staff of HCC are committed to the success of each student. HCC values and has clear policies on diversity, which are followed by all employees. All employees are required to complete online training modules focused on FERPA rights and responsibilities, harassment awareness and avoidance, safety, and emergency operations, and the College Vision, Mission, Values, Beliefs, and Strategic Initiatives. Refresher training models are required at intervals determined by of the President's Team.

HCC recognizes the importance of addressing the issue of minority student achievement, as evidenced by our Silas Craft Collegians (SSC) program, Howard P.R.I.D.E. program; the SSC program focuses on recent high school graduates whose academic achievement does not reflect their true potential. The program attempts to close this gap by maximizing academic achievement, retention, graduation, and transfer. Howard P.R.I.D.E. encourages the continued academic, professional, and personal development of black and minority male students via tutoring, mentoring, service learning, leadership seminars and individual academic advising and career plans. HCC also offers student affiliate chapters of NSBE (National Society of Black Engineers) and SWE (Society of Women Engineers) to encourage early professional affiliation of minority students. The college has recently implemented a "Women in Technology" student organization.

The Additive Manufacturing Technology certificate is expected to appeal to a diverse student population in terms of gender, age, and work experience. The certificate will enroll beginning students, current students and those seeking career advancement. The marketing staff along with program co-directors will implement a marketing outreach strategy utilizing existing publications (college catalog, website, etc.) and social media. The college anticipates that the students entering the program will reflect the diversity of Howard County and central Maryland.

O. Relationship to low productivity programs identified by the Commission:

If the proposed program is directly related to an identified low productivity program, discuss who the fiscal resources (including faculty, administration, library, resources and general operating expenses) may be redistributed to this program.

Not applicable. This program is not designated as a low productivity program.

P. If proposing a distance education program, please provide evidence of the Principles of Good Practice (as outlined in COMAR 13B.02.03.22C)

Not applicable.