

Board 3: WIP - Bachelor of Science in Engineering Technology with Biomedical Concentration (BMET) Curriculum Development

Dr. Iftekhhar Ibne Basith, Sam Houston State University

Dr. Iftekhhar Ibne Basith is an Assistant Professor in the Department of Engineering Technology at Sam Houston State University, Huntsville, TX, USA. Dr. Basith has a Ph.D and Masters in Electrical and Computer Engineering from University of Windsor, ON,

Vajih Khan, Sam Houston State University

Lecturer SHSU Department of Engineering Technology

Mr. Khan has 20+years of industry experience helping companies successfully design and launch digital platforms. He teaches special topics in the Department of Engineering Technology at Sam Houston State University. Mr. Khan has a Bachelor of Science in Engineering from Purdue University and an MBA degree from Cornell University.

<https://www.linkedin.com/in/vajihkhan/>

Dr. Faruk Yildiz, Sam Houston State University

Faruk Yildiz is currently an Associate Professor of Engineering Technology at Sam Houston State University. His primary teaching areas are in Electronics, Computer Aided Design (CAD), and Alternative Energy Systems. Research interests include: low power

Prof. Sumith Yesudasan, Sam Houston State University

Assistant Professor, Department of Engineering Technology, Sam Houston State University, Huntsville, TX, USA

Melinda Holt

James Harper

kevin lord

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Iftekhar Ibne Basith, Faruk Yildiz, Vajih Khan, Sumith Yesudasan, Kevin Lord, James Harper and Melinda Holt

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Introduction

This work-in-progress article describes the curriculum development and course/lab initiation for a new concentration called Biomedical Engineering Technology (BMET) to an existing program, Bachelor of Science (B.S.) degree in Engineering Technology at Sam Houston State University (SHSU). BMET will be a 4-year concentration which prepares individuals for careers in medical and health facilities that use medical equipment, different application specific instruments like MRI machine, X-Ray machine, Ultrasound, Cardiac Catheters, ECG, EKG etc. These are the most in-demand skills in the engineering and health fields. To meet this market demand, the proposed concentration prepares learners with the necessary skills for the many biomedical career options in major health industries. The proposed concentration consists of a minimum of 122 credit hours and focuses more on the general Engineering technology courses and in addition more CHEM/BIOL courses to prepare for the background information. New courses are developed and proposed in the senior level to justify the concentration.

Career for BMET

Graduates with a degree in B.S. in Engineering Technology – Biomedical Engineering Technology (BMET) concentration will typically work in different facilities such as Hospitals, Clinics, Urgent Care, Pharmaceuticals, Insurance, Bioinstrumentation Industry/ Companies, Private Engineering Firms, Research Laboratories, and Universities & Colleges, under following titles: Clinical Engineering Technician, Clinical Engineering Technologist, Biomedical Engineering Technician, Biomedical Engineering Technologist, Biomedical Equipment Technician, Laboratory Equipment specialist, Radiological Equipment Specialist, Manufacturing Engineer - biomedical device manufacturing, Quality Engineer / QA Specialist - examining medical products after/during manufacturing process, Biomedical Engineering Researcher - research on medical solutions - Research scientist/Research engineer, Physician - this could be a "Pre-Med" program leading to medical school.

BMET Market Analysis

The driving forces to create a Biomedical Engineering Technology (BMET) concentration are the following:

- Program Health: Positively trending 3-year enrollment trends (+15.5%) with most students migrating into the program as new to the institution.
- Workforce Demand: Both state and national data projects the target occupations related to the biomedical concentration within the Engineering Technology program to increase; ten-year projections 2022 2032 show that related jobs for the biomedical concentration within the Engineering Technology program will increase more than the nation overall (+13.8% for the State of Texas compared to +10.4 nationally).
- Competitive Landscape: The State of Texas has experienced a significant decrease in programs related to this CIP at the baccalaureate level. 60.1% related programs in the State of Texas are at the associate level with 116 total completions in 2021.
- Target Jobs (Texas): Target jobs for the proposed concentration total 17,164. All target occupations are anticipated to have a growth rate through 2032; compared to the nation, Texas shows higher projected job increases over the next ten years. As of 2021 2022, the number of related job postings per month outnumber the average monthly hires (approx. 1 hire for every 2 unique posting), showing a need for graduates with skills to fill these positions.
- Target Occupation Overview: Job opportunity falls about average in relation to national data. Both compensation and demand fall slightly below the national average in the State of Texas. The field does rank high in Racial Diversity with 31,841 diverse employees employed, compared to the national average for an area of the same size, 21,569.

Sample Curriculum, Educational Objectives and Student Outcomes

The table below shows the summary of the submitted curriculum for future BMET concentration.

Bachelor of Science, Major in Engineering Technology - Concentration in BIOMEDICAL ENGINEERING TECHNOLOGY (BMET)		
Core Curriculum		42
Degree Specific Requirements		22
Major/Concentration		71
BIOL 2403	Human Anatomy and Physiology I ²	
BIOL 2404	Human Anatomy and Physiology II ²	
MATH 1420	Calculus I ¹	
ETEC 4310 (NEW)	Medical Imaging Equipment	
ETEC 4374 (NEW)	Biomedical Instrumentation I	
ETEC 4375 (NEW)	Biomedical Instrumentation II	
Total Hours		122 (with double dip)

¹ MATH 1316 or MATH 1314 or MATH 1420 or MATH 1324 satisfies the Core Curriculum requirement for Component Area II (Mathematics) and the Degree Specific requirement. MATH 1420 satisfies one credit hour requirement for Component Area IX.

² BIOL 2403 and BIOL 2404 satisfies the Core Curriculum requirement for Component Area III.

The BMET educational objectives (EO) are summarized as below, that the graduates will:

- achieve professional knowledge, skillset, and competence in Biomedical Engineering Technology.
- apply their theoretical knowledge of bioinstrumentation, electrical and electronics devices, circuits, and systems to test, troubleshoot, analyze, interpret, improve, and design biomedical equipment's.
- collaborate with other professionals as members of technical teams and will communicate effectively with both oral and writing skills.
- grow professionally through self-study, continuing education, participation in professional societies, and the pursuit of possible professional registration or licensure.
- consider the social and ethical implications of their work and will comply with all codes and regulations governing their work.

The student outcomes (SO) are summarized below:

- Identify, formulate, and solve engineering problems associated with medical devices by applying principles of engineering, science, and mathematics.
- Characterize the role of technology in modern health care and limitations of diagnosis and management of diseases with different diagnosis/imaging method.
- Compare and contrast the benefits and limitations of biomedical equipment based on patient condition in an acute and chronic healthcare setting.
- Describe the engineering analysis of selected physiological systems, such as cardiovascular system, pulmonary gas transport system, neuro-muscular spinal reflex system etc.
- Students will have an ability to design and carry out experiments and tests, analyze and interpret data, and make iterative improvements by using safe and technically correct laboratory methods.
- Students will identify and use appropriate technical literature with the help of modern information technologies, and produce clear, precise, and effective technical documents and oral presentations for both professional and general audience.

- Students will collaborate with each other in laboratory and classroom settings to work effectively in teams.
- Understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity.

Curriculum Development Process:

The Biomedical Engineering has different possible concentrations. The Texas A&M in College Station has four different tracks or concentration in their senior year – Bioinstrumentation, Biomaterials, Biomechanics and Biomolecular and Cellular Engineering. The ETEC at SHSU is applied engineering and differs from pure engineering track. After careful research and looking into other existing BMET programs, the committee agreed to move ahead with a concentration, rather than a full-fledged program to begin with. The committee looked into the Biomedical Engineering Technology concentration under the ETEC program at East Tennessee State University and took it as a skeleton to develop our own. The committee also agreed to start with “Bioinstrumentation” as the chosen track for the students based on current courses available in the ETEC program at SHSU. The reason is bifold. Number one, short processing, and approval time for a degree versus a concentration. The percentage of new courses can be less than 20% in case of concentration (which is true in this case). A more rigorous process and longer timeline is needed for a standalone degree program where required new course development is 20% or higher. The second reason is obviously to monitor the market response in terms of student enrollment. If the enrollment looks healthy, the obvious goal is to convert the concentration into a standalone degree program in near future. Geographically, SHSU is in a challenging location where we have two reputed schools, both having this degree programs. However, the advantage is hands on skill, plus easier acceptance than the competing two. The committee met bi-weekly for almost 6 months with a short break during summer and finalized the proposed curriculum (as shown in the table above) at the end of Fall 2022. The three new courses proposed are: ETEC 4310 Medical Imaging Equipment, ETEC 4374 Biomedical Instrumentation I and ETEC 4375 Biomedical Instrumentation II. These new courses were developed by College of Osteopathic Medicine with a blend of lecture and hands on skills. In addition, the courses will offer integrated internship opportunities for the students around the region. After rigorous course description matching and analysis, several existing courses from SHSU is included in the curriculum.

Plan for Assessment and Future Work

Currently, the new courses are with ETEC curriculum committee for approval, and then will proceed to college level and university level. At the point, the finalized proposal along with approved courses will move to academic planning committee for a final approval. We hope the new concentration will be in effect from Fall 2023 or latest Fall 2024 to recruit new students. The plan for assessment for this new concentration is bifold. We expect to invite an external reviewer from similar program and concentration to review our curriculum progress and provide us feedback. In addition, we plan to monitor the enrollment numbers to see if it reflects what the market study shows. The expected enrollment is 50-60 students and gradually increasing. The committee will continue to meet at least once or twice in a semester to follow the progress of the proposed concentration. Once the concentration is approved under the general ETEC program, the department plans to apply for Accreditation Board for Engineering and Technology, Inc (ABET) accreditation. ABET is not applicable for individual concentration, but for a program area. The ETEC department is in the process of recruiting a full-time faculty from Mechanical Engineering with a research focus specifically in Biomedical area. The department will also submit a request for full-time faculty depending on the progress and student enrollment. As of now, we have several experts from health sector to cover the new courses hands on. The department is also seeking The Association of Technology, Management, and Applied Engineering (ATMAE), which is a little easier to get for the general engineering technology and all the concentration we have. BMET is also a part of this accreditation process.

References:

1. https://catalog.etsu.edu/preview_program.php?catoid=42&poid=13792#tt9065