Biomedical Engineering Study Plan (Undergraduate)

Program Code: 082601

1. Training objectives

The program of Biomedical Engineering is designed to meet the development needs of the "Healthy China" initiative. It is committed to cultivating well-rounded professionals with moral integrity, intellectual competence, physical fitness, aesthetic appreciation, and a strong work ethic. Graduates are expected to possess a strong sense of social responsibility, humanistic literacy, and professional ethics; a solid foundation in mathematics, natural sciences, and biomedical engineering theories and skills; as well as capabilities in engineering design and practice, teamwork, international perspective, innovative thinking, and lifelong learning. They will be equipped to become high-level applied professionals in the field of biomedical engineering, particularly in the medical device industry, engaged in product research and design, application development, engineering management, technical support, and market promotion.

In about 5 years after graduation, students of this program are expected to achieve the following objectives through industry practice and self-directed learning:

Objective 1: To be able to consciously and effectively integrate non-technical factors such as social, health, safety, environmental, and cultural into the solution of complex engineering problems in biomedical software, hardware, and systems; understand and adhere to laws, regulations, and professional ethical standards, and possess values of sustainable development and a sense of social responsibility.

Objective 2: To be able to comprehensively apply knowledge of mathematics, natural sciences, and professional knowledge to analyze engineering problems in the principles, structures, and other engineering aspects of biomedical software, hardware, and systems.

Objective 3: To be able to comprehensively apply professional knowledge and modern tools, possess engineering innovation capabilities, and solve complex engineering problems in the design, development, testing, operation, maintenance and management of biomedical software, hardware, and systems; and be competent in undertaking work in biomedical product research and design, application development, engineering management, technical support, and market promotion.

Objective 4: Possess strong professional ethics, a solid foundation in humanities and sciences, effective communication skills, and a spirit of collaboration; to be able to work as a team member or to organize and lead team collaboration, and adapt to different roles within a team setting.

Objective 5: Possess the ability to adapt to the constantly changing domestic and international environments and circumstances; be capable of continuously improving professional competence through continuous learning and self-improvement and maintain strong career competitiveness in the field of biomedical engineering, especially in the medical device industry.

2. Graduation requirements

Requirement 1 (Engineering Knowledge): Be able to apply mathematics, natural sciences, engineering fundamentals, and professional knowledge to solve complex biomedical engineering problems.

1-1 Be able to appropriately articulate complex biomedical engineering problems using mathematical, natural science, engineering fundamentals, and professional knowledge.

1-2 Be able to establish and solve appropriate mathematical models for specific biomedical devices or systems.

1-3 Be able to apply professional knowledge in biomedical engineering and mathematical analysis methods to deduce and analyze complex biomedical engineering problems.

1-4 Be able to apply engineering knowledge to compare and synthesize solutions for complex biomedical engineering problems and select optimal solutions.

Requirement 2 (Problem Analysis): Be able to apply the fundamental principles of mathematics, natural sciences, and engineering sciences, and conduct literature research to identify, articulate and analyze complex biomedical engineering problems to obtain effective conclusions.

2-1 Be able to apply the fundamental principles of mathematics, natural sciences, and engineering sciences to identify and determine the key components of complex biomedical engineering problems.

2-2 Be able to accurately articulate complex biomedical engineering problems based on scientific and engineering principles as well as mathematical modeling methods.

2-3 Be able to recognize that multiple solutions may be available for solving complex biomedical engineering problems.

2-4 Be able to apply the fundamental principles of biomedical engineering, analyze the influencing factors in engineering activities through literature research to obtain effective conclusions.

Requirement 3 (Design/Develop Solutions): Be able to design solutions for complex biomedical engineering problems including the design of systems, units (components), or process flows that meet specific requirements while demonstrating innovation and taking into account factors such as society, health, safety, law, culture, and environment.

3-1 Possess knowledge of technologies and methods required for the full cycle and entire process of biomedical device or system design and development, and understand various factors that affect design objectives and technical solutions.

3-2 Be able to design functional units (components) or subsystems of biomedical devices and systems based on specific biomedical requirements.

3-3 Be able to carry out the design of biomedical devices and systems with a demonstrated sense of innovation.

3-4 Be able to consider constraints related to health and safety, legal and ethical standards, energy efficiency and environmental impact, as well as social and cultural factors during the design of biomedical devices and systems.

Requirement 4 (Research): Be able to conduct research on complex biomedical engineering problems based on scientific principles and methods, including designing experiments, analyzing and interpreting data, and drawing rational and effective conclusions through information synthesis.

4-1 Be able to investigate and analyze solutions to complex biomedical engineering problems based on scientific principles, through literature research or relevant methodologies.

4-2 Be able to select appropriate research approaches and design experimental plans based on the characteristics of research subjects in the field of biomedical engineering.

4-3 Be able to construct experimental systems according to the experimental plan, conduct experiments safely, and correctly collect experimental data.

4-4 Be able to analyze and interpret experimental results, and draw rational and effective conclusions through the synthesis of information.

Requirement 5 (Use of Modern Tools): Be able to develop, select, and use appropriate technologies, resources, modern engineering tools, and information technology tools for complex biomedical engineering problems, including prediction and simulation, and be able to understand their limitations.

5-1 Understand the principles and methods for using commonly applied modern instruments, information technology tools, engineering tools, and simulation software in the biomedical engineering field, and recognize their limitations.

5-2 Be able to select and use appropriate instruments, information resources, engineering tools, and professional simulation software to analyze, calculate, and design solutions for complex biomedical engineering problems.

5-3 Be able to develop or select modern tools that tailored to specific needs, simulate and predict complex biomedical engineering problems for given subjects, and analyze the limitations for these tools.

Requirement 6 (Engineering and Society): Be able to conduct reasonable analysis based on relevant background knowledge of biomedical engineering to evaluate the impact of biomedical engineering practices and solutions to complex engineering problems on society, health, safety, law, and culture, and to understand the responsibilities that should be assumed.

6-1 Understand technical standards, intellectual property rights, industrial policies, and laws and regulations related to the biomedical engineering field, and comprehend the impact of different social and cultural contexts on engineering activities.

6-2 Be able to analyze and evaluate the impacts of biomedical engineering practices on society, health, safety, law, and culture, as well as the impact of these constraints on the implementation of biomedical engineering projects, and understand the responsibilities that should be assumed.

Requirement 7 (Environment and Sustainable Development): Be able to understand and evaluate the impact of engineering practices addressing complex biomedical engineering problems on the environment and on the sustainable development society.

7-1 Be aware and understand the concepts and connotations of environmental protection and sustainable development.

7-2 Be able to consider the sustainability of biomedical engineering practices from the perspective of environmental protection and sustainable development, and

evaluate the potential harm and risks to humans and the environment throughout the product life cycle.

Requirement 8 (Professional Standards): Possess a foundation in the humanities and social science as well as a strong sense of social responsibility; to understand and adhere to professional ethics and standards in biomedical engineering practice, and fulfill corresponding responsibilities.

8-1 Possess correct values, understand the relationship between the individual and society, and have a sound knowledge of China's national conditions.

8-2 Understand the engineering professional ethics and norms of honesty, impartiality, and integrity, and be able to consciously comply with them in engineering practice.

8-3 Understand the social responsibility of engineers for public safety, health, and well-being, as well as environmental protection, and be able to consciously fulfill these responsibilities in engineering practice.

Requirement 9 (Individual and Team): Be able to assume the roles of individual, team member, and leader in a multidisciplinary team.

9-1 Be able to effectively communicate and collaborate with other team members in multidisciplinary, diverse, and multi-format teams.

9-2 Be able to undertake tasks independently and collaborate in team-based work.

9-3 Be able to organize, coordinate, and lead team activities.

Requirement 10 (Communication): Be able to effectively communicate and exchange ideas with industry professionals and the general public on complex biomedical engineering issues, including writing reports and documents, delivering presentations and clearly expressing or responding to instructions. Possess a certain degree of international perspective and be capable of communication and exchange in cross-cultural contexts.

10-1 Be able to accurately express one's views, respond to questions, and understand the differences in communication with industry peers and the general public on complex biomedical engineering problems through oral presentations, written documents, graphic formats, and other means.

10-2 Be familiar with the international development trends and research hotspots in the field of biomedical engineering, and understand and respect the differences and diversity among global cultures.

10-3 Possess the language and written communication skills necessary for cross-cultural communication, and be able to engage in basic communication and exchange on biomedical engineering topics in a cross-cultural context.

Requirement 11 (Project Management): Understand and master the principles of engineering management and methods of economic decision-making, and be able to apply them in a multidisciplinary environment.

11-1 Master the management and methods of economic decision-making involved in biomedical engineering projects.

11-2 Understand the cost components throughout the entire life circle and process of biomedical engineering and related products, and comprehend the associated issues in engineering management and economic decision-making.

11-3 Be able to apply engineering management and economic decision-making methods in the process of designing and developing solutions in a multidisciplinary environment.

Requirement 12 (Lifelong Learning): Possess the awareness of self-directed and lifelong learning, and have the ability to continuously learn and adapt to development.

12-1 Be able to recognize the rapid advancement of biomedical engineering technologies in the context of social development, and clearly understand the necessity of self-directed and lifelong learning.

12-2 Possess the ability for self-directed learning, including the ability to understand biomedical engineering issues, ability to summarize and generalize, and ability to formulate questions, to address the challenges posed by new technologies and new problems.

3. Duration of study, graduation requirements, and degree awarding

1. Duration of study: The basic duration of study is four years, and the maximum duration of study shall not exceed six years.

2. Graduation requirements: Upon graduation, the following conditions must be met simultaneously to be eligible for graduation, and a graduation certificate from Shanghai Health Medical College will be issued. Within the prescribed study period, complete the minimum credits (171.5 credits) specified in the talent training program, and meet the graduation requirements for morality, intelligence, physical fitness,

aesthetics, and labor skills. Elective credits include general elective courses, professional elective courses, and interdisciplinary expansion courses, with a minimum of 12 credits for general elective courses, 6 credits for public elective courses (including 2 credits for art), 2 credits for social practice, 2 credits for innovation and entrepreneurship, and 2 credits for labor education; 10 credits for professional elective courses; 4 credits for interdisciplinary expansion courses.

3. Degree Awarding: According to the Degree Regulations of the People's Republic of China and the Measures for Awarding Bachelor's Degree to Full time Undergraduate Graduates of Shanghai Health Medical College, those who meet the conditions will be awarded a Bachelor of Engineering degree after being reviewed and approved by the school's Degree Evaluation Committee.

4. Total credits and class hours

Table 2 Statistics of Four-Year Course Hours for BME and CE programs

Classifications	**BME**			
	Contact hours	**Self-study hours**	**Total study hours**	**ECTS**
Mathematics and natural sciences	544	566	1110	37
Informatics	80	115	195	6.5
Engineering Fundamentals	384	471	855	28.5
Engineering Applications	272	493	765	25.5
Electives	224	196	420	14
Foreign Languages	256	104	360	12
General Courses	870	300	1170	39
Experiments and Practice	384	261	645	21.5
Bachelor Thesis	0	480	480	16
Total Study Hours	3014	**2986**	6000	**200**
Compulsory Courses	2790	2790	5580	186

Electives	224	196	420	14
Total Study Hours	3014	**2986**	6000	**200**
Professional Courses	1888	2582	4470	149
Non-Professional Courses	870	300	1170	39
Language Courses	256	104	360	12
Total Study Hours	3014	**2986**	6000	**200**

5. Basic Teaching Requirements

Adhering to the development philosophy of “enhancing the quality of medical services” and the strategy of “closely integrating science and engineering with biomedicine, and applied research with medical practice,” the program emphasizes practical teaching with a focus on the medical device development process. A structured pathway is followed: professional orientation, fundamental skills, integrated training, off-campus internship, where each stage not only incorporates relevant medical knowledge but also emphasizes hands-on teaching related to the clinical application and development of medical devices. In the professional orientation phase, instruction is strengthened in courses such as Clinical Medicine and Introduction to Basic Medicine. During the fundamental skills phase, in addition to teaching core electromechanical engineering knowledge, the specific characteristics of clinical application, such as target users and environmental contexts, are integrated throughout the training process. The teaching plan is closely aligned with clinical needs and applications. In the integrated training and internship phases, students' practical skills, engineering design capabilities, and social engagement are enhanced through the development of on- and off-campus experimental and training bases, hospital and enterprise placements, integration of specialized courses with engineering projects, engagement with leading industry professionals, participation in social practice activities, and involvement in extracurricular scientific and technological initiatives.

（2） Problem-based curriculum learning in the context of medical engineering integration

Problem-based learning (PBL) facilitates the close integration of engineering

technology with clinical applications. It also supports the development of students' abilities in self-directed learning, problem identification, and problem-solving, while fostering a spirit of teamwork. In the teaching process, instructors should shift away from the traditional teacher-centered, didactic model. Instead, teaching should be guided by real-world clinical problems or needs related to medical device applications. By leading students to analyze these issues and apply engineering solutions, students are enabled to effectively acquire relevant knowledge, develop analytical and problem-solving skills, and enhance their hands-on practical abilities—all while fully engaging their initiative.

（3） The combination of collaborative inquiry-based learning and process-oriented evaluation

In the teaching process, instructors should organize students into groups to address specific clinical application problems or projects. Through collaborative inquiry-based learning, students are encouraged to explore solutions together, which stimulates their enthusiasm for learning and enhances learning outcomes. Final assessment is not solely based on end-of-term experimental examinations; instead, emphasis is placed on students' performance throughout the learning process, highlighting formative assessment. The final grade may be composed of multiple elements, including performance in self-directed learning, participation and outcomes during the experimental process, lab reports, and experimental exams.

（4） Cultivation of innovation capability in medical device development

With the aim of cultivating outstanding application-oriented talents in medical device engineering, the program emphasizes individualized training through innovative experimental activities in medical devices, science and technology competitions, mentorship by excellent faculty, and entrepreneurship training. It seeks to foster an academic environment where teaching is closely integrated with research and engineering practice, thereby nurturing high-caliber, innovative professionals.

（5） Enhance internationalization and reinforce foreign language education

Foreign language teaching is implemented through goal management and tiered instruction. To ensure continuous foreign language learning throughout the four years, students entering the thesis stage should be assigned English literature reading to guarantee ongoing improvement in their language proficiency. Additionally, students' English skills are strengthened through international exchanges, overseas study

programs, and other activities, which enhance their practical application abilities in English.

（6） Strengthening the construction of the curriculum ideological and political education system with a focus on "theory, soft skills, and career development"

Guided by the education of socialist core values and aimed at cultivating outstanding professionals and responsible citizens, this initiative centers on “theoretical teaching, soft skills training, and career development” to create a supportive environment where everyone has the opportunity to succeed and fully develop their talents, thereby laying a solid ideological foundation for students’ future employment and career growth.

Integrate professional ethics education into curriculum instruction by implementing an “action-oriented teaching approach,” embedding implicit professional qualities such as career awareness, professional competence, and work ethics within courses. Fully utilize the professional courses’ resources for ethics education to continuously enhance the effectiveness of character education in the classroom. For example, the course “Principles and Applications of Medical Instruments” is divided into several modules including medical device knowledge, scientific thinking, engineering implementation, and humane management, effectively reflecting the integration of knowledge, skills, and values.

Incorporate professional ethics education into social practice activities by organizing and guiding students to engage in work-study programs, volunteer service, industry internships, entrepreneurship practice, and graduation internships. These experiences help improve students’ social adaptability, resilience in the face of challenges, and strengthen their sense of social responsibility and mission.

Embed professional ethics education into cultural development by building cultural cultivation projects and expanding the channels for cultural education. Organize soft skills events such as innovation and entrepreneurship competitions at various levels and academic vision lectures to promote teamwork and innovation among students.

（7） Core courses and featured courses

1. Core courses

Circuit Principles B, Analog Electronic Technology, Digital Electronic Technology, Introduction to Basic Medicine B, Clinical Medicine Overview E, C

Language Programming A, Python Programming, Signals and Systems, Digital Signal Processing, Microcontroller Application Technology, Biomedical Electronics, Principles and Applications of Medical Instruments, Artificial Intelligence and Applications

2. Featured courses

Single chip microcontroller application technology, circuit principles B, signals and systems, digital signal processing, biomedical electronics, principles and applications of medical instruments, comprehensive design of biomedical engineering

6.Curriculum Setting and Teaching Progress Table

Table of Supporting Relationships between Graduation Requirements and Training Objectives

Training objectives / Graduation requirements	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Requirement 1 (Engineering knowledge)		√			
Requirement 2 (Problem analysis)		√			
Requirement 3 (Design/development of solutions)	√		√		
Requirement 4 (Research)			√		
Requirement 5 (Use of modern tools)			√		
Requirement 6 (Engineering and society)	√				
Requirement 7 (Environment and sustainability)	√				
Requirement 8 (Ethics)	√				
Requirement 9 (Individual and teamwork)				√	
Requirement 10 (Communication)				√	
Requirement 11 (Project management)				√	
Requirement 12 (Life-long learning)				√	√

Goal 1: Capable of spontaneously and effectively integrating non-technical factors such as social, health, safety, environmental, and cultural considerations into solutions for complex biomedical engineering problems involving software, hardware, and systems; understanding and strictly adhering to laws, regulations, and professional ethics; and possessing sustainable development values and a sense of social responsibility.

Goal 2: Capable of comprehensively applying mathematical and natural sciences, as well as fundamental professional knowledge, to analyze engineering problems related to the principles, structures, and other aspects of biomedical software, hardware, and systems.

Goal 3: Capable of comprehensively applying professional knowledge and modern tools, possessing engineering innovation capabilities to solve complex engineering problems in the design, development, testing, operation, maintenance, and management of biomedical software, hardware, and systems; competent in roles including research, design, application development, engineering management, technical support, and market promotion of biomedical products.

Goal 4: Possesses sound professional ethics, humanistic literacy, communication skills, and a collaborative spirit; capable of working effectively both as a team member and in organizing/leading teams; adaptable to different roles within team collaborations.

Goal 5: Possesses the adaptability to navigate evolving domestic and international environments and circumstances; capable of continuously enhancing professional

competence through sustained learning and self-refinement; and maintains competitive professional standing in the biomedical engineering field, particularly within the medical device industry.

Table of Graduation Requirements Decomposition and Achievement

Course Name \ Requirements (R)		R1				R2				R3				R4				R5			R6		R7		R8			R9			R10			R11			R12	
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	1	2	1	2	1	2	3	1	2	3	1	2	3	1	2	3	1	2
Mathematics and Natural Science Courses	Advanced Mathematics A	√				√																																
	Probability Theory and Mathematical Statistics A	√				√																																
	linear algebra	√				√																																
	College Physics A	√				√																																
	College Physics Experiment A																																					
	Medical Chemistry (Inorganic) A	√				√																																
	Medical Chemistry (Organic) A	√				√																																
	Introduction to Basic Medicine B	√																																				
	Clinical Medical Summary E	√																																				
	Medical Statistics C		√				√										√	√																				
Engineering and Discipline Fundamentals Class courses	C program design															√		√																				
	Python program design															√		√																				
	Introduction to Engineering																				√		√				√						√	√	√			
	Introduction to Biomedical Engineering																					√									√						√	
	Engineering Mechanics B		√	√			√	√																														
	Circuit Principle B		√	√			√	√			√							√	√																			
	Analog Electronic Technology		√				√	√			√							√																				
	Digital Electronic Technology		√				√	√			√							√																				

Course Name	Requirements (R)	R1				R2				R3				R4				R5			R6		R7		R8			R9			R10			R11			R12	
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	1	2	1	2	1	2	3	1	2	3	1	2	3	1	2	3	1	2
	Mechanical drawing										√							√																			
	Signal and System		√	√		√				√				√				√																			
	MATLAB Fundamentals and Applications A																	√	√																		
	Comprehensive Practice of Analog Electronic Technology															√			√																		
	Comprehensive Practice of Digital Electronic Technology															√			√																		
	Electronic Integrated Design						√												√										√	√				√				
Professional courses	Biomedical Engineering Research Standards and Ethics												√											√	√	√	√										
	Biomedical sensors									√	√																										
	Application Technology of Single Chip Microcomputer		√				√				√							√																		
	Artificial Intelligence and Medical Applications		√								√																										
	Intelligent Medical Control Technology			√				√		√				√																							
	digital signal processing		√		√			√			√				√																						
	Biomedical Electronics		√		√			√		√	√				√																						
	Principles and Applications of Medical Instruments								√	√																											
	Course Design of Digital Signal Processing											√				√	√			√																	
	Course Design of Biomedical Electronics											√				√	√			√				√													
	Biomedical Engineering Integrated Design														√	√								√					√	√					√	√	√

Course Name	Requirements (R)	R1				R2				R3				R4				R5			R6		R7		R8			R9			R10			R11			R12	
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	1	2	1	2	1	2	3	1	2	3	1	2	3	1	2	3	1	2
	Professional Internship					√											√					√					√					√					√	
	Graduation Design (Thesis) A				√				√			√	√	√	√	√	√														√		√				√	√
Humanities and Social Sciences General Education Courses	Ideology, Morality, and Rule of Law																				√					√	√											
	Outline of Modern Chinese History																								√													
	Basic Principles of Marxism																								√													
	Introduction to Mao Zedong Thought and the Theoretical System of Socialism with Chinese Characteristics																						√		√													
	Introduction to Xi Jinping's Thought on Socialism with Chinese Characteristics for a New Era																						√		√													
	Situation and Policy																				√											√						
	Military theory																											√										
	Military skills																											√										
	Sports																											√										
	College English																																√						
	Psychological Health Education for College Students																									√	√											
	Career Planning and Employment Guidance A																									√	√											

Requirements (R) / Course Name		R1				R2				R3				R4				R5			R6		R7		R8			R9			R10			R11			R12	
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	1	2	1	2	1	2	3	1	2	3	1	2	3	1	2	3	1	2
	College Chinese																														√							
	Innovation and Entrepreneurship																																				√	√
	Social practice																								√													
	Labor education																								√													
	General Education Public Elective																							√	√	√												

Note: The symbol "√" in the table indicates that the course **has strong support** for the corresponding graduation requirement indicators.