Subject Description Form

Subject Code	BME31142
Subject Title	**Biomedical Engineering Research and Design Studies II – Engineer for the Community**
Credit Value	3
Level	3
Prerequisite	BME21111 Biomedical Engineering Research and Design Studies I
Objectives	The objectives of this subject are to: ▪ Introduce to students the concept and practice of service-learning ▪ Raise students' awareness of why existing healthcare technologies may not be readily available and adequate to fulfil the needs of the underserved/underprivileged populations ▪ Raise students' awareness of healthcare-related challenges and needs in Hong Kong ▪ Nurture students' empathy to the disabled people, especially those from the socioeconomically disadvantaged populations ▪ Provide opportunities for students to apply their biomedical engineering design knowledge/skills to solving real-life challenges in the community ▪ Enhance students' competencies in applying STEM knowledge and using engineering tools to solve BME problems innovatively and effectively in a team ▪ Provide opportunities for students to reflect on the roles and responsibilities of biomedical engineers in the community. ▪ Develop students' communication skills required by BME students to work effectively with healthcare professionals and clients in their future careers ▪ Enhance students' understanding of social entrepreneurship, intellectual property, medical device regulations, human ethics and potential challenges throughout the healthcare product development cycle.

Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Link their service-learning activities and experiences with academic content of the subject b. Demonstrate empathy for people in need and a strong sense of civic responsibility c. Evaluate people's needs by considering the healthcare issues in the community d. Understand the role and responsibilities both as a professional biomedical engineer and as a responsible citizen e. Apply STEM knowledge to developing a healthcare product to meet desired needs within realistic constraints f. Evaluate research and professional literature, understand the working principles and practise the use of engineering techniques and modern engineering tools relevant to BME g. Design and conduct BME human experiments, as well as to analyze and interpret data to critically evaluate the performance of a healthcare product h. Apply critical skills and knowledge to the evaluation of the impacts of BME solutions in a societal context, especially the importance of health, safety and environmental considerations to both healthcare workers and the general public i. Understand social entrepreneurship, product safety regulations and potential challenges throughout the healthcare product development cycle j. Function in multi-disciplinary team with understanding of professional and ethical responsibility k. Communicate effectively with end-users, professional colleagues and other members of the community.
Contribution to Programme Outcomes (Refer to Part I Section 10)	▪ Programme Outcome 1: Demonstrate an ability to apply knowledge of mathematics, science, and engineering appropriate to the Biomedical Engineering (BME) discipline. (Practice, and Measure) ▪ Programme Outcome 2: Demonstrate an ability to design and conduct BME experiments, as well as to analyze and interpret data. (Practice and Measure) ▪ Programme Outcome 3: Demonstrate an ability to design a system, component, or process relevant to BME to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability. (Practice and Measure)

	▪ Programme Outcome 4: Demonstrate an ability to identify, formulate, and solve BME problems. (Teach, Practice, and Measure) ▪ Programme Outcome 5: Demonstrate an ability to understand the impact of BME solutions in a global and societal context, especially the importance of health, safety, and environmental considerations to both workers and the general public. (Teach, Practice and Measure) ▪ Programme Outcome 6: Demonstrate an ability to critically evaluate research and professional literature, and understand the principles and practice of conducting research in clinical and industrial environments relevant to BME. (Practice and Measure) ▪ Programme Outcome 7: Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for BME practice. (Practice, and Measure) ▪ Programme Outcome 8: Demonstrate an ability to use the computer/IT tools relevant to the BME discipline along with an understanding of their processes and limitations. (Practice, and Measure) ▪ Programme Outcome 9: Demonstrate an ability to function in multi-disciplinary teams. (Practice and Measure) ▪ Programme Outcome 10: Demonstrate an understanding of professional and ethical responsibility. (Teach, Practice and Measure) ▪ Programme Outcome 11: Demonstrate an ability to communicate effectively and advise clients, professional colleagues, and other members of the community. (Teach, Practice and Measure) ▪ Programme Outcome 12: Demonstrate an ability to recognize the need for, and to engage in life-long learning. (Practice and Measure) ▪ Programme Outcome 13: Demonstrate an understanding of contemporary issues. (Teach, Practice and Measure) ▪ Programme Outcome 14: Demonstrate an understanding of entrepreneurship and leadership. (Teach, Practice and Measure)
Subject Synopsis/ Indicative Syllabus	The topics in the course syllabus cover three major areas: **1. <u>Concept and Practice of Service-Learning</u>** ▪ Understand the social responsibility ▪ Proper attitude and behaviors in service delivery ▪ Reflection as a tool for learning ▪ Ethical issues in service-learning **2. <u>Discipline-Specific Concepts, Issues and Skills</u>** Fundamental knowledge of biomedical engineering design for problem solving including: ▪ Engineering design process and healthcare product development cycle ▪ Application of engineering principles and effective use of modern engineering tools in healthcare product development ▪ Design for reliability, safety and sustainability ▪ Biomedical terminology and layman's terms for effective

	communication with the public and healthcare professionals ▪ Understanding of social entrepreneurship, intellectual property, medical device regulations, human ethics and human subject research methodologies 3. **Project-Specific Concepts, Issues and Skills** Knowledge about and understanding of an identified target group of the community including: ▪ Market situation and impact on human psychology and behaviour ▪ Market demand for the possible preferable healthcare-related product ▪ Societal issues related to healthcare services and products available to the underserved and underprivileged population
Teaching and Learning Methodology	**1. e-Learning Module (10 hours)** In this part of the course, students are required to complete 10 hours of e-Learning activities related to the basic concept and practice in service-learning (developed by the Service-Learning and Leadership Office at PolyU). The e-Learning module includes readings, exercises and assessments. Students are required to complete this part within the first week of the semester in which they are taking the course. **2. Discipline-specific lectures and seminars (6 hours)** The lectures and seminars will be conducted by the subject team. The aim is to enhance students' understanding of social entrepreneurship, intellectual property, medical device regulations, human ethics and potential challenges throughout the healthcare product development cycle. How these factors could affect the quality of healthcare received by the underserved or underprivileged population will be discussed. Design for reliability, safety and sustainability through the effective use of engineering techniques and modern engineering tools relevant to BME will be emphasized. Students are also required to complete activities to get familiar with the use of biomedical terminology and layman's terms for effective communication with the public and healthcare professionals.

Teaching and Learning Methodology	**3. Project-specific lectures and seminars (6 hours)** The lectures and seminars will be conducted by the subject team and/or other speakers who have experience in using/developing healthcare devices, such as industry experts and front-line healthcare service providers. These lectures and seminars aim to develop students' skills in communicating with and understanding the needs of the end users, and enhance students' understanding of how the availability and accessibility of high-quality healthcare could impact on the community. Civic learning is emphasized in these lectures to increase students' awareness of societal issues and possible reasons why off-the-shelf healthcare products may not be adequate to fulfil the needs of the underserved or underprivileged community; and to equip students with the knowledge of moral and ethical considerations/issues related to the prescription and use of healthcare tools. **4. Service-learning projects** During the compulsory subject BME21111 Biomedical Engineering Research and Design Studies I, BME students should have already formed project teams and discussed with the end-user(s) to identify their needs, which may not be easily fulfilled by existing products. Students in this SL subject will further focus on the societal issue by: 1) implementing their product development plan by building a working prototype proposed and co-designed with the end-user(s) in BME21111 (students are expected to communicate closely with the end-user(s) during the prototyping stage to refine their design), 2) teaching the end-user(s) to use the developed product prototype through face-to-face meetings and demonstration, 3) studying the psychological or behavioural changes of the beneficiaries due to the product through questionnaire(s) and/or other human research methodologies, and 4) disseminating the findings via the Jockey Club Smart Ageing Hub or on websites to alert product companies and the public about the healthcare needs of the community. Examples of projects include designing a device to facilitate the daily activities of the visually impaired people; developing a wheelchair controller for the people with disabilities; developing a medical training device for physiotherapists to enhance their skills and services to the clients, etc. The main goal of following a co-design approach is to allow PolyU project teams to gain "inside knowledge" of the perception of the end-user(s) for a better fit between the designed system and their needs. PolyU teams must listen to what the end-users have to "say" about their needs, observe what would the end-users "do" every day in their living environment in order to formulate a suitable solution. Students are expected to spend about 40 hours of direct contact with the product end-user(s) and/or the product beneficiaries. In between, students will have about 60 hours to conduct background explorations and for the design/fabrication work and evaluation of their product. The "evaluation/improvement" stage of the engineering design process is also considered as a co-design activity. Project teams will co-evaluate the product

	together with the end-user(s) to ensure the intended benefits are indeed realized before finalising the design of the prototype. The end users are from the underserved or underprivileged community. Examples of organisations that students may work with are: ▪ Kowloon Home for the Aged Blind (The Hong Kong Society for the Blind) ▪ Hong Kong Sheng Kung Hui Welfare Council ▪ Jockey Club Smart Ageing Hub ▪ Individuals (e.g. patients, healthcare professionals) **5. Reflective Journals, Project report and Presentations** Students are required to write a personal reflective journal to reflect on their experience gained during service delivery and their interaction with the end-user(s). A project report which documents the technical aspects of the product development and evaluation is required from each group. This report will summarize the design considerations, implementation and evaluations of the device, facilitating the future development by another group of students, if needed. A project exhibition will be arranged at the end of the course to allow students to report to and share their experience with the stakeholders (e.g. collaborative partners, industry representatives, healthcare professionals, elders, etc.). Both the presentation and products will be jointly graded by the audience.
Assessment Methods in Alignment with Intended Learning Outcomes	

Specific assessment method/tasks	% weighting	Intended subject learning outcomes to be assessed										
		a	b	c	d	e	f	g	h	i	j	k
1. e-Learning module on service-learning (individual)	Pass/Fail	✓	✓		✓							
2. Reflective journal (individual)	35	✓	✓	✓	✓		✓	✓				
3. Performance in service delivery (individual)	20		✓	✓				✓			✓	✓
4. Final report (group)	30			✓	✓	✓	✓	✓	✓	✓	✓	
5. Final presentation & product exhibition (group)	15			✓		✓	✓	✓	✓	✓	✓	✓
Total	100%											

	Students must obtain a pass in all of the components in order to pass the subject. **The e-Learning Module** will include learning tasks that are designed to assess students' ability to link service-learning with the academic content of the subject, their understanding and empathy for people in need as well as their understanding of their role and responsibilities in society. **Reflective journal and SWOT analysis (to be included in the Final report)** will require students to reflect on the strengths and weaknesses of the product and its potential impact on the community. There will be debriefing sessions at the end of each meeting with the end-user(s) to guide students to reflect on their experience and learning through interaction with the end-user(s). They need to write on how they see the contribution of and barrier to BME practice in the healthcare sector and the community (e.g. can be based on their study on the psychological or behavioural changes of the beneficiaries due to their designed product through questionnaire(s) and/or other human research methodologies), and how their own personal qualities, values, professional knowledge and attitude may contribute to community and healthcare services. **Performance in service delivery** is assessed based on project supervisors' observation. Each student should have a clear role and duties in the service, and should meet the hours required for implementation of their service. The students' attitude and performance in the rendering of service, their degree of engagement with the service recipients, their collaboration with other students, and interactions with the service recipients and/or collaborating partners are obviously indicators of their ability to communicate effectively with service recipients and other stakeholders, their sense of responsibility, professional ethics and their empathy for the people in need. **Project presentations/exhibition/report** allow students to demonstrate their understanding of the service recipients and community needs, and their responsibility in performing the product design task. The report will describe the planning, implementation and evaluation of the project. The project teams will present their products to supervisors, as well as other stakeholders (e.g. collaborative partners, industry representatives, healthcare professionals, elders, etc.). Both the presentation and products will be jointly graded by the audience. Students' ability to explain precisely and concisely about the product and their contribution will be assessed.	
Student Study Effort Expected	e-Learning module	10 Hrs.
	Class contact:	
	▪ Lectures and seminars	12 Hrs.
	▪ Project discussions and consultations	13 Hrs.
	Other student study effort:	
	▪ Visits to the identified target group(s) at different stages of the project	40 Hrs.

	▪ Prepare final report, reflective journal and oral presentations and participate in prototype fabrication and evaluation	50 Hrs.
	▪ Self-studying, evaluation, reflection and review	10 Hrs.
	Total student study effort	**135 Hrs.**
Reading List and References	▪ Luc de Witte, Emily Steel, Shivani Gupta, Vinicius Delgado Ramos & Uta Roentgen (2018) Assistive technology provision: towards an international framework for assuring availability and accessibility of affordable high-quality assistive technology, Disability and Rehabilitation: Assistive Technology, 13:5, 467-472, DOI: 10.1080/17483107.2018.1470264 ▪ Cook, A. M., & Polgar, J. M. (2014). Assistive technologies : principles and practice (Fourth edition.). Elsevier/Mosby. ▪ Moreira, T. (2017). Science, technology and the ageing society. Routledge. ▪ Ulrich, K.T., Product design and development, McGraw-Hill, latest edition. ▪ Fries RC, Handbook of Medical Device Design, Marcel Dekker, latest edition. ▪ King PH and Fries RC, Design of Biomedical Devices and Systems, CRC Press, latest edition. ▪ Steen, M., Manschot, M., & Koning, N. (2011). Benefits of co-design in service design projects. International Journal of Design, 5(2), 53-60.	
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