หลักสูตรวิศวกรรมศาสตรมหาบัณฑิต
สาขาวิชาวิศวกรรมชีวการแพทย์
(หลักสูตรนานาชาติ / หลักสูตรปรับปรุง พ.ศ. ๒๕๖๖)

MASTER OF ENGINEERING PROGRAM
IN
BIOMEDICAL ENGINEERING
(INTERNATIONAL PROGRAM / REVISED PROGRAM B.E. 2566)

FACULTY OF ENGINEERING
AND
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY

CONTENT

Appendix

Collaboration with Foreign Universities
Master Program in Biomedical Engineering
(International Program / Revised Program in 2023)

Name of Institution	Mahidol University
Campus/Faculty/Department	Faculty of Engineering
	Department of Biomedical Engineering

Section 1 General Information

1. Curriculum Name

Thai	หลักสูตรวิศวกรรมศาสตรมหาบัณฑิต สาขาวิชาวิศวกรรมชีวการแพทย์ (หลักสูตรนานาชาติ)
English	Master of Engineering Program in Biomedical Engineering (International Program)

2. Name of Degree and Major

Full Title	Thai: วิศวกรรมศาสตรมหาบัณฑิต (วิศวกรรมชีวการแพทย์)
Abbreviation	Thai: วศ.ม. (วิศวกรรมชีวการแพทย์)
Full Title	English: Master of Engineering (Biomedical Engineering)
Abbreviation	English: M.Eng. (Biomedical Engineering)

3. Major Subjects –None-

4. Required Credits: not less than 36 credits

5. Curriculum Characteristics

5.1 **Curriculum type/model:** curriculum level: Master's Degree

5.2 **Language:** English

5.3 **Recruitment:** Thai or International students

5.4 **Collaboration with Other Universities:**

This program is a joint program with

Collaborating institution: University of Strathclyde

Country: United Kingdom

Types of collaboration: Dual Degree

5.5 **Graduate Degrees Offered to the Graduates**:

5.5.1 For student who choose One degree with one major at Mahidol University

Full Title Thai: วิศวกรรมศาสตรมหาบัณฑิต (วิศวกรรมชีวการแพทย์)

Abbreviation Thai: วศ.ม. (วิศวกรรมชีวการแพทย์)

Full Title English: Master of Engineering (Biomedical Engineering)

Abbreviation English: M.Eng. (Biomedical Engineering)

5.5.2 For student who choose dual degree with University of Strathclyde and be able to complete the graduation criteria specified in both programs will receive additional degree below.

Full Title English: Master of Science (Biomedical Engineering)

Abbreviation English: MSc (Biomedical Engineering)

6. Curriculum Status and Curriculum Approval

6.1 Program Revised 2023

6.2 Starting in semester 1, the academic year 2023 onwards.

6.3 Curriculum screening committee approved the program in its meeting 36/2022 on August 25, 2022**.**

6.4 The Mahidol University Council approved the program in its meeting 592 on May 24, 2023.

7. Readiness to Implement/Promote the Curriculum

The curriculum from the program is readily implemented and promoted its quality and standard according to criteria set by the Ministerial Regulation on Higher Education Curriculum Standards B.E.2565 in the academic year 2025 (2 years after implementation).

8. Career Opportunities of the Graduates

8.1 Medical Device Company: Product specialist, Research and Development Engineer, etc.

8.2 High skill and potential researcher in Biomedical Engineering or related fields

8.3 Officials in a government agency in the field of Biomedical Engineering or related fields

8.4 Biomedical Engineer

9. Name, ID Number, Title and Degree of the Faculty in Charge of the Program

No.	Identification Card Number Academic position - Name – Surname	Degree (Field of Study) University: Year of graduate	Department
1.	XXXXXXXXXXXXX Associate Professor Dr. Jackrit Suthakorn	Ph.D. (Robotics) Johns Hopkins University, USA: 2003 M.S. (Controls) Michigan Technological University, USA: 1997 B.Eng. (Mechanical Engineering) Mahidol University: 1995	Biomedical Engineering
2.	XXXXXXXXXXXXX Associate Professor Dr. Yodchanan Wongsawat	Ph.D. (Electrical Engineering) University of Texas, Arlington: 2007 M.S. (Electrical Engineering) University of Texas, Arlington: 2003 B.Eng. (Electrical Engineering) Sirindhorn International Institute of Technology, Thammasat University: 2001	Biomedical Engineering
3.	XXXXXXXXXXXXX Lecturer Dr. Pornpat Athamanolap	Ph.D. (Biomedical Engineering) Johns Hopkins University, USA: 2019 M.Sc.Eng. (Biomedical Engineering) Johns Hopkins University, USA: 2013	Biomedical Engineering

No.	Identification Card Number Academic position - Name – Surname	Degree (Field of Study) University: Year of graduate	Department
		B.Eng. (Computer Engineering) Kasetsart University (KU): 2007	
4.	XXXXXXXXXXXXX Lecturer Dr.Songpol Ongwattanakul	Ph.D. (Computer Engineering) University of Alabama, USA.: 2003 M.S. (Computer Engineering) University of Alabama, USA.: 1997 B.Eng. (Computer Engineering) King Mongkut's University of Technology Thonburi: 1994	Biomedical Engineering
5.	XXXXXXXXXXXXX Lecturer Dr. Soracha Dechaumphai (Thamphiwatana)	Ph.D. (NanoEngineering) University of California, San Diego, USA: 2014 M.S. (NanoEngineering) University of California, USA: 2011 M.E. Biomedical Engineering Colorado State University, USA: 2010 B.Pharm., Pharmaceutical Sciences Prince of Songkla University: 2006	Biomedical Engineering

10. Venue for Instruction

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University
University of Strathclyde, the United Kingdom

11. External Factors to Be Considered in Curriculum Planning

11.1 Economic Situation/Development

Technological, social and innovation development are one of the key factors for the country's economic development. According to National plan of Economic and Social Development 12 (B.E. 2560 - 2564), Thailand has formulated a strategy to develop economic competition based on 5 new industries, namely 1) Robotic industry 2) Aerospace and Logistic industry 3) Biological process industry 4) Digital industry and integrated medicine, 5) Fully integrated medical industry. These new industries generate new research directions for developing new technologies and innovations. One of the great opportunities is these developments include biomedical digital industry, medical industry, integrated medical, etc. This development also covers healthcare, telemedicine, medical services, medical devices, technology for the elderly, and other related biomedical areas. These developments can prepare the development for the next generation to have a better life and healthcare system. The production of more graduate level students and researchers can help generate these developments and invent new medical innovations. Moreover, it can prepare the social infrastructure and research structure for the new proposed industries, backbone for economic development, competitive technological in ASEAN Community, backbone technology in the south east Asia regions and the world.

11.2 Social and Cultural Situation/Development

Thailand is facing a new social and cultural change that we have not seen before. The society is transitioning into an aging society in the coming decades as the population of the newborns has been declining over the years. As a result, we may not have as many people driving the country as before. Therefore, preparing medical technological readiness is one of the crucial for this social and cultural transition. To prepare for this situation, educational institutions have to train researchers, independent researchers, innovators, and practitioners to contribute to Thailand's future development. Here, biomedical engineering and biomedical science can provide crucial training to suit these social and cultural changes. These trained graduates have the potential to lay the technological foundation for an incoming decade. Our graduates can provide contribution to a country's development, collaboration within the country and international collaboration, and technological innovations needed in the future. These infrastructure and future innovations

not only lay the foundation for the country but also bring more economical competitiveness. These factors can bring efficiency for the country's future growth.

12. The Effects Mentioned in No.11.1 and 11.2 on Curriculum Development and Relevance to the Missions of the University/Institution

12.1 Curriculum Development

The development of this curriculum focuses on teaching the foundation and research which strengthen the country's needs. It supports the mission of the university on the part of academic competency and technological innovation. It aims to enhance student to apply their knowledge to advance the biomedical development. Therefore, this curriculum will provide foundation knowledge needed for developing innovation, creation and development of novel biomedical devices, development of novel drugs or therapy, neuroscience, healthcare innovations, and related biomedical research which suits the country and university needs. Moreover, it also pushed the multi-disciplinary knowledge which allow students to further develop their skills for collaboration.

12.2 Relevance to the Missions of the University/Institution

According to items 11 and 11.2, Faculty of Engineering, Mahidol University developed the curriculum for Master's Degree in Engineering, Major in Biomedical Engineering by integrating biomedical knowledge, research skills, and innovations where students are able to integrate their knowledge for future career development. We also focus on teaching and bringing knowledge which can be used for improving the country in the future. This curriculum development directly relates to the university's missions to drive biomedical research, healthcare, economy, and industry through innovations and collaborations. It is driven by university's actions to bring healthcare knowledge, biomedical research, interdisciplinary research, arts and ethics to push the university towards the best in the country and the best internationally. Moreover, the curriculum pushes the best academic training which allows the institution to create trained graduates equipped with skills who can be leading scientists or leading persons in academia or industry.

13. Collaboration with Other Curricula of the University -None-

Section 2 Information of the Curriculum

1. Philosophy, Justification, and Objectives of the Curriculum

1.1 Philosophy and Justification of the Curriculum

The Master's Degree program in Biomedical Engineering (International Program) focuses on enriching development of biomedical engineers and disseminate of biomedical engineering knowledge to various personnel in healthcare industry. To be in accordance with Mahidol University Education Philosophy "Administering education that focuses on learners' achievements by means of a learning-centered approach for self-development of knowledge, abilities, and new skills", our program aims to educate each individual engineer as they are the center of learnings. One of the sustainable development goals defined by the United Nations, Envision 2030, includes "Good health and well-being". The new paradigm for healthcare technologies employs biomedical engineering as one of the mechanisms to enable sustainability in humanity. For the alignment with the latest NESDC's plan, Thailand aims to become the center for medical services and to deliver high-value healthcare services. Therefore, cutting-edge, high performance, medical technologies and public health workers are critical to stay competence and competitive in the national strategic expansion, and healthcare innovation research promote the collaboration between academic and global/Thai industries. This program is a multi-disciplinary program that integrate knowledge from medicines, health sciences, and engineering. Graduates from this program are considered a maker and/or value adder of healthcare innovations and technologies with the moral, ethical, and responsibility to society and Thailand.

1.2 Objectives of the Program

The Master's degree program is designed to produce graduates who are able to:

1.2.1 Design and develop medical innovations that resolves the current societal healthcare challenges by applying the principles of biomedical engineering.

1.2.3 Demonstrate effective communication, teamwork, and leadership skills, as well as engage in life-long learning and continuous self-development in biomedical engineering, or other related fields, through professional development.

1.2.3 Commit to a high standard of moral, ethical responsibility, and professional integrity in both industries, academic and research.

1.2.4 Be resilient professionals, adept in teamwork, leadership, constructive criticism, and accountability, while driving innovation in the ever-evolving landscape of biomedical engineering field.

1.3 Program Learning Outcomes (PLOs)

PLO1 Apply knowledge of biomedical engineering to the solution of complex biomedical engineering problems

PLO2 Design, conduct appropriate experiments using proper research methodology, analyze and interpret data for biomedical engineering innovation.

PLO3 Communicate and function effectively within multi-disciplinary teams.

PLO4 Comprehend professional, ethical and moral responsibility.

PLO5 Provide leadership, be capable of working in diverse environments, and create a collaborative and inclusive environment.

PLO6 Recognize the need for, and have the ability to engage in life-long learning.

2. Plan for Development and Improvement

Plan for Development/Revision	Strategies	Evidences/Indexes
The curriculum is to be revised every five years based on the policy of The Office of the Ministry of Higher Education, Science, Research and Innovation	1. Follow and evaluate the proceeding of the program every 5 year on a part of - Satisfaction of employer /entrepreneur / or those who hire graduates - Weak point analysis	1. Satisfactory evaluation report 1 time/academic year 2. Program proceeding report 1 time/academic year

Plan for Development/Revision	Strategies	Evidences/Indexes
Curriculum improvements in accordance with new technologies and innovations	Follow the advance of technology continuously	(1) Amount of attendances for the national and international conference 10 attendances / year (2) Amount of publications in academic journals 10 publications / year
Teaching development of lecturers	(1) Support lecturers to use technologies for teaching (2) Encourage lecturers to attend training, seminars or academic conferences (3) Encourage lecturers to have the opportunity to do research or academic services with other organizations	(1) Amount of teaching media that using technologies 80% of classes / academic year (2) Certificate for attending a training, seminar or academic conference 5 certificates /academic year (3) Amount of research or academic services of lecturers 10 researches or academic services / year
Curriculum improvements according to graduate's professional fields	Follow up with graduates' employers on their performance	(1) Satisfactory evaluation report from graduate's employers 1 time/academic year

Plan for Development/Revision	Strategies	Evidences/Indexes
		(2) Graduate's skills and knowledge evaluation are in level "good" or higher

Section 3 Educational Management System, Curriculum Implementation and Structure

1. Educational Management System

1.1 System: Two Semester Credit system. 1 Academic Year consists of 2 Regular Semesters, each with not less than 15 weeks of study.

1.2 Summer Session: As considered by the Curriculum Committee.

1.3 Credit Equivalence to Semester System : None

2. Curriculum Implementation

2.1 Plan 1.2 Academic (Course work and Research) : Teaching Schedule - Weekdays from Monday to Friday

2.2 Plan 2 Profession: Teaching Schedule - Weekend or Out of Working Hours

2.3 Qualifications of Prospective Students

1. Holding a Bachelor's Degree or equivalent in Biomedical Engineering, Engineering, Science, Medicine, Dentistry, Pharmacy, or other related fields
2. Other requirements shall follow those that specified by the Faculty of Graduate Studies
3. Qualifications different from 2. may be considered by the Program Administrative Committee and the Dean of the Faculty of Graduate Studies.

For students who choose the dual degree with University of Strathclyde

1. Holding a Bachelor's Degree in Biomedical Engineering, Engineering, Science, Medicine, Dentistry, Pharmacy, or an equivalent degree from either Thai or overseas universities which is accredited by the Office of the Ministry of Higher Education, Science, Research and Innovation.
2. Having a cumulative GPA not less than 3.20 in the first academic year at Mahidol University.
3. Have an IELTS score at 6.5
4. Qualifications Different from item 2. to 3. may be made by the Program Administrative Committee of Master Program in Biomedical Engineering, Mahidol University and University of Strathclyde, and the Dean of the Faculty of Graduate Studies.

2.4 Problems Encountered by New Students

Poor of English skills

2.5 Strategies for Problem Solving/Limited Requirement in No.2.3

Problems of New Students	Strategies for Problem Solving
Poor English skills	Students are required to have an English Proficiency Examination score as the requirement of Faculty of Graduate Studies, if not, they are required to take a course "English" before the first semester or between the semester.

2.6 Five-Year-Plan for Recruitment and Graduation of Students

Plan 1.2 Academic (Course work and Research)

Academic Year	2023	2024	2025	2026	2027
1st	20	20	20	20	20
2nd	-	20	20	20	20
Cumulative numbers	20	40	40	40	40
Expected number of students who graduated		20	20	20	20

Remark: the mentioned numbers are from a two-year plan.

Plan 2 Profession

Academic Year	2023	2024	2025	2026	2027
1st	20	20	20	20	20
2nd	-	20	20	20	20
Cumulative numbers	20	40	40	40	40
Expected number of students who graduated		20	20	20	20

Remark: the mentioned numbers are from a two-year plan.

2.7 Budget based on the plan

Budget: The budget is from the Department of Biomedical Engineering, Faculty of Engineering, Mahidol University.

Plan 1.2 Academic (Course work and Research)

The estimated income per student

Registration fee

Tuition xxxxxx

Thesis xxxxxx

Thesis research fee	xxxxxx
Faculty of Engineering Fee	xxxxxx
Total income per student	xxxxxxx
Estimated expenses	
Variable expenses per student	
College/university allocation	xxxxxx
Position allowance of thesis advisor and committee	xxxxxx
Faculty of Engineering Fee	xxxxxx
Total variable expenses per student	xxxxxx
Fixed expenses	
Program director payment	xxxxxxx
Program secretary payment	xxxxxx
Staff salary	xxxxxxx
Teaching payment	xxxxxx
Utility fee	xxxxx
Material fee	xxxxx
Equipment fee	xxxxx
Total Fixed expenses	**xxxxxxxx**
Number of students at break-even point	9 persons
Cost of students at break-even point	2,951,200.00 Baht
Expenses per student per academic year	1,475,600.00 Baht

Plan 2 Profession

The estimated income per student

Registration fee	
Tuition	xxxxxx
Independent Study	xxxx
Thesis research fee	xxxxx
Faculty of Engineering Fee	xxxxx
Total income per student	xxxxxxx

Estimated expenses

Variable expenses per student	
College/university allocation	xxxxx
Position allowance of thesis advisor and committee	xxxx
Faculty of Engineering Fee	xxxxx
Total variable expenses per student	xxxxx
Fixed expenses	
Staff salary	xxxxxx
Teaching payment	xxxxxx
Utility fee	xxxxx
Material fee	xxxxxxx
Equipment fee	xxxxxxx
Total Fixed expenses	**xxxxxxxx**
Number of students at break-even point	5 persons
Cost of students at break-even point	1,969,600.00 Baht
Expenses per student per academic year	984,800.00 Baht

Remark: For students who choose the Collaboration Program between Mahidol University and the University of Strathclyde for a dual degree program, will have additional expenses that students will be responsible for as follows:

· Registration fee and tuition fee is based on Agreement to Establish a Double Master's Degree Program between Mahidol University, Thailand and the University of Strathclyde

· Travel expenses.

· Accommodation and personal expenses.

2.8 Educational System: Classroom Mode

2.9 Transfer of Credits, Courses and Cross University Registration (If any)

Credits transferring must be in compliance with Mahidol University's regulations on Graduate Studies.

3. Curriculum and Instructors

3.1 Curriculum

3.1.1 Number of credits

(1) Plan 1.2 Academic: Coursework and Research

Not less than 36 credits

(2) Plan 2 Profession

Not less than 36 credits

3.1.2 Curriculum Structure

The curriculum structure is set in compliance with the Announcement of The Commission on Higher Education Standard on the Subject of Criteria and Standards of Graduate Studies B.E. 2565, as below:

(1) Plan 1.2 Academic: Coursework and Research

1) Required courses	18	credits
2) Elective courses not less than	6	credits
3) Thesis	12	credits
Total not less than	36	credits

(2) Plan 2 Profession

1) Required courses	18	credits
2) Elective courses not less than	12	credits
3) Independent Study	6	credits
Total not less than	36	credits

3.1.3 Courses in the curriculum

1) Required Courses		Credits (lecture – practice – self-study)
EGBE 517	Physiology for Biomedical Engineering	3(3-0-6)
วศชพ ๕๑๗	สรีรวิทยาสำหรับวิศวกรรมชีวการแพทย์	
EGBE 518	Engineering Mathematics for Research	3(3-0-6)
วศชพ ๕๑๘	คณิตศาสตร์วิศวกรรมเพื่อการวิจัย	

EGBE 524	Research Methodology	2(2-0-4)
วศชพ ๕๒๔	วิทยาระเบียบวิธีวิจัย	
EGBE 601	Medical Signal Processing and Instrumentation	3(3-0-6)
วศชพ ๖๐๑	การประมวลผลสัญญาณและเครื่องมือทางการแพทย์	
EGBE 607	Materials and Mechanics in Medicine	3(3-0-6)
วศชพ ๖๐๗	วัสดุและกลศาสตร์ทางการแพทย์	
EGBE 609	Fundamental of Biomedical Engineering	3(3-0-6)
วศชพ ๖๐๙	มูลฐานวิศวกรรมชีวการแพทย์	
EGBE 657	Research Seminar for Biomedical Engineers	1(1-0-2)
วศชพ ๖๕๗	สัมมนาวิจัยเพื่อวิศวกรชีวการแพทย์	

2) Elective Courses

Plan 1.2 Academic (Course work and Research) : Not less than 6 credits

Plan 2 Profession: Not less than 12 credits

Credits (lecture – laboratory – self-study)

EGBE 522	Biomedical Signal Processing	3(3-0-6)
วศชพ ๕๒๒	การประมวลผลสัญญาณชีวการแพทย์	
EGBE 523	Advanced Biomedical Image Processing	3(3-0-6)
วศชพ ๕๒๓	การประมวลผลภาพทางชีวการแพทย์ขั้นสูง	
EGBE 551	Computational Methods for Biomedical Engineering	3(3-0-6)
วศชพ ๕๕๑	วิธีคำนวณสำหรับวิศวกรรมชีวการแพทย์	
*EGBE 552	Ultrasound Technology and Application	3(3-0-6)
วศชพ ๕๕๒	เทคโนโลยีอัลตราซาวด์และการนำไปใช้งาน	
*EGBE 553	Intelligent Wearable Biosensors	3(3-0-6)
วศชพ ๕๕๓	อุปกรณ์รับรู้ชีวภาพอัจฉริยะที่สวมใส่ได้	
*EGBE 554	Healthcare Automation and Robotics	3(3-0-6)
วศชพ ๕๕๔	ระบบอัตโนมัติด้านการดูแลสุขภาพและวิทยาการหุ่นยนต์	
*EGBE 555	Metaverse in Medicine	3(3-0-6)
วศชพ ๕๕๕	เมตาเวิร์สทางการแพทย์	

*EGBE	556	Biomedical Cyber-Physical Systems	3(3-0-6)
วศชพ	๕๕๖	ระบบไซเบอร์กายภาพชีวการแพทย์	
*EGBE	557	Nonlinear System Identification and Control in Biomedical Engineering	3(3-0-6)
วศชพ	๕๕๗	การระบุเอกลักษณ์และควบคุมระบบแบบไม่เชิงเส้นในทางวิศวกรรมชีวการแพทย์	
*EGBE	558	Assistive Technologies for Enhancing Human Movement and Rehabilitation	3(3-0-6)
วศชพ	๕๕๘	เทคโนโลยีสิ่งอำนวยความสะดวกเพื่อการเสริมสร้างการเคลื่อนไหวของมนุษย์และการฟื้นฟูสมรรถภาพ	
EGBE	610	Neural Networks	3(3-0-6)
วศชพ	๖๑๐	เครือข่ายระบบประสาท	
EGBE	611	Advanced Medical Imaging	3(3-0-6)
วศชพ	๖๑๑	การสร้างภาพทางการแพทย์ขั้นสูง	
*EGBE	614	Deep Learning for Biomedical Engineering	3(3-0-6)
วศชพ	๖๑๔	การเรียนรู้เชิงลึกสำหรับวิศวกรรมชีวการแพทย์	
EGBE	617	IC Design for Wireless Medical Device and Health Care	3(3-0-6)
วศชพ	๖๑๗	การออกแบบวงจรรวมสำหรับระบบสื่อสารไร้สายทางการแพทย์	
*EGBE	626	Molecular Diagnostics for Clinical Applications	3(3-0-6)
วศชพ	๖๒๖	การประยุกต์ใช้เทคนิคอณูชีววิทยาทางการแพทย์	
*EGBE	627	Machine Learning and Data Science for Biomedical Engineering	3(3-0-6)
วศชพ	๖๒๗	การเรียนรู้ของเครื่องและวิทยาศาสตร์ข้อมูลสำหรับวิศวกรรมชีวการแพทย์	
EGBE	635	Biotechnology for Biomedical Engineering	3(3-0-6)
วศชพ	๖๓๕	เทคโนโลยีชีวภาพสำหรับวิศวกรรมชีวการแพทย์	
EGBE	642	Advanced Biomechanics	3(3-0-6)
วศชพ	๖๔๒	ชีวกลศาสตร์ขั้นสูง	
EGBE	648	Respiratory Engineering System	3(3-0-6)
วศชพ	๖๔๘	ระบบวิศวกรรมการหายใจ	
EGBE	653	Intelligent Systems	3(3-0-6)
วศชพ	๖๕๓	ระบบอัจฉริยะ	
EGBE	664	Nanobiotechnology	3(3-0-6)

วศชพ ๖๖๔ เทคโนโลยีชีวภาพระดับนาโน

EGBE 683 Special Topics in Biomedical Engineering 3(3-0-6)

วศชพ ๖๘๓ หัวข้อพิเศษทางวิศวกรรมชีวการแพทย์

In addition to elective courses mentioned above, a student may register other courses in international programs offered by other faculties equivalent to graduate studies, Mahidol University or the ones offered by other universities according to the student's interest with the approval of the curriculum committee or the advisor.

3) Thesis (Plan 1.2 Academic (Course work and Research)

Credits (lecture – laboratory – self-study)

EGBE 698 Thesis 12 (0-36-0)

วศชพ ๖๙๘ วิทยานิพนธ์

4) Inde (Plan 2 Profession)

Credits (lecture – laboratory – self-study)

EGBE 696 Independent Study 6(0-24-0)

วศชพ ๖๙๖ การค้นคว้าอิสระ

5) For Students who choose Dual Degree program, in additional to Plan 1.2: Coursework and Research Curriculum Structure, a candidate has accumulated 120 credits of taught classes (Initial Classes: 20 credits, Compulsory Class: 40 credits and Optional classes: 60 credits) from the curriculum, together with 60 credits for the BE907 MSc Project, they will be awarded an MSc (Biomedical Engineering) of University of Strathclyde

Code – Class name	Semester	Credits
Initial Classes (one of):		
BE915 Medical Science for Engineering	1	20
or		
BE911 Engineering Science	1	20

Compulsory (for MSc) Classes:		
BE918 Professional studies in Biomedical Engineering	1	10
BE919 Research Methodology	1	10
BE909 Biomedical Electronics	1	10
BE908 Biomedical Instrumentation	1	10
Optional Classes (6 to be taken for MSc):		
BE916 Introduction to Biomechanics	1	10
BE902 Prosthetics and Orthotics	2	10
BE901 Regenerative Medicine and Tissue Engineering	2	10
BE900 Tissue Mechanics	2	10
BE904 Clinical and Sports Biomechanics	2	10
BE905 Biosignal Processing and Analysis	2	10
BE912 Anatomy and Physiology	2	10
BE906 Biomaterials and Biocompatibility	2	10
BE903 Cardiovascular Devices	2	10
BE920 The Medical Device Regulatory Process	2	10
BE924 Medical Robotics	2	10
BE928 Rehabilitation Technology	2	10
Independent Research Classes:		
BE907 MSc Project	1,2 and 3	60

3.1.4 Plan 1.2 Thesis Project of the Program

Guidelines for conducting a research project are as follows:

(1) Neuroengineering and Medical Imaging

(2) Drug delivery system and tissue engineering

(3) Advanced Computing in Medicine

(4) Rehabilitation Engineering and Artificial Organs

(5) Medical Robotics

(6) Biosensors and Medical Instrumentation

3.1.5 Plan 2 Profession

Guidelines for conducting a Independent Study project are as follows:

(1) Neuroengineering and Medical Imaging

(2) Drug delivery system and tissue engineering

(3) Advanced Computing in Medicine

(4) Rehabilitation Engineering and Artificial Organs

(5) Medical Robotics

(6) Biosensors and Medical Instrumentation

3.1.6 Definition of Course Codes

Four main alphabets are defined as follows:

The first two alphabets are abbreviations of the faculty offering the course.

EG is an abbreviation of the faculty offering the course

The latter two alphabets are abbreviation of the department or the major offering the course.

BE means an abbreviation of the Department of Biomedical Engineering

3 digits of number are 5XX and 6XX indicate that the courses are in the graduate study level.

3.1.7 Study Plan

Plan 1.2 Academic (Course work and Research) : One Degree at Mahidol University

Year	Semester 1	Semester 2
1	EGBE 517 Physiology for Biomedical Engineering 3(3-0-6) EGBE 518 Engineering Mathematics for Research 3(3-0-6) EGBE 609 Fundamental of Biomedical Engineering 3(3-0-6) EGBE 657 Research Seminar for Biomedical Engineers 1(1-0-2) Elective Course 3(3-0-6) **Total 13 credits**	EGBE 524 Research Methodology 2(2-0-4) EGBE 601 Medical Signal Processing and Instrumentation 3(3-0-6) EGBE 607 Materials and Mechanics in Medicine 3(3-0-6) Elective Course 3(3-0-6) **Total 11 credits**
2	EGBE 698 Thesis 6(0-18-0) **Total 6 credits**	EGBE 698 Thesis 6(0-18-0) **Total 6 credits**

Plan 1.2: Academic (Course work and Research) : Dual Degree

Year	Semester 1	Semester 2
1	EGBE 517 Physiology for Biomedical Engineering 3(3-0-6) EGBE 518 Engineering Mathematics for Research 3(3-0-6) EGBE 609 Fundamental of Biomedical Engineering 3(3-0-6) EGBE 657 Research Seminar for Biomedical Engineers 1(1-0-2) Elective Course 3(3-0-6) **Total 13 credits**	EGBE 524 Research Methodology 2(2-0-4) EGBE 601 Medical Signal Processing and Instrumentation 3(3-0-6) EGBE 607 Materials and Mechanics in Medicine 3(3-0-6) Elective Course 3(3-0-6) **Total 11 credits**
2	BE915 Medical Science for Engineering 20 credits or BE911 Engineering Science 20 credits BE918 Professional studies in Biomedical Engineering 10 credits BE919 Research Methodology 10 credits BE909 Biomedical Electronics 10 credits BE908 Biomedical Instrumentation 10 credits BE907 MSc Project 60 credits Total 120 credits	Optional Classes 10 credits Optional Classes 10 credits Optional Classes 10 credits Optional Classes 10 credits Optional Classes 10 credits Optional Classes 10 credits Total 60 credits
3	EGBE 698 Thesis 6(0-18-0) **Total 6 credits**	EGBE 698 Thesis 6(0-18-0) **Total 6 credits**

Plan: 2 Profession

Year	Semester 1	Semester 2	Semester 3
1	EGBE 517 Physiology for Biomedical Engineering 3(3-0-6) EGBE 518 Engineering Mathematics for Research 3(3-0-6) EGBE 609 Fundamental of Biomedical Engineering 3(3-0-6) EGBE 657 Research Seminar for Biomedical Engineers 1(1-0-2) Elective Course 3(3-0-6) **Total 13 credits**	EGBE 524 Research Methodology 2(2-0-4) EGBE 601 Medical Signal Processing and Instrumentation 3(3-0-6) EGBE 607 Materials and Mechanics in Medicine 3(3-0-6) Elective Course 3(3-0-6) **Total 11 credits**	Comprehensive Examination
2	EGBE 696 Independent Study 3(0-12-0) Elective Course 3(3-0-6) Elective Course 3(3-0-6) **Total 9 credits**	EGBE 696 Independent Study 3(0-12-0) **Total 3 credits**	

3.1.6 Course Description

Please see Appendix A.

3.2 Name, I.D. Number, Title and Degree of Instructors

3.2.1 Full time instructors of the curriculum (Please see Appendix B**)**

No.	Identification Card Number Academic position - Name – Surname	Degree (Field of Study) University: Year of graduate	Department
1.	XXXXXXXXXXXXX Associate Professor Dr. Benchaporn Lertanantawong	Ph.D. (Biotechnology) King Mongkut's University of Technology Thonburi: 2007 M.Sc. (Biotechnology) King Mongkut's University of Technology Thonburi: 2002 B.Sc. (Chemistry) King Mongkut's University of Technology Thonburi: 1998	Biomedical Engineering
2.	XXXXXXXXXXXX Associate Professor Dr. Jackrit Suthakorn	Ph.D. (Robotics) Johns Hopkins University, USA: 2003 M.S. (Controls) Michigan Technological University, USA: 1997 B.Eng. (Mechanical Engineering) Mahidol University: 1995	Biomedical Engineering
3.	XXXXXXXXXXXXX Associate Professor Dr. Norased Nasongkla	Ph.D. (Polymer Science) Case Western Reserve University, USA : 2006 B.Sc. (Chemistry) Mahidol University: 2000	Biomedical Engineering

No.	Identification Card Number Academic position - Name – Surname	Degree (Field of Study) University: Year of graduate	Department
4.	XXXXXXXXXXXXX Associate Professor Dr. Panrasee Ritthipravat	D.Eng. (Mechanical Engineering) King Mongkut's University of Technology Thonburi: 2005 M.Eng. (Manufacturing Systems Engineering) King Mongkut's University of Technology Thonburi: 1999 B.Eng. (Mechanical Engineering) King Mongkut's University of Technology Thonburi: 1996	Biomedical Engineering
5.	XXXXXXXXXXXXX Associate Professor Dr. Yodchanan Wongsawat	Ph.D. (Electrical Engineering) University of Texas at Arlington, USA : 2007 M.S. (Electrical Engineering) University of Texas at Arlington, USA : 2003 B.Eng. (Electrical Engineering) Sirindhorn International Institute of Technology, Thammasat University: 2001	Biomedical Engineering
6.	XXXXXXXXXXXX Assistant Professor Dr. Chamras Promptmas	Ph.D. (Biochemistry) Mahidol University: 1994 M.Sc. (Biochemistry) Chulalongkorn University: 1980 B.Sc. (Medical Technology) Mahidol University: 1976	Biomedical Engineering
7.	XXXXXXXXXXXXX Assistant Professor Dr. Phornphop Naiyanetr	Dr.scient.med (Biomedical Engineering) Medical University of Vienna, Austria: 2010 M.Eng. (Biomedical Engineering)	Biomedical Engineering

No.	Identification Card Number Academic position - Name – Surname	Degree (Field of Study) University: Year of graduate	Department
		Mahidol University: 2000 B.Eng. (Electrical Engineering) Mahidol University: 1997	
8.	XXXXXXXXXXXXX Assistant Professor Dr. Warakorn Charoensuk	Ph.D. (Electrical Engineering) Vanderbilt University, USA.: 2001 M.S. (Electrical Engineering) Vanderbilt University, USA.: 1998 B.Eng. (Control Engineering) King Mongkut's Institute of Technology Ladkrabang: 1991	Biomedical Engineering
9.	XXXXXXXXXXXXX Lecturer Dr. Pornpat Athamanolap	Ph.D. (Biomedical Engineering) Johns Hopkins University, USA: 2019 M.Sc.Eng. (Biomedical Engineering) Johns Hopkins University, USA: 2013 B.Eng. (Computer Engineering) Kasetsart University: 2007	Biomedical Engineering
10.	XXXXXXXXXXXXX Lecturer Dr. Songpol Ongwattanakul	Ph.D. (Computer Engineering) University of Alabama, USA: 2003 M.S. (Computer Engineering) University of Alabama, USA:1997 B.Eng. (Computer Engineering) King Mongkut's University of Technology Thonburi: 1994	Biomedical Engineering

No.	Identification Card Number Academic position - Name – Surname	Degree (Field of Study) University: Year of graduate	Department
11.	XXXXXXXXXXXXX Lecturer Dr. Soracha Dechaumphai (Thamphiwatana)	Ph.D. (NanoEngineering) University of California, San Diego, USA: 2014 M.S. (NanoEngineering) University of California, USA: 2011 M.E. Biomedical Engineering Colorado State University, USA: 2010 B.Pharm. Pharmaceutical Sciences Prince of Songkla University: 2006	Biomedical Engineering
12.	XXXXXXXXXXXXX Lecturer Dr.Titipat Achakulvisut	Ph.D. (Bioengineering) University of Pennsylvania, USA: 2021 M.S., (Biomedical Engineering) Northwestern University, USA: 2017 B.Eng. (Electrical Engineering) Chulalongkorn University: 2012	Biomedical Engineering

3.2.2 Full time instructors

No.	Identification Card Number Academic position - Name – Surname	Degree (Field of Study) University: Year of graduate	Department
1.	XXXXXXXXXXXXX Lecturer Dr. Jetsada Arnin	Ph.D. (Biomedical Engineering) University of Strathclyde, UK: 2022 M.Eng. (Biomedical Engineering) Mahidol University: 2013 B.Eng. (Biomedical Engineering) Mahidol University: 2011	Biomedical Engineering
2.	XXXXXXXXXXXXX Lecturer Dr. Pracha Yambangyang	Ph.D. (Biomedical Engineering) University of Glasgow, UK: 2019 M.Eng. (Biomedical Engineering) Mahidol University: 2003 B.Eng. (Electrical Engineering) King Mongkut's University of Technology North Bangkok: 1994	Biomedical Engineering

3.2.3 Part time instructors

No.	Identification Card Number Academic position - Name – Surname	Degree (Field of Study) University: Year of graduate	Department
1.	XXXXXXXXXXXXX Associate Professor Panya Kaimuk	M.D. Chiang Mai University: 1973	Retired

4. Details of Practicum (if any): None

5. Thesis requirement

5.1 Thesis requirement

5.1.1 Short Description

Regarding the thesis requirement, it must be relevant to knowledge of Biomedical Engineering. The format of the thesis must be followed by the instruction accurately. Identifying research topic in Section 3.1.4, developing research proposal related to the topic, conducting the research including research ethics, data collection, Thesis, analysis, interpretation of the result and Thesis report, and publishing research in the journal.

5.1.2 Standard Learning Outcomes

After finishing the thesis, students are able to apply to analyze core knowledge in the field of Biomedical Engineering and develop research proposals to be published in academic journals.

5.1.3 Time Frame

The student is recommended to start Thesis research in the 1st semester of the second year.

5.1.4 Number of credits 12 credits

5.1.5 Preparation

Advising time must be provided including advice from advisors. Thesis information from official documents or websites must be continually revised and up-to-date.

5.1.6 Evaluation Process

Evaluation of thesis in every semester by Thesis advisor committee

5.2 Independent Study requirements

5.2.1 Short Description

Regarding the independent study requirement, it must be relevant to knowledge of Biomedical Engineering. The format of the independent study must be followed by the instruction accurately. Identifying research topic in Section 3.1.4, developing independent study proposal related to the topic, conducting the research including research ethics, data collection, independent study, analysis, and independent study, presenting or publishing research.

5.2.2 Standard Learning Outcomes

After finishing the independent study, students are able to apply and analyze core knowledge in the field of Biomedical Engineering to the solution of complex biomedical engineering problems.

5.2.3 Time Frame

The student is recommended to start independent study research in the 1st semester of the second year.

5.2.4 Number of credits : 6 credits

5.2.5 Preparation

Advising time must be provided including advice from advisors. independent study information from official documents or websites must be continually revised and up-to-date.

5.2.6 Evaluation Process

Evaluation of independent study in every semester by Thesis advisor committee

Section 4 Learning Outcome, Teaching Strategies and Evaluation

1. Development of Students' Specific Qualifications

Characteristics	Teaching Strategies and Student Activities
Creative problem solving	In our Biomedical Engineering Master's program, we foster creative problem-solving skills through project-based learning, real-world case studies, and interdisciplinary teamwork. Students collaborate on industry-driven projects, analyze complex challenges, and participate in hackathons and design competitions. Interactive workshops and guest lectures from leading experts provide insights into cutting-edge research and applications. By focusing on hands-on experiences and practical applications, we equip our graduates with the innovative thinking necessary to excel in biomedical engineering and contribute to this rapidly evolving field.
Academic Leadership	Encourage students to have the opportunity to participate in national or international academic conferences Including encouraging the presentation of research results to the public at least once a year Example: Conference experience sharing project
Life-long learning	Encourage students to attend national, international seminar or conference demonstrate awareness of the ongoing need for additional knowledge in biomedical engineering and locate, evaluate, integrate, and apply this knowledge appropriately. Example: Journal and innovation club project, BMEiCON

2. Development of Learning Outcome in Each Objective

Expected Outcome	Teaching Strategies	Evaluation Strategies
1. Knowledge 1.1 Explain how to apply the theories and techniques for inquiring, probing, and solving the challenges in biomedical engineering 1.2 Provide a reasonable idea for designing and developing innovations for Biomedical Engineering. 1.3 Comply the techniques of research and development to translate the knowledge in biomedical engineering rationally.	1) Lecture 2) Case studies 3) Group and individual assignment and presentation 4)Seminar 5)Report and Exam	1) Written examination 2) Quality of assignment 3) Analysis report from the case studies 4) Presentation 5) Proposal 6) Dissertations Progress
2. Skills 2.1 Solve the problems in engineering efficaciously. 2.2 Conduct the research process by themselves. 2.3 Present the result of research to the academic society, i.e., oral presentation, academic conference, and national or international publication. 2.4 Effectively use the suitable information technology for searching analyzing, creating, and presenting the academic reports or research results.	1) Group Discussion 2) Project assignment and presentation 3) Analysis of case studies 4) Seminar 5) Thesis/ independent study	1) Analysis report from the case studies 2) Provide the answers correctly and precisely, according to the academic principals. 3) Quality of assignment 4) Analysis Report of the case studies 5) Quality of report 6) Proposal 7) Thesis/ independent study Progress

Expected Outcome	Teaching Strategies	Evaluation Strategies
3. Ethics 3.1 Respect for the other rights, their believes, and their points of view. 3.2 Be punctual, have disciplines, 3.3 Do not plagiarism the work of others 3.4 Follow morality and ethics in academic and research works.	1) Discuss 2) Individual Assignment 3) Case Studies 4) Seminar	1) Behavioral observation for group discussion 2) Quality of assignment 3) Originality without plagiarism
4. Character 4.1 Foster strong relationships in biomedical teams through collaborative activities that promote empathy and understanding. 4.2 Lead interdisciplinary teams effectively, leveraging engineering expertise to tackle complex biomedical challenges. 4.3 Critique and improve biomedical engineering concepts, designs, and methodologies, fostering innovation. 4.4 Ensure accountability for individual and collective outcomes in biomedical projects, upholding ethical and professional standards.	1) Discuss 2) Individual Assignment 3) Case Studies 4) Knowledge Sharing Session 5) Group Activities	1) Behavioral observation for group discussion 2) Quality of assignment 3) Summary from discussion 4) Evaluation from group members

3. Curriculum Mapping

Please see Appendix C**.**

Section 5 Criteria for Student Evaluation

1. Grading System

Grading system and graduation shall be complied with the criteria stated in Regulations of Mahidol University on Graduate studies.

2. Evaluation Process for the Learning Outcome of Students

2.1 Continuous Assessment: Utilize quizzes, assignments, and presentations to gauge students' understanding and skills throughout the program.

2.2 Project-Based Evaluation: Assess students' creative problem-solving, teamwork, and leadership in real-world biomedical engineering projects.

2.3 Comprehensive Exams & Thesis Defense: Test students' mastery of core concepts and techniques through exams, and evaluate their research capabilities via thesis defense.

3. Graduation Requirement

Plan 1.2 Academic (Course work and Research)

For Mahidol University Degree

1) Students must complete their courses as stated in the curriculum with a minimum CUM-GPA of 3.00.

2) Propose thesis to the committee appointed by the Faculty of Graduate Studies and to the public and pass oral thesis examination as the final stage

3) The complete or part of the thesis has to be published as a review article, accepted as an innovation, acknowledged as a creative product, or accepted as an academic article that can be searched

4) Other requirements shall follow those that specified by the Faculty of Graduate Studies

For Dual Degree

1) Total time of study should not exceed the study plan.

2) Students must complete courses as stated in the curriculum at least 24 credits and thesis (12 credits) for 36 credits in total with a minimum CUM-GPA of 3.00.

3) Students must meet the English Competence Standard of Graduate Students, Mahidol University defined by the Faculty of Graduate Studies, Mahidol University.

4) Students must pass the skill development activities of the Graduate Studies, Mahidol University

5) In order to qualify for the award of the degree of MSc (Biomedical Engineering) of University of Strathclyde, a candidate must have performed to the satisfaction of the Board of Examiners and must have accumulated no fewer than 180 credits including those for all the compulsory classes within the curriculum and the Project.

6) Students must submit theses and pass the thesis defense by following the Regulations of Mahidol University on Graduate Studies. The Thesis examination must open for public interest.

7) The complete or part of the thesis has to be published as a review article, accepted as an innovation, acknowledged as a creative product, or accepted as an academic article that can be searched.

8) Students must complete all require courses at University of Strathclyde with a minimum CUM-GPA of 3.00.

9) Students must submit theses and pass the thesis defense by following the Regulations of University of Strathclyde.

10) Students receive a degree from the University of Strathclyde, when students pass the thesis defense from Mahidol University.

Plan 2 Profession (Course work and Independent Study)

1) Students must complete their courses as stated in the curriculum with a minimum CUM-GPA of 3.00.

2) Students must pass the Comprehensive Examination following Regulations of Mahidol University on Graduate Studies.

3) Students must present their Independent Study and pass the defense examination by

following Regulations of Mahidol University on Faculty Graduate Studies.

4) Other requirements shall follow those that specified by the Faculty of Graduate Studies

Section 6 Faculty Development

1. The Orientation for New Faculty Members

1) New faculty members have to attend an orientation that aims to provide knowledge and understanding about the policies of Mahidol University and the faculty
2) New full-time and part-time faculty members are trained to acknowledge and understand the curriculum, including divisional activities.
3) The heads of programs are required to explain concerned disciplines, curriculum, process of teaching, and assignments to the new faculty members.
4) To understand the process of teaching and research, the new faculty members are required to be a co-advisor of dissertations.

2. Skill and Knowledge Development for New Faculty Members

2.1 Skills Development in Teaching and Evaluation

2.1.1 Provide workshops to develop skills on teaching and learning methods by supporting to do research with the support of the university for both national and international levels.

2.1.2 Allow the instructor to participate in the evaluation and revision of the curriculum, courses, and research implemented by the university of other organizations to participate in the international conferences.

2.2 Other Academic and Professional Skill Development

2.2.1 Support instructors to do research, produce and present academic projects

2.2.2 Support instructors for proceedings of national and international conferences.

2.2.3 Support instructors to attend meetings, training sessions, seminars and studies at other institutes and organizations.

Section 7 Quality Assurance

1. Regulatory Standard

The faculty is committed to make this program reach the world- class level. The Department of Biomedical Engineering has set up a curriculum committee to develop and improve the curriculum and produce study plans with instructors, which will be used to further improve the curriculum. A systematic and comprehensive quality assurance system is essential to monitor and evaluate the program's performance regularly, ensuring it effectively achieves the Program Learning Outcomes (PLOs) while meeting the needs of students, employers, and other stakeholders.

Biomedical engineering master's program is committed to implementing a clear and comprehensive assessment and evaluation plan to measure the extent to which our students achieve the Program Learning Outcomes (PLOs) and to identify areas for improvement. This plan encompasses a combination of direct and indirect measures to provide a well- rounded understanding of our program's effectiveness.

For direct measures, we will design assessments that evaluate our students' knowledge, skills, and attitudes directly linked to the PLOs. These assessments will include exams, quizzes, projects, presentations, lab reports, research papers, and research projects. We will ensure that these assessments accurately reflect our students' mastery of the curriculum content by carefully aligning them with the PLOs.

In addition to direct measures, we will implement indirect measures to gain insights into our students' perceptions and experiences of the program, as well as its overall effectiveness. We will conduct surveys, course evaluations, and gather feedback from alumni and employers. Furthermore, we will track graduation and employment rates to assess the program's success in preparing our graduates for their careers.

To guarantee the effectiveness of our assessment and evaluation plan, we will establish clear criteria and rubrics for grading and create a regular schedule for assessments. We will involve multiple evaluators, when possible, to reduce bias. Moreover, we will analyze and interpret the data collected from both direct and indirect measures to inform continuous improvement efforts in our curriculum, teaching, and learning strategies. By implementing this well-defined assessment

and evaluation plan, we aim to ensure that our biomedical engineering master program meets the PLOs and maintains high academic standards.

We recognize the importance of engaging key stakeholders, particularly from related industries or employers, to enhance the quality and relevance of our curriculum. To gather their valuable insights, we will implement the following strategies:

1. Industry Advisory Board: Establish an Industry Advisory Board (IAB) composed of representatives from relevant industries and employers. The IAB will meet regularly to provide guidance on curriculum updates, emerging trends, and workforce needs, ensuring our program remains aligned with industry demands.

2. Employer surveys and feedback: Conduct surveys and collect feedback from employers who hire our graduates. This feedback will help us understand how well our graduates are prepared for their careers and identify any gaps or areas for improvement in our curriculum.

3. Collaboration on projects and internships: Collaborate with industry partners to offer real-world projects and internships for our students. These opportunities allow students to apply their knowledge and skills in practical settings while providing us with insights into the current industry practices and expectations.

4. Guest lectures and workshops: Invite industry experts to deliver guest lectures, workshops, and seminars to our students, enriching their learning experience and exposing them to current trends and practices in the biomedical engineering field.

5. Networking events and career fairs: Organize networking events and career fairs, allowing students, faculty, and industry representatives to interact and exchange ideas. These events can help us gather feedback from industry partners and identify potential areas for improvement in our curriculum.

6. Alumni engagement: Engage with our alumni, who can provide valuable insights into their experiences in the workforce and how well our program prepared them for their careers. Utilize alumni feedback to make necessary adjustments to the curriculum.

By implementing these strategies, we will actively involve industry partners and employers in the continuous improvement of our biomedical engineering master's curriculum. Their input will help us ensure that our program remains relevant, rigorous, and well-aligned with the needs of the biomedical engineering field.

2. Graduate Students

2.1 Program accomplishment evaluation based on graduated students' knowledge, ability, and skills that meet the program's objectives and be competent for employers in related fields or universities for higher education.

2.2 Perform graduated students' quality assessment through students themselves and their employers/supervisors for satisfactory evaluation.

3. Students

3.1 Academic and general advising

3.1.1 The Department of Biomedical Engineering holds orientations for new students in order to provide educational consultants with curriculum planning and also general consultants.

3.1.2 Each student has an advisor to provide academic guidance, specific program advisory to meet the academic goal, and help students in distress.

3.2 Students have opportunities to participate in international conferences/expos to present their works, which helps improve their public speaking skills and gain knowledge from outside for continuous improvement as well.

3.3 Students are strongly encouraged to participate in various activities provided by the Faculty of Engineering and the Faculty of Graduate Studies.

3.4 Continual improvement is promoted for all students. They are encouraged to improve both hard and soft skills to be knowledgeable and work well with others.

3.5 Students may appeal grades, academic or other issues through the program director and to the Dean of the Faculty of Graduate Studies or the assigned person, either directly in person or filing documents. The Dean will consider the implementation of such appeals.

4. Instructors

4.1 Teacher Recruitment

The department of biomedical engineering has the procedure for hiring new instructors by filtering qualification and experience. The committee then selects the applicant from the knowledge and skill from the academic presentation using the academic criteria which relate to the standard of the graduate study from the Ministry of Higher Education, Science, Research and

Innovation, the experience which will be benefit the department, and the opinion of the committee. The procedure is as follow,

- Indicate the qualification of the instructor which can pass the standard of the department by considering the academic qualification, practice experience in the field and teaching experience in academic institute. Moreover, the applicant must have English skill and able to use information and communication technology such as computer and its basic program.

- Announce and seek the qualified candidate

- Appoint the committee to select new instructors by systematic searching for record and qualification of the applicant from the trustworthy source and have a fair judgement of the information.

- Suggest an appointment and assess the work by following the university regulation.

4.2 Participation of Teachers in Curriculum Planning, Monitoring and Revision

Chairmen and instructors have joint meetings in order to plan and improve teaching and learning methods by using students' evaluations of instructors in order to review and assess the curriculum.

- Instructors along with students assess each course when the course is finished. If the course is a workshop, the workshop staff must assess the course as well.

- Instructors must attend the seminar for the curriculum and the course management.

- The instructor must inform the course committee to collect and create a curriculum adjustment document and must attend the public hearing to give an opinion.

5. Program, Study and Student Assessment

5.1 Advice on Academic and Other Issues for Student

5.1.1 The faculty appoints the instructor to provide an academic guidance for every student as well as assigning the role.

5.1.2 The faculty appoints the instructor as an advisor to the students in each academic year.

5.1.3 The faculty provides the students with an academic visitation either in Thailand or in foreign country to encourage the students to present the developed project to

the public and have the students receive the knowledge which have been develop recently and up-to-date.

5.1.4 The education and student affair staff member of the faculty will provide the guidance for the instructor and the student in the problem that beyond the capability of the student advisor and the advisor for the academic year.

5.2 Student Appeal

Faculty provides criteria and procedures for appeals under the regulations of the University. Students can appeal with regard to the Dean of the Faculty of Graduate Studies or the assigned person, either directly in person or filing documents. The Dean will consider the implementation of such appeals.

6. Learning Support

In our biomedical engineering master's program, we are dedicated to providing comprehensive learning support, ensuring our students have access to a wide range of academic and non-academic resources to facilitate their success.

6.1 Existing Teaching Resources

The Faculty of Engineering is well-equipped to offer students, instructors, and staff members access to books, course packs, and databases from Mahidol University's central library. Key teaching resources include:

- The library and electronic databases for research, with computer networks and internet access to resources from both domestic and international institutions.
- A dedicated computer room to support students in their information search and learning process.
- Scientific laboratories with necessary equipment and supplies for study and research.
- Classrooms equipped with learning media and audiovisual technology for effective course delivery.

6.2 Non-Academic Support Services

To enhance the overall student experience, we also provide non-academic support services, including:

- A dedicated student support team to assist with academic and personal issues.
- Career guidance and placement services to help students with internships, job opportunities, and career development.
- Health and wellness services, including access to counseling and healthcare facilities.
- Social and cultural activities to foster a sense of community and belonging among students.
- Mentorship programs, workshops, and training sessions to develop essential non-academic skills, such as time management, stress management, communication, and leadership.
- Networking events, seminars, and industry visits to facilitate connections between students, alumni, faculty, and industry professionals.
- Support for student clubs and organizations, encouraging community building and the development of interpersonal and organizational skills.
- Financial aid counseling and assistance, helping students explore and apply for scholarships, grants, and other funding opportunities.

6.3 Provision of Additional Teaching Resources and Continuous Improvement

The Faculty of Engineering allocates an annual budget for the acquisition of updated teaching resources, such as books, journals, electronic databases, and other teaching aids. We regularly assess resource adequacy through instructor and student satisfaction surveys conducted each semester. These online surveys help us identify areas for improvement in both the number and quality of resources available.

6.4 Budget Management and Improvement Plan

The Faculty of Engineering manages an annual budget dedicated to purchasing books, teaching and learning media, visual aids, and other materials, ensuring a supportive learning environment both inside and outside the classroom. This budget also aims to enhance non-

academic support services by allocating resources for staff training, facility improvements, and additional services as needed. Continuous improvement efforts include:

- Evaluating and enhancing facilities and services to ensure accessibility and inclusivity for all students, providing necessary accommodations when needed.

- Establishing a dedicated support system for international students, offering language assistance, cultural adjustment programs, and visa and immigration advice.

- Creating a platform for students to provide feedback and suggestions on non-academic support services, enabling us to identify areas for improvement and implement necessary changes.

By continually investing in our academic and non-academic support services and striving for improvement, we aim to provide our biomedical engineering master's program students with an enriching and successful educational experience.

7. Key Performance Indicators

The Master program, Department of Biomedical Engineering divides key performance based on the curriculum that meets the standards of Thai Qualifications Framework following conditions: (1) the compulsory performance indicators (numbers 1-5) must pass beyond expectations and (2) the total number of performance indicators must reach their goal by no less than 80 percent each year. The Key Performance Indicators are as follows:

Key Performance Indicators	Academic Year				
	2023	2024	2025	2026	2027
1. At least 80% of all full-time instructors in each program have to participate in meetings that set up plans to evaluate and revise the curriculum.	√	√	√	√	√
2. The program must have the details of the curriculum according to TQF2 which is associated	√	√	√	√	√

Key Performance Indicators	Academic Year				
	2023	2024	2025	2026	2027
with the Thai Qualifications Framework or the standards of the program (if any)					
3. The program must have course specifications and field experience specifications (if any) according to TQF3 and TQF4 before the beginning of each trimester	√	√	√	√	√
4. Instructors must produce course reports and file experience reports (if any) according to TQF5 and TQF6 within 30 days after the end of the trimester.	√	√	√	√	√
5. Instructors must produce program reports according to TQF7 within 60 days after the end of the academic year	√	√	√	√	√
6. Instructors must revise the grading of students according to learning standards indicated in TQF3 and TQF4 (if any) for at least 25 percent of courses that are offered each academic year.	√	√	√	√	√
7. Instructors must assess the development and/or improvement of teaching methods, teaching techniques or the grading system from the evaluation results in TQF 7 of the previous year.	√	√	√	√	√
8. Every new instructor (if any) has to participate in the orientation and receive adequate information on the college's teaching requirements.	√	√	√	√	√

Key Performance Indicators	Academic Year				
	2023	2024	2025	2026	2027
9. Full-time instructors must demonstrate academic and/or profession improvement at least once a year.	√	√	√	√	√
10. The number of supporting staff (if any) who demonstrate academic and/or professional improvement by at least 50 percent each year.	√	√	√	√	√
11. The level of satisfaction from the previous year's students and new graduates toward curriculum quality, with an average score of at least 3.5 out of 5			√	√	√
12. The level of satisfaction from employers of new graduates with an average score of at least 3.5 out of 5				√	√
13. Instructors have been evaluated by students after teaching at 100 percent.	√	√	√	√	√
14. The number of accepted students in accordance with the program's plan.	√	√	√	√	√
15. Graduates who get a job with a starting rate salary not lower than the rate stated by the Office of the Civil Service Commission (OCSC).				√	√

Section 8 Evaluation and Improvement of the Curriculum Implementation

1. Evaluation on the Teaching Efficiency

1.1 Evaluation of Teaching Strategies

1.1.1 Observation of student's behavior and response

1.1.2 Meeting of the department faculty for discussion and suggestion

1.1.3 Student inquiry

1.2 Evaluation of Instructors' Skills in Using Teaching Strategies

1.2.1 Assessment students in many aspects; e.g. teaching methods, punctuality, learning objective, grading criterion, and multimedia.

1.2.2 Assessment from the instructor himself and co-workers

2. Overall Evaluation of the Curriculum

2.1 Survey instructors' opinions toward students and vice versa

2.2 Survey on jobs of graduates

2.3 Curriculum evaluation from external expertise

2.4 Survey on employers' satisfaction with graduates

3. Evaluation of Curriculum Implementation in Accordance with the Curriculum

Evaluation is made annually by the chairman and instructors according to the key performance indicators of section 7, item 7. The curriculum committee must comprise 3 persons. The criteria of curriculum revision are

"Fair" means the program does not cover the first 10 Key Performance Indicators,

"Good" means the program shows all first 10 Key Performance Indicators,

"Excellent" means the program has all Key Performance Indicators

4. Review of the Evaluation and Plans for Improvement

4.1 Collecting all information, advices, and evaluations of the newly graduates, users/stakeholders, and experts

4.2 Review and analyze the above information by the faculty member in-charge of the program

4.3 Presenting the improvement plan for the program

Appendix A

Course Description

Appendix A
Course Description

(1) Required Courses

Credits (Lecture-Practice-Self Study)

EGBE 517 Physiology for Biomedical Engineering 3(3-0-6)

วศชพ ๕๑๗ สรีรวิทยาสำหรับวิศวกรรมชีวการแพทย์

Anatomy and physiology of human organ systems, Integumentary, skeletal, muscular, nervous, endocrine, cardiopulmonary, lymphatic, immune, digestive, urinary, reproductive, cellular, tissue, senses, nutrition, metabolism, developmental and inheritance systems, Applications in biomedical engineering research, Ethics in human research

กายวิภาคศาสตร์และสรีรวิทยาของระบบอวัยวะต่างๆของมนุษย์ ผิวหนัง โครงกระดูก กล้ามเนื้อ ประสาท ต่อมไร้ท่อ ระบบหัวใจและปอด น้ำเหลือง ภูมิคุ้มกัน การย่อยอาหาร ปัสสาวะ ระบบสืบพันธุ์ เซลล์ เนื้อเยื่อ ประสาทสัมผัส สารอาหาร เมแทบอลิซึม ระบบการเจริญเติบโต และการถ่ายทอดพันธุกรรม การประยุกต์ทางการวิจัยวิศวกรรมชีวการแพทย์ จริยธรรมทางการวิจัยมนุษย์

EGBE 518 Engineering Mathematics for Research 3(3-0-6)

วศชพ ๕๑๘ คณิตศาสตร์วิศวกรรมเพื่อการวิจัย

Ordinary differential equations (ODEs): Legendre's equation; Legendre polynomials; orthogonal functions: Laplace transform: Linear algebra; matrices; vectors; linear systems; matrix Eigen value problems; vector differential calculus; vector integral calculus: Fourier Analysis: Fourier series: Fourier integral: Fourier transform: Partial differential equations (PDEs); wave equation; heat equation; modeling membrane; rectangular membrane; Laplacian in polar coordinates; circular membrane and solutions

สมการอนุพันธ์สามัญ (โอดีอี) สมการเลอร์จองด์ พหุนามเลอร์จองด์ ฟังก์ชันเชิงตั้งฉาก การแปลงลาปลาซ พีชคณิตเชิงเส้น เมทริกซ์ เวกเตอร์ ระบบเชิงเส้น ปัญหาค่าไอเกนแบบเมทริกซ์ เวกเตอร์แคลคูลัสเชิงอนุพันธ์ เวกเตอร์แคลคูลัสเชิงปริพันธ์ การวิเคราะห์ฟูริเยร์ อนุกรมฟูริเยร์ ปริพันธ์ฟูริเยร์และการแปลงฟูริเยร์ สมการเชิงอนุพันธ์ย่อย (พีดีอี) สมการคลื่น สมการความร้อน การจำลองเมมเบรน เมมเบรนรูปสี่เหลี่ยมผืนผ้า ลาพลาเซียนในพิกัดเชิงขั้ว เมมเบรนรูปวงกลมและผลเฉลย

EGBE 524 Research Methodology 2(2-0-4)

วศชพ ๕๒๔ วิทยาระเบียบวิธีวิจัย

Research methodology: the research statement set up and the theoretical framework; literature review; research hypothesis; research design; data collection; data analysis and interpretation; the statistical data analysis; conclusion; case studies and presentations; moral and ethics learning; reporting and presentations; business, marketing knowledge; entrepreneurship; industrialization; research and development towards product commercialization

วิทยาระเบียบวิธีวิจัยสู่การเป็นผู้ประกอบการวิศวกรรมชีวการแพทย์ การตั้งปัญหาวิจัย และกรอบทางทฤษฎี การทบทวนวรรณกรรม สมมุติฐานการวิจัย การออกแบบวิจัย การเก็บรวบรวมข้อมูล การวิเคราะห์ข้อมูลและแปลความหมาย การวิเคราะห์ข้อมูลทางสถิติ การสรุป กรณีศึกษาและการนำเสนอ คุณธรรมและจริยธรรมในการวิจัย การทำรายงานและการนำเสนอผลงาน ความรู้เชิงธุรกิจการตลาด การเป็นผู้ประกอบการ การเชื่อมโยงภาคอุตสาหกรรม การวิจัยและพัฒนาสู่โอกาสเชิงพาณิชย์

EGBE 601 Medical Signal Processing and Instrumentation 3(3-0-6)

วศชพ ๖๐๑ การประมวลผลสัญญาณและเครื่องมือทางการแพทย์

Introduction to biomedical instrumentation: Principle of measurement system; patient monitoring system; therapeutic devices; and electrical safety; biomedical imaging: Principle and image formation of X-ray; computed tomography (CT); ultrasound imaging; nuclear magnetic resonance (NMR); magnetic resonance imaging (MRI); positron emission tomography (PET); and single photon emission computed tomography (SPECT). Introduction to medical signal processing and general medical system in biomedical engineering: convolution method; correlation method; C transform; Laplace transform; and filter design: Interpretation medical signal from spectrum analysis in time domain and frequency domain: Medical signal processing and Image processing

หลักการใช้เครื่องมือวัดในทางการแพทย์ การใช้เครื่องบำบัดรักษาทางการแพทย์ เทคนิคการใช้งานของอุปกรณ์รับรู้ การเฝ้าระวังและความปลอดภัยทางไฟฟ้าทางชีวการแพทย์ การถ่ายภาพทางชีวการแพทย์ หลักการทำงานและการสร้างภาพทางการแพทย์ของ เอ็กซ์เรย์ ซีทีสแกน อัลตราซาวน์ เอ็นเอ็มอาร์ เอ็มอาร์ไอ เพทสแกนและสเปคสแกน หลักการการประมวลผลสัญญาณทางการแพทย์และระบบทั่วไปสำหรับวิศวกรรมชีวการแพทย์โดยใช้ คอนโวลูชั่น คอรีเรชั่น การแปลงแบบซีและลาปลาซ การออกแบบตัวกรองสัญญาณ การวิเคราะห์สัญญาทางการแพทย์โดยใช้สเปกตรัม การวิเคราะห์ในโดเมนเวลาและความถี่ การแปลงสัญญาณทางการแพทย์และการแปลงภาพทางการแพทย์

EGBE 607 Materials and Mechanics in Medicine 3(3-0-6)

วศชพ ๖๐๗ วัสดุและกลศาสตร์ทางการแพทย์

Biological materials: structural proteins; polysaccharides; structural tissues Polymers; metals; ceramics and composite materials in medical applications. Introduction to biomaterials: materials characterization; fracture mechanics. Concepts in biomechanics: locomotion; stress analysis; fatigue; anisotropy. Case Studies including human locomotion; mechanics of joint replacement; cardiovascular implants; surgical implants

วัสดุทางชีววิทยา โปรตีนโครงสร้าง พอลีแซคคาไรด์ เนื้อเยื่อโครงสร้าง การประยุกต์พอลิเมอร์ โลหะและเซรามิกทางการแพทย์ แนะนำชีววัสดุการตรวจและวิเคราะห์วัสดุ กลศาสตร์รอยแตก แนวคิดทางชีวกลศาสตร์ การเคลื่อนไหว การวิเคราะห์ความเค้น ความล้า อะนิโซโทรปี กรณีศึกษาประกอบด้วย การเคลื่อนไหวของมนุษย์ กลศาสตร์ของข้อต่อเทียม การฝังวัสดุในหัวใจและหลอดเลือด การฝังวัสดุในทางศัลยกรรม

EGBE 609 Fundamental of Biomedical Engineering 3(3-0-6)

วศชพ ๖๐๙ มูลฐานวิศวกรรมชีวการแพทย์

Fundamental of biomechanics and rehabilitation: Tissue engineering and drug delivery: Biosignal and imaging processing: Advanced computing in medicine and bioinformatics: Robotics and computer-integrated surgery: Biosensors: Ethics for human and animal

มูลฐานชีวกลศาสตร์และวิศวกรรมฟื้นฟู วิศวกรรมเนื้อเยื่อ และการส่งยาชีวสัญญาณ และการประมวลภาพ การคำนวณขั้นสูงทางการแพทย์ และเวชสารสนเทศ หุ่นยนต์และศัลยกรรมบูรณาการคอมพิวเตอร์ ไบโอเซนเซอร์ จริยธรรมการวิจัยในมนุษย์และสัตว์

EGBE 657 Research Seminar for Biomedical Engineers 1(1-0-2)

วศชพ ๖๕๗ สัมมนาวิจัยเพื่อวิศวกรชีวการแพทย์

Seminar to enhance research abilities in various topics related to biomedical engineering; biomedical imaging; biomedical signal and image processing; drug delivery system; computer assisted surgery; biosensor; and assistive technology. Moral and ethical learning; reporting and presentation

สัมมนาเพื่อส่งเสริมการทำวิจัยในเรื่องต่างๆ เกี่ยวกับวิศวกรรมชีวการแพทย์ การถ่ายภาพทางการแพทย์ การประมวลผลสัญญาณและภาพทางชีวการแพทย์ ระบบส่งยา คอมพิวเตอร์ช่วยในการผ่าตัด อุปกรณ์รับรู้ทางชีวภาพ

เทคโนโลยีช่วยคนพิการ คุณธรรมและจริยธรรมของวิศวกรรมชีวการแพทย์ในการเรียน การทำรายงานและการนำเสนอผลงาน

(2) Elective Course

Credits (Lecture-Practice-Self Study)

EGBE 522 Biomedical Signal Processing 3(3-0-6)

วศชพ ๕๒๒ การประมวลผลสัญญาณชีวการแพทย์

An analysis of signals generated by excitable tissues, electrocardiograms, electromyograms, electroencephalograms and others; an integration of physiological knowledge and mechanisms of signal; signal modeling; implementation of these techniques on a computer; stationary and ergodicity random processes, auto-correlation, cross-correlation, power spectral estimation of random signals; response of linear systems to random inputs; linear mean square estimation, random signal modeling, modern spectral analysis techniques; coherence estimation; linear prediction; research on biomedical signal processing

การวิเคราะห์สัญญาณที่ได้จากเนื้อเยื่อที่ถูกกระตุ้น คลื่นไฟฟ้าหัวใจ คลื่นไฟฟ้ากล้ามเนื้อ คลื่นไฟฟ้าสมองและอื่น ๆ การรวมองค์ความรู้ด้านสรีรวิทยาและกลไกสัญญาณ การจำลองสัญญาณ การนำเทคนิคไปจำลองบนคอมพิวเตอร์ ขบวนการแบบสุ่มสเตชั่นนารีและเออโกดิซิตี้ ออโตคอรีเรชั่น ครอสคอรีเรชั่น การประมาณค่าเพาว์เวอร์สเปคตรัมของสัญญาณแบบสุ่ม การตอบสนองของระบบเชิงเส้นต่ออินพุตแบบสุ่ม การประมาณค่าเฉลี่ยกำลังสองเชิงเส้น การสร้างแบบจำลองของสัญญาณแบบสุ่ม เทคนิคการประมาณค่าเพาว์เวอร์สเปกตรัมสมัยใหม่ การประมาณค่าโคเฮียเรียนซ์ การทำนายเชิงเส้น งานวิจัยเกี่ยวกับการประมวลผลสัญญาณชีวการแพทย์

EGBE 523 Advanced Biomedical Image Processing 3(3-0-6)

วศชพ ๕๒๓ การประมวลผลภาพทางชีวการแพทย์ขั้นสูง

Principles and applications of the digital image processing; systems and Fourier transforms; the image enhancement in spatial and frequency domains; the image restoration; the image segmentation; the image morphology; the image registration; the image reconstruction from the projection data; image compression with applications in medicine

หลักการและงานด้านการประมวลผลภาพแบบดิจิทัล ระบบและการแปลงฟูริเยร์ การปรับปรุงคุณภาพของภาพในโดเมนพื้นที่และความถี่ การกู้คืนภาพ การตัดแยกภาพ การเปลี่ยนแปลงโครงสร้างภาพ การซ้อนทับภาพ การสร้างภาพจากข้อมูลการฉาย การบีบอัดภาพกับการประยุกต์ทางการแพทย์

EGBE 551 Computational Methods for Biomedical Engineering 3(3-0-6)

วศชพ ๕๕๑ วิธีคำนวณสำหรับวิศวกรรมชีวการแพทย์

Mathematical principles and errors in scientific computation: Solutions of equations of one variable: Interpolation and polynomial approximation: Numerical integration and differentiation: Numerical solution of initial-value problems: Direct and iterative methods for solving linear systems: Approximation theory: Eigen values approximation: Solutions of systems of nonlinear equations: Boundary-value problems for ordinary differential equations: Numerical methods for partial-differential equations: Practical applications in biomedical engineering

หลักการทางคณิตศาสตร์และความผิดพลาดในการคำนวณทางวิทยาศาสตร์ ผลเฉลยของสมการหนึ่งตัวแปร การประมาณค่าในช่วงและการประมาณโดยใช้โพลีโนเมียล ปริพันธ์และอนุพันธ์เชิงเลข ผลเฉลยเชิงเลขของปัญหาค่าเริ่มต้น วิธีโดยตรงและเชิงโต้ตอบสำหรับหาผลเฉลยของระบบเชิงเส้น ทฤษฎี การประมาณ การประมาณค่าไอเก้น ผลเฉลยของระบบสมการไม่เชิงเส้น ปัญหาแบบมีค่าขอบสำหรับสมการอนุพันธ์แบบสามัญ วิธีเชิงเลขสำหรับสมการอนุพันธ์บางส่วน การประยุกต์ทางวิศวกรรมชีวการแพทย์

EGBE 552 Ultrasound Technology and Application 3(3-0-6)

วศชพ ๕๕๒ เทคโนโลยีอัลตราซาวด์และการนำไปใช้งาน

Introduction and overview of ultrasound, acoustic wave propagation, attenuation, transducers and sources of ultrasound, beamforming and array, ultrasound imaging, ultrasonic tissue characterization, Doppler, nonlinear ultrasound, ultrasound induced bioeffects.

แนะนำภาพรวมของอัลตราซาวด์หลักการเดินทางของคลื่นเสียงและการลดทอดของคลื่นในตัวกลาง แทรนส์ดิวเซอร์และแหล่งกำเนิดคลื่นอัลตราซาวด์ หลักการบีมฟอมมิ่งและอาเรย์บีมฟอมมิ่ง การสร้างภาพด้วยอัลตราซาวด์ การวิเคราะห์คุณสมบัติของเนื้อเยื่อด้วยอัลตราซาวด์ ดอปเพลอร์เทคนิค คุณสมบัติไม่เป็นเชิงเส้นของอัลตราซาวด์ ผลของคลื่นอัลตราซาวด์ต่อเนื้อเยื่อ

EGBE 553 Intelligent Wearable Biosensors 3(3-0-6)

วศชพ ๕๕๓ อุปกรณ์รับรู้ชีวภาพอัจฉริยะที่สวมใส่ได้

General overview of wearable biosensors: the sources of chemical, electrical, and mechanical biological signals; basic sensing principles and sensing elements. The application of wearable biosensors for: early diagnosis; monitoring; follow up, both onsite and remote relevance biological signal. The fundamentals of materials and processing technologies related to wearable

biosensors; the design and function of wearable biosensors and microsystems, wearable electrocardiograms, wearable sweat biosensor, wearable blood-glucose biosensors, implantable biosensor, electronic tattoos, “smart” clothing,; the state-of-the-art integrated healthcare microsystems. Integration of artificial intelligence (AI) for diagnostic and monitoring development of wearable biosensors using; big data processing, pattern analysis, classification algorithms and Self-learning.

ภาพรวมของอุปกรณ์รับรู้ชีวภาพแบบสวมใส่ได้ แหล่งที่มาของสัญญาณเคมี สัญญาณไฟฟ้า และสัญญาณทางกลศาสตร์ชีวภาพ หลักการพื้นฐานอุปกรณ์รับรู้และวัสดุในอุปกรณ์รับรู้ การประยุกต์ใช้อุปกรณ์รับรู้ชีวภาพแบบสวมใส่ได้ ในการวินิจฉัยโรคขั้นต้น ตรวจติดตามด้วยสัญญาณทางชีวภาพที่เกี่ยวข้องทั้งแบบติดตั้งในตำแหน่งตรวจวัดและการสื่อสารทางไกล วัสดุพื้นฐานและเทคโนโลยีการดำเนินการที่เกี่ยวข้องกับอุปกรณ์รับรู้ชีวภาพแบบสวมใส่ได้ เช่น เครื่องตรวจคลื่นไฟฟ้าหัวใจแบบสวมใส่ได้ อุปกรณ์รับรู้ชีวภาพในเหงื่อแบบสวมใส่ได้ อุปกรณ์ตรวจวัดกลูโคสในเลือดแบบสวมใส่ได้ อุปกรณ์รับรู้ชีวภาพแบบฝังในร่างกาย ลายสักอีเล็กโทรนิคส์ เครื่องนุ่งห่มอัจฉริยะ การบูรณาการความรู้อันล้ำสมัยกับระบบดูแลสุขภาพระดับจุลภาค การบูรณาการปัญญาประดิษฐ์ในการพัฒนาอุปกรณ์รับรู้ชีวภาพแบบสวมใส่ได้โดยใช้ การประมวลผลข้อมูลขนาดใหญ่ การวิเคราะห์รูปแบบข้อมูล ระบบกฎเกณฑ์ในการแก้ปัญหาทางคณิตศาสตร์เพื่อการจำแนกประเภทและการเรียนรู้ด้วยตัวเอง

EGBE 554 Healthcare Automation and Robotics 3(3-0-6)

วศชพ ๕๕๔ ระบบอัตโนมัติด้านการดูแลสุขภาพและวิทยาการหุ่นยนต์

Overview of healthcare industry and its digital landscape, system modeling and analysis, lean concept, lean automation, medical hardware/software/data and network, robotization, simulation technologies, healthcare logistic and supply chain, cyber-physical system, medical internet of things, data analytics and telemedicine. Topics may include system designing; system modeling; service-oriented architecture; lean concepts in healthcare; solution development; and computer simulation.

ภาพรวมของอุตสาหกรรมการดูแลสุขภาพและภูมิทัศน์ดิจิทัลของอุตสาหกรรม การโมเดลและการวิเคราะห์ระบบแนวคิดของลีน ระบบอัตโนมัติแบบลีน ฮาร์ดแวร์ ซอฟต์แวร์ ข้อมูล ระบบเครือข่ายทางการแพทย์ การปรับปรุงด้วยหุ่นยนต์ เทคโนโลยีการจำลอง โลจิติกและห่วงโซ่อุปทานทางการแพทย์ ระบบไซเบอร์ภายภาพ อินเตอร์เน็ตของสรรพสิ่งทางการแพทย์ การวเคราะห์ข้อมูล และโทรเวช หัวข้ออาจประกอบด้วย การออกแบบระบบ การโมเดลระบบ สถาปัตยกรรมเชิงบริการ แนวคิดลีนในการดูแลสุขภาพ การพัฒนาโซลูชั่น และการจำลองการทำงานด้วยคอมพิวเตอร์

EGBE 555 Metaverse in Medicine 3(3-0-6)

วศชพ ๕๕๕ เมตาเวิร์สทางการแพทย์

Introduction to blockchain technology; 2D and 3D computer graphics;; virtual reality; augmented reality; mixed reality;fundamental of blockchain; point cloud processing, mesh optimization and 3D medical object reconstruction; data visualization; human-computer interfaces; advance healthcare applications and services.

แนะนำเทคโนโลยีบล็อกเชน คอมพิวเตอร์กราฟิกส์ การสร้างวัตถุ 3 มิติ ความเป็นจริงเสมือน ความเป็นจริงแบบแต่งเติม ความเป็นจริงแบบผสม พื้นฐานบล็อกเชน การประมวลผลพ้อยคลาวด์ การลดรูปของตาข่าย การสร้างวัตถุทางการแพทย์แบบ 3 มิติ การสร้างภาพข้อมูล ปฏิสัมพันธ์ระหว่างมนุษย์และคอมพิวเตอร์ การประยุกต์ขั้นสูงและบริการเพื่อดูแลสุขภาพ

EGBE 556 Biomedical Cyber-Physical Systems 3(3-0-6)

วศชพ ๕๕๖ ระบบไซเบอร์กายภาพชีวการแพทย์

Introduction to telemedicine; medical data processing; business intelligence for Healthcare; UI and UX design; data analytic and data visualization; medical internet of things and cloud services human behavior and interaction; designing data visualization: user interfaces, multimedia, and smart interaction; Medical data ETL: extract, transfer, and load; standalone system; client-server model; real-time monitoring and feedback system; security issues; advance healthcare applications and services.

แนะนำโทรเวช การประมวลผลข้อมูลทางการแพทย์ ระบบธุรกิจอัจฉริยะสำหรับดูแลสุขภาพ การออบแบบส่วนประสานและประสบการณ์ผู้ใช้ การวิเคราะห์ข้อมูล การสร้างภาพข้อมูล อินเตอร์เน็ตของสรรพสิ่งและบริการคลาวด์ พฤติกรรมการบริโภคข้อมูลของมนุษย์และการตอบสนอง การออกแบบการสร้างภาพข้อมูล ส่วนประสานผู้ใช้ มัลติมีเดีย และปฏิสัมพันธ์ที่ฉลาด การเตรียมข้อมูลทางการแพทย์ สกัด ย้าย และโหลด ระบบยืนเดี่ยว โมเดลแบบไคลเอนต์เซิร์ฟเวอร์ ระบบเฝ้าระวังและป้อนกลับแบบเวลาจริง เรื่องที่เกี่ยวข้องกับความมั่นคง การประยุกต์ขั้นสูงและบริการเพื่อดูแลสุขภาพ

EGBE 557 Nonlinear System Identification and Control in Biomedical Engineering 3(3-0-6)
วศชพ ๕๕๗ การระบุเอกลักษณ์และควบคุมระบบแบบไม่เชิงเส้นในทางวิศวกรรมชีวการแพทย์

An overview of biomedical applications of system identification; Build nonlinear mathematical models; Gray-box to black-box system identification; The identification of general nonlinear systems; Identification of Wiener systems; Introduction to the foundations of nonlinear control theory: feedback stabilization; Applications of nonlinear system identification and control in biomedical engineering

ภาพรวมของการประยุกต์ใช้การระบุเอกลักษณ์ของระบบทางชีวการแพทย์ การสร้างแบบจำลองทางคณิตศาสตร์แบบไม่เชิงเส้น การระบุระบบกล่องสีเทาถึงกล่องดำ การระบุเอกลักษณ์ของระบบแบบไม่เชิงเส้นทั่วไป การระบุเอกลักษณ์ของระบบวีนเนอร์ พื้นฐานของทฤษฎีการควบคุมแบบไม่เชิงเส้น การรักษาเสถียรภาพของผลป้อนกลับ การประยุกต์ใช้การระบุเอกลักษณ์และควบคุมระบบแบบไม่เชิงเส้นในวิศวกรรมชีวการแพทย์

EGBE 558 Assistive Technologies for Enhancing Human Movement and Rehabilitation 3(3-0-6)
วศชพ ๕๕๘ เทคโนโลยีสิ่งอำนวยความสะดวกเพื่อการเสริมสร้างการเคลื่อนไหวของมนุษย์และการฟื้นฟูสมรรถภาพ

Introduction to technologies used for rehabilitation and improved function, biomechanics of human movement: limb and spinal orthoses and prostheses, gait analysis, and sensory aids and augmentation; introduction to various rehabilitation and assistive technologies with a wide range of applications; real-world applications of the theoretical materials; devices used to regain function after limb amputation or paralysis, software used in rehabilitation, their use in enhancing performance of athletes in sport.

ความรู้เบื้องต้นเกี่ยวกับเทคโนโลยีที่ใช้สำหรับการฟื้นฟูสมรรถภาพและการทำงานที่ดีขึ้น ชีวกลศาสตร์ของการเคลื่อนไหวของมนุษย์ ออร์โธซิส ของแขนและขา และอวัยวะเทียม การวิเคราะห์การเดิน การช่วยเหลือทางประสาทสัมผัสและการเสริมต่อเติม การแนะนำเทคโนโลยีการฟื้นฟูและช่วยเหลือต่างๆ กับการใช้งานที่หลากหลาย การใช้งานจริงของวัสดุต่างๆ ทางทฤษฎี อุปกรณ์ที่ใช้ในการฟื้นสมรรถภาพหลังการตัดแขนขาหรืออัมพาต ซอฟต์แวร์ที่ใช้ในการฟื้นฟู การนำมาใช้เพื่อเพิ่มประสิทธิภาพของนักกีฬาในการเล่นกีฬา

วศชพ ๖๑๐ เครือข่ายระบบประสาท ๓(๓-๐-๖)

EGBE 610 Neural Networks

Description and analysis of computing methods based on structure and operation of the brain: Physiological principles and neural architecture: Completely interconnected networks: Single layer perceptron: Multi-layer perceptron: Back propagation learning algorithm: Radial basis function network: Unsupervised learning algorithm: Applications in medicine.

การอธิบายและการวิเคราะห์วิธีการคำนวณโดยอาศัยโครงสร้างและการทำงานของสมอง หลักการทางสรีรวิทยาและสถาปัตยกรรมประสาท เครือข่ายที่เชื่อมโยงกันอย่างสมบูรณ์ เพอร์เซ็ปตรอน
ชั้นเดียว เพอร์เซ็ปตรอนหลายชั้น ขั้นตอนวิธีการเรียนรู้แบบแพร่กลับ เครือข่ายฟังก์ชันฐานรัศมี ขั้นตอนวิธีการเรียนรู้แบบไม่มีผู้สอน การประยุกต์ในงานทางการแพทย์

วศชพ ๖๑๑ การสร้างภาพทางการแพทย์ขั้นสูง ๓(๓-๐-๖)

EGBE 611 Advanced Medical Imaging

Inverse imaging theory: Image reconstruction methods for X-ray; computed tomography (CT); ultrasound imaging; nuclear magnetic resonance (NMR); magnetic resonance imaging (MRI); positron emission tomography (PET); and single photon emission computed tomography (SPECT): Ultrasound system design: Reconstruction problems reconstruction from non-uniform frequency domain data; reconstruction from incomplete data; back-projection; and reconstruction of time series of images

ทฤษฎีการสร้างภาพย้อนกลับ การสร้างภาพกลับสำหรับการถ่ายภาพทางการแพทย์ชนิดต่างๆ เครื่องเอ็กซ์เรย์ เครื่องคำนวนโทโมกราฟี (ซีที) อัลตราซาวน์ นิวเคลียแม่เหล็กสั่นพ้อง (เอ็นเอ็มอาร์) เครื่องแม่เหล็กไฟฟ้าสั่นพ้อง (เอ็มอาร์ไอ) เครื่องส่งโพซิตรอนโทโมกราฟี (พีอีที) และเครื่องส่งโปรตอนเดี่ยวคำนวนโทโมกราฟี (สเปคท์) การออกแบบการถ่ายภาพอัลตราซาวน์ การสร้างภาพกลับสำหรับการถ่ายภาพจากกล้องจุลทรรน์ กล้องจุลทรรศน์แสง และกล้องจุลทรรศน์อิเล็กตรอน ปัญหาต่างๆ สำหรับการสร้างภาพกลับ การสร้างภาพกลับจากข้อมูลที่กระจายตัวไม่สม่ำเสมอ การสร้างภาพกลับจากข้อมูลที่ไม่สมบูรณ์ การสร้างภาพกลับแบบแบล็กโปรเจคชั่น และการสร้างภาพกลับจากภาพถ่าย ณ เวลาแตกต่างกัน

***EGBE 614 Deep Learning for Biomedical Engineering 3(3-0-6)**

วศชพ ๖๑๔ การเรียนรู้เชิงลึกสำหรับวิศวกรรมชีวการแพทย์

Linear algebra, probability and information theory, calculus for deep learning. Basic concepts for machine learning, deep feedforward network, regularization for deep learning, optimization for training deep models, convolutional networks, sequence modeling, autoencoders.

พีชคณิต ทฤษฎีความน่าจะเป็น ทฤษฎีสารสนเทศและแคลคูลัสสำหรับการเรียนรู้เชิงลึก การสร้างโมเดลการเรียนรู้ของเครื่อง โมเดลการเรียนรู้เชิงลึกแบบไปข้างหน้า การเพิ่มความเป็นมาตรฐานสำหรับการเรียนรู้เชิงลึก การหาค่าเหมาะสมในการสร้างโมเดลการเรียนรู้เชิงลึก โมเดลเชิงลึกแบบคอนโวลูชั่น โมเดลเชิงลึกแบบลำดับ และการเรียนรู้แบบบีบอัด

EGBE 617 IC Design for Wireless Medical Device and Health Care 3(3-0-6)

วศชพ ๖๑๗ การออกแบบวงจรรวมสำหรับระบบสื่อสารไร้สายทางการแพทย์

Introduction to technology trend in wireless medical device; System architecture and design consideration; biomedical signal acquisition circuits; wireless body area network transceiver design; power management; low power digital controller for SIDs; system on chip design; applications in Wireless Medical System

แนะนำแนวโน้มเทคโนโลยีระบบสื่อสารไร้สายทางการแพทย์ สถาปัตยกรรมและแนวคิดการออกแบบ วงจรวัดสัญญาณทางชีวการแพทย์ การออกแบบระบบรับส่งสัญญาณไร้สายจากระบบเซนเซอร์ เนตเวิร์คบนร่างกาย การบริหารจัดการพลังงาน ระบบควบคุมเชิงดิจิตอลแบบพลังงานต่ำสำหรับเอสไอดี การออกแบบระบบบนชิป การประยุกต์ในระบบสื่อสารไร้สายทางการแพทย์

***EGBE 626 Molecular Diagnostics for Clinical Applications 3(3-0-6)**

วศชพ ๖๒๖ การประยุกต์ใช้เทคนิคอณูชีววิทยาทางการแพทย์

Molecular Diagnostics, Clinical Chemistry, Fundamentals of Nucleic Acid Biochemistry: Nucleic Acids and Proteins, Gene Expression and Epigenetics, Common Techniques in Molecular Biology, Analysis and Characterization of Nucleic Acids and Proteins, Nucleic Acid Amplification, Gene Mutations: Genomes and Nucleic Acid Variations, DNA Sequencing, Techniques in the Clinical Lab: DNA Polymorphisms and Human Identification, Molecular Detection for Various Diseases, Molecular Oncology

เทคนิคอณูชีววิทยา เคมีคลินิก ความรู้พื้นฐานทางชีวเคมีของกรดนิวคลิอิก กรดนิวคลิอิกและโปรตีน การแสดงออกของยีนและอีพีเจเนติกส์ เทคนิคทางชีววิทยาระดับโมเลกุล การวิเคราะห์และการพิสูจน์คุณลักษณะของกรดนิวคลิอิกและโปรตีน การเพิ่มจำนวนกรดนิวคลิอิก การกลายพันธุ์ของยีน จีโนมและการเปลี่ยนแปลงของกรดนิวคลิอิก การหาลำดับพันธุกรรมดีเอ็นเอ เทคนิคในห้องปฏิบัติการทางคลินิก ความหลากหลายของดีเอ็นเอและการระบุตัวตนของมนุษย์ การตรวจวัดในระดับโมเลกุลสำหรับโรคต่างๆ เนื้องอกวิทยาระดับโมเลกุล

***EGBE 627 Machine learning and data science for Biomedical Engineering 3(3-0-6)**
วศชพ ๖๒๗ การเรียนรู้ของเครื่องและวิทยาศาสตร์ข้อมูลสำหรับวิศวกรรมชีวการแพทย์

Introduction to data science and machine learning to biomedical engineering; Python programming for data science; Tools for statistical techniques, machine learning, and data science; Data manipulation, data wrangling, and visualization; Machine learning models: linear regression, logistic regression, clustering algorithms, dimensionality reduction, tree-based algorithm, boosting algorithm, neural network; Model evaluation and assessment; Machine learning applications

พื้นฐานการใช้วิทยาศาสตร์ข้อมูลและการเรียนรู้ของเครื่องสำหรับวิศวกรรมชีวการแพทย์ การใช้โปรแกรมภาษาไพธอนสำหรับวิทยาศาสตร์ข้อมูล การใช้การวิเคราะห์ทางสถิติ การเรียนรู้ของเครื่องและวิทยาศาสตร์ข้อมูล การประมวลผล การจัดการข้อมูลและการแสดงผลข้อมูล การสร้างการเรียนรู้ของเครื่องแบบต่างๆ การทำนายแบบถดถอย การลดมิติของข้อมูล อัลกอริทึมแบบต้นไม้ อัลกอริทึมแบบบูส โครงข่ายประสาทเทียม การประเมินและวิเคราะห์ผลการทำนายของโมเดล การประยุกต์ใช้การเรียนรู้ของเครื่อง

EGBE 635 Biotechnology for Biomedical Engineering 3(3-0-6)
วศชพ ๖๓๕ เทคโนโลยีชีวภาพสำหรับวิศวกรรมชีวการแพทย์

DNA structure and function: Gene expression: Genetic analysis: Knowledge on classical bacterial genetics and bacterial physiology: Gene cloning in both prokaryotes and eukaryotes: Transcriptomics and application: Concepts and use of genomics: Metabolomics; Proteomics and advanced techniques in molecular biology: Biological processes in microorganisms for process optimization based on engineering approach: Regulatory issues that constrain bioprocess design and modification: Bioprocess strategies to make enzymes and therapeutic proteins from recombinant clones: Commercial bioprocess technology for animal and plant cell cultures

โครงสร้างและบทบาทของดีเอ็นเอ การควบคุมการแสดงออกของยีน เทคนิค ในการวิเคราะห์ยีน พันธุศาสตร์ของแบคทีเรีย และสรีรวิทยาของแบคทีเรีย การโคลนนิ่งยีนทั้งเซลล์ พืชและสัตว์ เทคโนโลยีของขบวนการชีวภาพใน

เชิงธุรกิจ หลักการและการใช้จีโนมิกส์ เมตาบอโลมิกส์ โปรตีโอมิกส์และเทคนิคขั้นสูงในชีววิทยาระดับโมเลกุลการหาสภาวะที่เหมาะสมในเชิงวิศวกรรมของขบวนการชีวะภาพของจุลินทรีย์ ปัจจัยที่สำคัญในการออกแบบและปรับปรุงขบวนการชีวภาพ ขบวนการชีวภาพเพื่อที่จะทำโปรตีน จากรีคอมบิแนทโคลน ทรานสคริปโตมิกส์และการประยุกต์

EGBE 642 Advanced Biomechanics 3(3-0-6)

วศชพ ๖๔๒ ชีวกลศาสตร์ขั้นสูง

Human motor control system using tools from control theory and robotics: mechanics of multi-joint limbs dynamics of muscles and spinal control structures: Kinematics and biological motion planning: Time delays and predictive control: Neural correlates of control in the brain: Motor disorders: Learning and adaptive control in humans

ระบบควบคุมมอเตอร์ในมนุษย์ โดยใช้วิธีการจากทฤษฎีควบคุมและวิชาการหุ่นยนต์ กลศาสตร์ของแขนขาแบบหลายข้อ กลศาสตร์ของกล้ามเนื้อ และโครงสร้างการควบคุมกระดูกสันหลัง จลนศาสตร์และการวางแผนการเคลื่อนที่ของระบบชีววิทยา การล้าช้าของเวลาและการควบคุมคาดเดา ความเกี่ยวข้องของระบบประสาทและการควบคุมในสมอง ความผิดปกติในมอเตอร์มนุษย์ การเรียนรู้และ การควบคุมปรับได้ในมนุษย์

EGBE 648 Respiratory Engineering System 3(3-0-6)

วศชพ ๖๔๘ ระบบวิศวกรรมการหายใจ

Respiratory Physiology; Gas Flow Mechanics in Respiratory System; Respiratory Measurments; Mechanical Ventilation : Negative Pressure Ventilation; Positive Pressure Ventilation; Alveolar Gas Exchange; Blood Gas Transport; Modes of Ventilation; Triggering; Mechanical Ventilation for Specific Disease; Design of Respiratory Devices: Technical Design; Safety; Materials; Optional Functions; Calibration and Testing Respiratory Devices

สรีระวิทยาของระบบหายใจ กลศาสตร์การไหลของแก๊สในทางเดินหายใจ การวัดในระบบหายใจ กลไกการระบายอากาศ แบบความดันลบ และความดันบวก การแลกเปลี่ยนแก๊สที่ลุงลม การขนส่งออกซิเจนและคาร์บอนไดออกไซด์ในเลือด วิธีการช่วยหายใจ การกระตุ้นการการหายใจแบบต่างๆ กลไก การระบายอากาศเฉพาะกลุ่มโรค การออกแบบเครื่องช่วยการหายใจ การสอบเทียบค่าความถูกต้องและ ความปลอดภัยของเครื่องช่วยการหายใจ

EGBE 653 Intelligent Systems 3(3-0-6)

วศชพ ๖๕๓ ระบบอัจฉริยะ

Intelligent systems: Fuzzy set: Fuzzy logic: Fuzzy inference system: Evolutionary computation: Hybrid systems based on fuzzy; neural and evolutionary computation: Bayesian networks: Maximum likelihood estimation: Data clustering and dimensionality Reduction

ระบบอัจฉริยะ เซตคลุมเครือ ตรรกศาสตร์คลุมเครือ ระบบการอนุมานคลุมเครือ การคำนวณวิวัฒนาการ ระบบลูกผสมบนพื้นฐานของความคลุมเครือ การคำนวณระบบประสาทและวิวัฒนาการ เครือข่ายเบเยอร์เซียน การประมาณความคล้ายกันสูงสุด การเกาะกลุ่มข้อมูล การลดมิติ

EGBE 664 Nanobiotechnology 3(3-0-6)

วศชพ ๖๖๔ เทคโนโลยีชีวภาพระดับนาโน

Prospect of bioapplications of nanotechnologies including; biosensors; drug delivery systems; biomaterials; nanomaterials; nanomedicine; cancer and nanotechnology; polymeric nanoparticles; nanoparticles for drug delivery and imaging; characterization in nanotechnology

แนวทางของชีวประยุกต์ระดับเทคโนโลยีระดับนาโน รวมอุปกรณ์รับรู้ทางชีววิทยา ระบบส่งยา วัสดุทางชีววิทยา วัสดุระดับนาโน ยาระดับนาโน การใช้วัสดุระดับนาโนกับโรคมะเร็ง อนุภาคนาโนที่ผลิตจากพอลิเมอร์ อนุภาคนาโนสำหรับการส่งยาและถ่ายภาพลักษณะเฉพาะในเทคโนโลยีระดับนาโน

EGBE 683 Special Topics in Biomedical Engineering 3(3-0-6)

วศชพ ๖๘๓ หัวข้อพิเศษทางวิศวกรรมชีวการแพทย์

Selected topics of current interest in biomedical engineering; biosignal processing, imaging, image processing, tissue engineering; drug delivery, biomechanics, rehabilitation engineering; biomaterials, medical robotics, advanced computing

เลือกหัวข้อซึ่งเป็นที่สนใจในวิศวกรรมชีวการแพทย์การประมวลผลสัญญาณ ชีวการสร้างภาพ การประมวลผลภาพ วิศวกรรมเนื้อเยื่อ การส่งยา ชีวกลศาสตร์ วิศวกรรมการฟื้นฟู ชีววัสดุ หุ่นยนต์ทางการแพทย์ การคำนวณขั้นสูง

(3) วิทยานิพนธ์

EGBE 698 Thesis 12(0-36-0)

วศชพ ๖๙๘ วิทยานิพนธ์

Identifying research project title; submitting research proposal; conducting research study with concern of ethics; data collection, analysis, synthesis and critics of research results; reporting the research results in terms of thesis; thesis presentation. Publishing the research results in academic printing materials or journal or presenting it in academic conference; ethics in dissemination of the research results

การกำหนดหัวข้อโครงการวิจัย การเสนอโครงร่างการวิจัย การดำเนินการวิจัย อย่างมีจริยธรรม การรวบรวมข้อมูล การวิเคราะห์ สังเคราะห์และวิพากษ์ข้อมูลผลการวิจัย การนำผลการวิจัยมาเรียบเรียงเป็นวิทยานิพนธ์ การนำเสนอวิทยานิพนธ์ การเผยแพร่ผลงานวิจัยในวารสารหรือสิ่งพิมพ์ทางวิชาการ หรือเสนอต่อที่ประชุมวิชาการ จริยธรรมในการเผยแพร่ผลงานวิจัย

(4) การค้นคว้าอิสระ

EGBE 696 Independent Study 6(0-24-0)

วศชพ ๖๙๖ การค้นคว้าอิสระ

Identifying research project title; submitting research proposal; conducting research study with concern of ethics; data collection, analysis, synthesis and critics of research results; reporting the research results in terms of thesis; thesis presentation. Publishing the research results in academic printing materials or journal or presenting it in academic conference; ethics in dissemination of the research results

การกำหนดหัวข้อโครงการวิจัย การเสนอโครงร่างการวิจัย การดำเนินการวิจัย อย่างมีจริยธรรม การรวบรวมข้อมูล การวิเคราะห์ สังเคราะห์ และวิพากษ์ข้อมูล ผลการวิจัยการนำผลการวิจัยมาเรียบเรียงเป็นวิทยานิพนธ์ การนำเสนอวิทยานิพนธ์ การเผยแพร่ผลงานวิจัยในวารสารหรือสิ่งพิมพ์ทางวิชาการ หรือเสนอต่อที่ประชุมวิชาการ จริยธรรมในการเผยแพร่ผลงานวิจัญ

(5) For Students who choose Dual Degree program, in additional to Plan A: Coursework and Research Curriculum Structure, a candidate has accumulated 120 credits of taught classes from the curriculum, together with 60 credits for the BE907 MSc Project, they will be awarded an MSc (Biomedical Engineering) of University of Strathclyde.

Initial Classes

BE911 Engineering Science **20 Credits**

This module aims to provide instruction in the areas of fundamental engineering (mechanics of rigid bodies, mechanics of deformable bodies, mechanics of fluids and electronics) for life scientists who have no formal education in the engineering sciences.

BE915 Medical Science for Engineering **20 Credits**

To provide students of Biomedical Engineering with instruction in key areas of human anatomy, physiology and cell biology relevant to the advanced study of bio- and clinical engineering. We aim to provide understanding of normal biological function and control as derived from scientific and clinical evidence. The course will educate students to use knowledge of normal function to better understand pathology, disease diagnosis and treatment.

Compulsory classes

BE908 Biomedical Instrumentation **10 Credits**

Give a detailed description of the principles and applications of a number of the most widely used biomedical instrumentation systems and devices found in the modern hospital environment**.** This course will enable students to understand the diagnostic and research applications of the various instrumentation**-**related techniques currently available and to appreciate their limitations**.**

BE909 Biomedical Electronics **10 Credits**

This module aims to give the student a thorough introduction to the use of electronic circuits for the pre**-**conditioning, acquisition and display of biomedical signals and to provide an understanding of the components required in a basic biomedical measurement device**.**

BE918 Professional Studies in Biomedical Engineering **10 Credits**

Provide an introduction to the philosophy, ethics and methodology of research; Outline the role that the bioengineer plays in the solution of clinical problems; Provide training in the principles, assessment and application of safety procedures in areas relevant to

medical physics and biomedical engineering; and Engender an awareness of the importance of regulatory issues in medical device design and manufacturing.

BE919 Research Methodology **10 Credits**

This module aims to equip the students with the knowledge and skills necessary for undertaking a research project. Students will gain an understanding of aspects including experimental design, research writing skills, and the use of mathematics and statistics tools including software for data visualization and analysis, all of which are needed to progress in their research in Biomedical Engineering.

Optional Class

BE900 Tissue Mechanics **10 Credits**

This module aims to provide an introduction to the mathematical theory of time-dependent mechanical properties of human tissue, i.e. viscoelasticity and photoelasticity. Finite Element modelling will be used to demonstrate tissue behaviour in a variety of loading scenarios. A group project of a specific tissue will enhance understanding of the application of the learned theory and demonstrate the state-of-the-art experimental techniques in the field.

BE901 Regenerative Medicine and Tissue Engineering **10 Credits**

Source of cells, Cell expansion/seeding and bioreactor technology Tissue scaffolds: design criteria, fabrication and characterisation, Clinical status of replacement tissues and organs

BE902 Prosthetics and Orthotics **10 Credits**

This module aims to demonstrate to students how biomechanical principles can be applied to the design, manufacture, fitting procedures and evaluation of prostheses, orthoses and other devices externally applied to the body of patients in need of rehabilitation. It is hoped that students taking this module should be able to join manufacturing companies, research groups or clinical teams responsible for the delivery of such systems.

BE903 Cardiovascular Devices **10 Credits**

Give students a broad overview of cardiovascular devices used in the clinical setting for the treatment of a range of clinical conditions. Demonstrate and develop an understanding of the clinical, design and regulatory challenges involved in developing devices for this clinical sector. Offer some insight into the pathologies underlying the need for cardiovascular device technologies.

BE904 Clinical and Sports Biomechanics **10 Credits**

This module aims to provide the student with the ability to appraise the role of biomechanics and biomechanical measurement techniques in the physical rehabilitation of movement disorders and sports performance.

BE905 Biosignal Processing and Analysis **10 Credits**

This module aims to familiarise students with the fundamentals and concepts of signals and systems (both continuous-time and discrete-time), and to develop a framework for processing and analysing a variety of biomedical signals and images, including electromyography, electrocardiograms (ECGs) and magnetic resonance images. Students will also develop valuable signal/image processing skills, through non-compulsory self-study laboratory exercises.

BE906 Biomaterials and Biocompatibility **10 Credits**

Provide fundamental information on the properties of synthetic biomaterials, and how these are evaluated experimentally and from the literature. Outline how material properties are influenced by methods of processing. Explore with the aid of appropriate examples what is meant by biocompatibility; provide an overview of the host responses to and interactions with biomaterials, and how these interactions are assessed and influenced by surface properties. Introduce the principles of toxicology, identify the major toxic interactions with foreign chemicals and the protective mechanisms which enable us to survive most toxic insults. Assessment of the safety of materials according to the International Standards will be discussed.

BE912 Anatomy and Physiology **10 Credits**

This module aims to provide a student with the basic knowledge of the anatomical structure of the major body systems, together with an understanding of their physiological functioning.

BE916 Introduction to Biomechanics **10 Credits**

This module aims to provide the student with a tool set of analytical skills to enable them to undertake valid biomechanical analyses of human movement, including the science, engineering and mathematical skill to produce kinematic and kinetic analyses of human movement and the external and internal load actions experienced by humans during activity. The module will provided generic analysis skills but examples will focus primarily on human gait.

BE920 The Medical Device Regulatory Process **10 Credits**

This module aims to give students an understanding of the regulatory pathway and requirements to deliver a new medical device to the marketplace from concept to clinical use. The student should understand the complexity of the regulatory requirements internationally, the importance of the maintenance of technical files and pre and post- certification vigilance.

BE924 Medical Robotics **10 Credits**

This module aims to introduce the concepts and the design of medical robotics and its applications in various medical disciplines including, interventions, surgery and rehabilitation. The course focuses on fundamental principles such as kinematics, dynamics, control and artificial intelligent combined with medical applications and examples.

BE928 Rehabilitation Technology **10 Credits**

Provide students with the evidence and rationale for embedding technology into rehabilitation practice considering the technological, design and cultural barriers to adoption.

Project

BE907 MSc Project **60 Credits**

This module aims to provide an opportunity for students to experience the challenges and rewards of sustained, independent study in a topic of their own choice in the general field of

Biomedical Engineering. It will involve students in a number of processes which include justification of the selected topic; selecting, devising and applying appropriate methods and techniques; anticipating and solving problems which arise; displaying knowledge of background literature; and evaluating and reporting the conclusions of the study. The project will involve experimental work. This project work will have been supported by a compulsory research methods module and specialist knowledge classes throughout the year designed to assist with technical aspects of methodology and analysis.

Appendix B

Curriculum Vitae of the Faculty in Charge of the Program

Appendix B

Curriculum Vitae of the Faculty in Charge of the Program

1. Name: Associate Professor Dr. Benchaporn Lertanantawong

Education

Degree	Major	Graduated From		
		Institution	Country	Year
Ph.D.	Biotechnology	King Mongkut's University of Technology Thonburi	Thailand	2007
M.Sc.	Biotechnology	King Mongkut's University of Technology Thonburi	Thailand	2002
B.Sc.	Chemistry	King Mongkut's University of Technology Thonburi	Thailand	1998

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Nanobiosensors for biomedical application, DNA self-assembly, Immunosensors, Enzyme based biosensors, Electrochemistry, Nanomaterials for sensing application, Bio-Chemical Sensors, Electroanalytical chemistry, Electrodeposition, Electrocatalysis

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Devkota, M., Chuangchote, S., La-o-vorakiat, C., Lertsathitphong, P., Lertanantawong, B., Somasundrum, M., & Surareungchai, W. (2021).	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Photoelectrochemical reduction rate of ferricyanide at different TiO2 forms: comparison of SECM and cyclic voltammetric results. Journal of Solid State Electrochemistry, 25(5), 1691–1698. doi: 10.1007/s10008-021-04928-8		
Published research work	Ngo, D. B., Chaibun, T., Yin, L. S., Lertanantawong, B., & Surareungchai, W. (2021). Electrochemical DNA detection of hepatitis E virus genotype 3 using PbS quantum dot labelling. Analytical and Bioanalytical Chemistry, 413(4), 1027–1037. doi: 10.1007/s00216-020-03061-1	12/1	2021
Published research work	Yeap, C. S. Y., Chaibun, T., Lee, S. Y., Zhao, B., Jan, Y., La-o-vorakiat, C., Surareungchai, W., Song, S., & Lertanantawong, B. (2021). Ultrasensitive pathogen detection with a rolling circle amplification-empowered multiplex electrochemical DNA sensor. Chemical Communications, 57(91), 12155–12158. doi: 10.1039/D1CC05181D	12/1	2021
Published research work	Alam, I., Lertanantawong, B., Prongmanee, W., Lertvanithphol, T., Horprathum, M., Sutthibutpong, T., & Asanithi, P. (2021). Investigating lysozyme amyloid fibrillization by electrochemical impedance spectroscopy for application in lysozyme sensor. Journal of	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Electroanalytical Chemistry, 901, 115799. doi: 10.1016/j.jelechem.2021.115799		
Published research work	Lertsathitphong, P., O'Mullane, A. P., & Lertanantawong, B. (2020). Electrochemical restructuring of Gold electrodes with redox active species to create electrocatalytically active nanostructured surfaces. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 592. doi: 10.1016/j.colsurfa.2020.124580	12/1	2020
Published research work	Ngamdee, T., Yin, L. S., Vongpunsawad, S., Poovorawan, Y., Surareungchai, W., & Lertanantawong, B. (2020). Target Induced-DNA strand displacement reaction using gold nanoparticle labeling for hepatitis E virus detection. Analytica Chimica Acta, 1134, 10–17. doi: 10.1016/j.aca.2020.08.018	12/1	2020
Published research work	Marimuthu, K., Subramaniam, R., Lertanantawong, B., Lee, S. Y., Borgio, J. F., Amin, S. M. N., Abdul Azeez, S., Rahman, M. A., & Arshad, A. (2020). Toxicity of gold nanoparticles on the survival and hatching rates of African catfish (Clarias gariepinus) embryo and larvae. Journal of Environmental Biology, 41(5(SI)), 1179–1185. doi: 10.22438/jeb/41/5(SI)/MS_09	12/1	2020

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Pringkasemchai, A., Hoshyargar, F., Lertanantawong, B., & O'Mullane, A. P. (2019). Lightweight ITO Electrodes Decorated with Gold Nanostructures for Electrochemical Applications. Electroanalysis, 31(11), 2095–2102. doi: 10.1002/elan.201900152	12/1	2019

Current Teaching Load

1. EGBE 692 Research Seminar for Biomedical Engineering Seminar I 1(1-0-6)
2. EGBE 693 Research Seminar for Biomedical Engineering Seminar II 1(1-0-6)
3. EGBE 609 Fundamental of Biomedical Engineering 3(3-0-6)
4. EGBE 635 Biotechnology for Biomedical Engineering 3(3-0-6)
5. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1. EGBE 609 Fundamental of Biomedical Engineering 3(3-0-6)
2. EGBE 635 Biotechnology for Biomedical Engineering 3(3-0-6)
3. EGBE 698 Thesis 12(0-36-0)
4. EGBE 696 Independent Study 6(0-24-0)

2. Name: Associate Professor Dr. Jackrit Suthakorn

Education

Degree	Field of Study	Graduated From		
		Institution	Country	Year
Ph.D.	Robotics	Johns Hopkins University	USA	2003
M.S.	Controls	Michigan Technological University	USA	1997
B.Eng	Mechanical Engineering	Mahidol University	Thailand	1995

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Medical Robotics, Computer-Integrated Surgical System and Technology

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Ajay, P., Nagaraj, B., Pillai, B. M., Suthakorn, J., & Bradha, M. (2022). Intelligent ecofriendly transport management system based on IoT in urban areas. Environment, Development and Sustainability. doi: 10.1007/s10668-021-02010-x	12/1	2022

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Chumnanvej, S., Pillai, B. M., Chalongwongse, S., & Suthakorn, J. (2021). Endonasal endoscopic transsphenoidal approach robot prototype: A cadaveric trial. Asian Journal of Surgery, 44(1), 345–351. doi: 10.1016/j.asjsur.2020.08.011	12/1	2021
Published research work	Nillahoot, N., Patel, S., & Suthakorn, J. (2021). A Technique for Mimicking Soft Tissue Manipulation from Experimental Data to a Wave Equation Model for a New Laparoscopic Virtual Reality Training System. The Open Biomedical Engineering Journal, 15(1), 16–28. doi: 10.2174/1874120702115010016	12/1	2021
Published research work	Nakdhamabhorn, S., Pillai, M. B., & Suthakorn, J. (2021). Design and development of sensorless based 5-DOF bilaterally controlled surgical manipulator: A prototype. Bulletin of Electrical Engineering and Informatics, 10(2), 619–631. doi: 10.11591/eei.v10i2.2331	12/1	2021
Published research work	Bohara, S., Rohner, N., Budziszewski, E., Suthakorn, J., von Recum, H. A., & Exner, A. A. (2021). Ultrasound Triggered Drug Release from Affinity-Based β-Cyclodextrin Polymers for Infection Control. Annals of Biomedical Engineering, 49(9), 2513–2521. doi: 10.1007/s10439-021-02814-y	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Academic Article	Sharma, B., Pillai, B. M., & Suthakorn, J. (2021). Live Displacement Estimation for Rough Terrain Mobile Robot: BART LAB Rescue Robot. 2021 International Siberian Conference on Control and Communications (SIBCON), 1–6, 13-15 May 2021, Kazan, Russia doi: 10.1109/SIBCON50419.2021.9438919	11/0.4	2021
Published research work	Nillahoot, N., Pillai, B. M., Chumnanvej, S., & Suthakorn, J. (2021). The development of a virtual simulator for a novel design surgical tool in endoscopic endonasal transsphenoidal surgery. Bulletin of Electrical Engineering and Informatics, 10(3), 1368–1379. doi: 10.11591/eei.v10i3.3037	12/1	2021
Published research work	Direkwatana, C., Suthakorn, J., & Wilasrussamee, C. (2020). MU-LapaRobot: A Corporative Surgical Robot for Laparoscopic Surgery. The Open Biomedical Engineering Journal, 14(1), 43–54. doi: 10.2174/1874120702014010043	12/1	2020
Published research work	Suthakorn, J., Tanaiutchawoot, N., & Wiratkapan, C. (2020). Ultrasound calibration with ladder phantom at multiple depths for breast biopsy navigation system. Theoretical	12/1	2020

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	and Applied Mechanics Letters, 10(5), 343–353. doi: 10.1016/j.taml.2020.01.037		
Published research work	Suthakorn, J., & Patel, S. (2020). Constructing a Heterogeneous Model for Soft Tissue Deformation Using Two Dimensional Wave Equations. 2020 International Symposium on Medical Robotics (ISMR), 118–124. doi: 10.1109/ISMR48331.2020.9312953	12/1	2020
Published research work	Magid, E., Pashkin, A., Simakov, N., Abbyasov, B., Suthakorn, J., Svinin, M., & Matsuno, F. (2020). Artificial Intelligence Based Framework for Robotic Search and Rescue Operations Conducted Jointly by International Teams. In Smart Innovation, Systems and Technologies (Vol. 154, pp. 15–26). doi: 10.1007/978-981-13-9267-2_2	12/1	2020
Published research work	Pillai, B. M., Wilasrusmee, C., & Suthakorn, J. (2020). Observer based dynamic control model for bilaterally controlled MU-lapa robot: Surgical tool force limiting. International Journal of Electrical and Computer Engineering (IJECE), 10(1), 828. doi: 10.11591/ijece.v10i1.pp828-839	12/1	2020

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Chumnanvej, S., Chalongwongse, S., Pillai, B. M., & Suthakorn, J. (2019). Pathway and workspace study of Endonasal Endoscopic Transsphenoidal (EET) approach in 80 cadavers. International Journal of Surgery Open, 16, 22–28. doi: 10.1016/j.ijso.2018.12.002	12/1	2019
Published research work	Chatrasingh, M., & Suthakorn, J. (2019). A novel design of N-fiducial phantom for automatic ultrasound calibration. Journal of Medical Physics, 44(3), 191–200. doi: 10.4103/jmp.JMP_92_18	12/1	2019
Published research work	Pillai, B. M., & Suthakorn, J. (2019). Challenges for Novice Developers in Rough Terrain Rescue Robots: A Survey on Motion Control Systems. Journal of Control Science and Engineering, 2019, 1–12. doi: 10.1155/2019/2135914	12/1	2019
Published research work	Chalongwongse, S., Chumnanvej, S., & Suthakorn, J. (2019). Analysis of Endonasal Endoscopic Transsphenoidal (EET) surgery pathway and workspace for path guiding robot design. Asian Journal of Surgery, 42(8), 814–822. doi: 10.1016/j.asjsur.2018.12.016	12/1	2019

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Chumnanvej, S., Pattamarakha, D., Sudsang, T., & Suthakorn, J. (2019). Anatomical workspace study of Endonasal Endoscopic Transsphenoidal Approach. Open Medicine, 14(1), 537–544. doi: 10.1515/med-2019-0060	12/1	2019
Published research work	Chumnanvej, S., Pillai, B. M., & Suthakorn, J. (2019). Surgical Robotic Technology for Developing an Endonasal Endoscopic Transsphenoidal Surgery (EETS) Robotic System. The Open Neurology Journal, 13(1), 96–106. doi: 10.2174/1874205X01913010096	12/1	2019
Published research work	Pillai, B. M., & Suthakorn, J. (2019). Motion control applications: observer based DC motor parameters estimation for novices. International Journal of Power Electronics and Drive Systems (IJPEDS), 10(1), 195. doi: 10.11591/ijpeds.v10.i1.pp195-210	12/1	2019
Published research work	Sattayasoonthorn, P., Suthakorn, J., & Chamnanvej, S. (2019). On the feasibility of a liquid crystal polymer pressure sensor for intracranial pressure measurement. Biomedical Engineering / Biomedizinische Technik, 64(5), 543–553. doi: 10.1515/bmt-2018-0029	12/1	2019

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Pillai, B. M., & Suthakorn, J. (2019). Motion control applications: observer based DC motor parameters estimation for novices. International Journal of Power Electronics and Drive Systems (IJPEDS), 10(1), 195. doi: 10.11591/ijpeds.v10.i1.pp195-210	12/1	2019
Published research work	Chumnanvej, S., Chalongwongse, S., Pillai, B. M., & Suthakorn, J. (2019). Pathway and workspace study of Endonasal Endoscopic Transsphenoidal (EET) approach in 80 cadavers. International Journal of Surgery Open, 16, 22–28. doi: 10.1016/j.ijso.2018.12.002	12/1	2019
Published research work	Sattayasoonthorn, P., Suthakorn, J., & Chamnanvej, S. (2019). Sensitivity and packaging improvement of an LCP pressure sensor for intracranial pressure measurement via FEM simulation. International Journal of Electrical and Computer Engineering, 9(5), 4044–4052. doi: 10.11591/ijece.v9i5.pp4044-4052	12/1	2019
Published research work	Nakdhamabhorn, S., & Suthakorn, J. (2019). System integration of a fluoroscopic image calibration using robot assisted surgical guidance for distal locking process in closed	12/1	2019

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	intramedullary nailing of femur. International Journal of Electrical and Computer Engineering (IJECE), 9(5), 3739. doi: 10.11591/ijece.v9i5.pp3739-3750		

Current Teaching Load

1. EGBE 680 Advance Medical Robotics 3(3-0-6)
2. EGBE 660 Advanced Computer-Integrated Surgery 3(3-0-6)
3. EGBE 662 Design and Control of Haptic Interfaces 3(3-0-6)
4. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1. EGBE 680 Advance Medical Robotics 3(3-0-6)
2. EGBE 660 Advanced Computer-Integrated Surgery 3(3-0-6)
3. EGBE 662 Design and Control of Haptic Interfaces 3(3-0-6)
4. EGBE 698 Thesis 12(0-36-0)
5. EGBE 696 Independent Study 6(0-24-0)

3. Name: Associate Professor Dr. Norased Nasongkla

Education

Degree	Field of Study	Graduated From		
		Institution	Country	Year
Ph.D.	Polymer Science	Case Western Reserve University	USA	2006
B.Sc.	Chemistry	Mahidol University	Thailand	2000

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Nanomedicine, MRI/SPECT contrast agent, Multifunctional polymeric micelle, Nano-coating of medical devices, Regenerative medicine

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Chinavinijkul, P., Riansuwan, K., Kiratisin, P., Srisang, S., & Nasongkla, N. (2021). Dip- and Spray-coating of Schanz pin with PLA and PLA nanosphere for prolonged antibacterial activity. Journal of Drug Delivery Science and	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Technology, 65, 102667. doi: 10.1016/j.jddst.2021.102667		
Published research work	Srisang, S., Boongird, A., Ungsurungsie, M., Wanasawas, P., & Nasongkla, N. (2021). Biocompatibility and stability during storage of Foley urinary catheters coated chlorhexidine loaded nanoparticles by nanocoating: in vitro and in vivo evaluation. Journal of Biomedical Materials Research Part B: Applied Biomaterials, 109(4), 496–504. doi: 10.1002/jbm.b.34718	12/1	2021
Published research work	Nasongkla, N., Tuchinda, P., Munyoo, B., & Eawsakul, K. (2021). Preparation and Characterization of MUC-30-Loaded Polymeric Micelles against MCF-7 Cell Lines Using Molecular Docking Methods and In Vitro Study. Evidence-Based Complementary and Alternative Medicine, 2021, 1–9. doi: 10.1155/2021/5597681	12/1	2021
Published research work	Srisang, S., Boongird, A., Ungsurungsie, M., Wanasawas, P., & Nasongkla, N. (2021). In vivo catheterization study of chlorhexidine□loaded nanoparticle coated Foley urinary catheters in male New Zealand white rabbits. Journal of Biomedical Materials Research Part B: Applied Biomaterials, 109(11), 1836–1843. doi: 10.1002/jbm.b.34844	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Eawsakul, K., Tancharoen, S., & Nasongkla, N. (2021). Combination of dip coating of BMP-2 and spray coating of PLGA on dental implants for osseointegration. Journal of Drug Delivery Science and Technology, 61, 102296. doi: 10.1016/j.jddst.2020.102296	12/1	2021
Published research work	Kurniawan, F. H., Chinavinijkul, P., & Nasongkla, N. (2021). Hydrophobic and antibacterial bed sheet using ZnO nanoparticles: A large-scale technique. Journal of Drug Delivery Science and Technology, 62, 102339. doi: 10.1016/j.jddst.2021.102339	12/1	2021
Published research work	Jobdeedamrong, A., Theerasilp, M., Nasongkla, N., & Crespy, D. (2021). Nanocapsules with excellent biocompatibility and stability in protein solutions. Biomaterials Science, 9(17), 5781–5784. doi: 10.1039/D1BM00510C	12/1	2021
Published research work	Wongsuwan, N., Dwivedi, A., Tancharoen, S., & Nasongkla, N. (2020). Development of dental implant coating with minocycline-loaded niosome for antibacterial application. Journal of Drug Delivery Science and Technology, 56, 101555. doi: 10.1016/j.jddst.2020.101555	12/1	2020

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Jobdeedamrong, A., Theerasilp, M., Wongsuwan, N., Nasongkla, N., & Crespy, D. (2020). Inflammation-responsive nanocapsules for the dual-release of antibacterial drugs. Chemical Communications, 56(84), 12725–12728. doi: 10.1039/D0CC05287F	12/1	2020
Published research work	Srisang, S., Wongsuwan, N., Boongird, A., Ungsurungsie, M., Wanasawas, P., & Nasongkla, N. (2020). Multilayer nanocoating of Foley urinary catheter by chlorhexidine-loaded nanoparticles for prolonged release and anti-infection of urinary tract. International Journal of Polymeric Materials and Polymeric Biomaterials, 69(17), 1081–1089. doi: 10.1080/00914037.2019.1655752	12/1	2020
Published research work	Dwivedi, A., Mazumder, A., & Nasongkla, N. (2019). In vitro and in vivo biocompatibility of orthopedic bone plate nano-coated with vancomycin loaded niosomes. Journal of Drug Delivery Science and Technology, 52, 215–223. doi: 10.1016/j.jddst.2019.04.018	12/1	2019
Published research work	Thitichai, N., Thanapongpibul, C., Theerasilp, M., Sungkarat, W., & Nasongkla, N. (2019). Study of biodistribution and systemic toxicity of glucose functionalized SPIO/DOX micelles.	12/1	2019

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Pharmaceutical Development and Technology, 24(8), 935–946. doi: 10.1080/10837450.2019.1569679		
Published research work	Horprasertkij, K., Dwivedi, A., Riansuwan, K., Kiratisin, P., & Nasongkla, N. (2019). Spray coating of dual antibiotic-loaded nanospheres on orthopedic implant for prolonged release and enhanced antibacterial activity. Journal of Drug Delivery Science and Technology, 53, 101102. doi: 10.1016/j.jddst.2019.05.051	12/1	2019
Published research work	Srisang, S., & Nasongkla, N. (2019). Spray coating of foley urinary catheter by chlorhexidine-loadedpoly(**ε**-caprolactone) nanospheres: effect of lyoprotectants, characteristics, and antibacterial activity evaluation. Pharmaceutical Development and Technology, 24(4), 402–409. doi: 10.1080/10837450.2018.1502317	12/1	2019
Published research work	Srisang, S., & Nasongkla, N. (2019). Layer-by-layer dip coating of Foley urinary catheters by chlorhexidine-loaded micelles. Journal of Drug Delivery Science and Technology, 49, 235–242. doi: 10.1016/j.jddst.2018.11.019	12/1	2019
Published research work	Mazumder, A., Assawapanumat, W., Dwivedi, A., Reabroi, S., Chairoungdua, A., & Nasongkla, N.	12/1	2019

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	(2019). Glucose targeted therapy against liver hepatocellular carcinoma: In vivo study. Journal of Drug Delivery Science and Technology, 49, 502–512. doi: 10.1016/j.jddst.2018.12.036		

Current Teaching Load

1. EGBE 631 Advanced Drug Delivery 3(3-0-6)
2. EGBE 633 Biomedical Polymer 3(3-0-6)
3. EGBE 634 Biomaterials and Biocompatibility 3(3-0-6)
4. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1. EGBE 631 Advanced Drug Delivery 3(3-0-6)
2. EGBE 633 Biomedical Polymer 3(3-0-6)
3. EGBE 634 Biomaterials and Biocompatibility 3(3-0-6)
4. EGBE 698 Thesis 12(0-36-0)
5. EGBE 696 Independent Study 6(0-24-0)

4. Name: Associate Professor Dr. Panrasee Ritthipravat

Education

Degree	Major	Graduated From		
		Institution	Country	Year
D.Eng.	Mechanical Engineering	King Mongkut's University of Technology Thonburi	Thailand	2005
M.Eng.	Manufacturing System Engineering	King Mongkut's University of Technology Thonburi	Thailand	1999
B.Eng.	Mechanical Engineering	King Mongkut's University of Technology Thonburi	Thailand	1996

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Neural Network for Medical Diagnosis, Advanced Rehabilitation System

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Aung, Z. H., Soonthareeya, S., Chuenchat, S., Kusakunniran, M. (2022). Designing a novel teaching platform for AI: A case study in a Thai school context. Vol. 38(6), 38–44. https://doi.org/10.1111/jcal.12706	12/1	2022

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Kusakunniran, W., Aukkapinyo, K., Ritthipravat, P., Borwarnginnn, P., Imaromkul, T., Thongkanchorn, K., Wattanadhirach, D., Mongkolluksamee, S., Thammasudjarit, R., Tuakta, P., & Benjapornlert, P. (2022). Measurement of Tongue Motion using Optical Flows on Segmented Areas. 2022 14th International Conference on Knowledge and Smart Technology (KST), 24–28, 26-29 January 2022, Chon buri, Thailand. doi: 10.1109/KST53302.2022.9729063	11/0.1	2022
Published research work	Kaewlee, T., & Ritthipravat, P. (2021). Development of Rehabilitation System with Bilateral Upper Extremity Training Robot and Virtual Reality for Stroke Patient IFMBE Proceedings, Vol. 82, pp. 38–44, May 25-27, 2020, Japan. doi: 10.1007/978-3-030-66169-4_6	11/0.1	2021
Academic Article	ปัณรสี ฤทธิประวัติ และคณะ, “การพัฒนาแพลตฟอร์ม aithaigen เพื่อการเรียนรู้ด้านปัญญาประดิษฐ”, The 2nd ECTI workshop on Biomedical Electrical-Electronics and Communications Engineering, P.53	11/0.1	2021

Current Teaching Load

1. EGBE 623 Pattern Recognition 3(3-0-6)
2. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1.	EGBE 623	Pattern Recognition	3(3-0-6)
2.	EGBE 698	Thesis	12(0-36-0)
3.	EGBE 696	Independent Study	6(0-24-0)

5. Name: Associate Professor Dr. Yodchanan Wongsawat

Education

Degree	Major	Graduated From		
		Institution	Country	Year
Ph.D.	Electrical Engineering	University of Texas at Arlington	USA	2007
M.S.	Electrical Engineering	University of Texas at Arlington	USA	2003
B.Eng.	Electrical Engineering	Sirindhorn International Institute of Technology, Thammasat University	Thailand	2001

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Brain Computer Interface, Neuroengineering

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Puttanawarut, C., Sirirutbunkajorn, N., Tawong, N., Jiarpinitnun, C., Khachonkham, S., Pattaranutaporn, P., & Wongsawat, Y. (2022). Radiomic and Dosiomic Features for the Prediction of Radiation Pneumonitis Across	12/1	2022

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Esophageal Cancer and Lung Cancer. Frontiers in Oncology, 12. doi: 10.3389/fonc.2022.768152		
Published research work	Chatthong, W., Khemthong, S., & Wongsawat, Y. (2022). Neuropsychological classification based on brain mapping performance in Thai children with and without ADHD. Applied Neuropsychology: Child, 11(1), 18–24. doi: 10.1080/21622965.2020.1729155	12/1	2022
Published research work	Jatupornpoonsub, T., Thimachai, P., Supasyndh, O., & Wongsawat, Y. (2022). EEG Delta/Theta Ratio and Microstate Analysis Originating Novel Biomarkers for Malnutrition-Inflammation Complex Syndrome in ESRD Patients. Frontiers in Human Neuroscience, 15. doi: 10.3389/fnhum.2021.795237	12/1	2022
Published research work	Puttanawarut, C., Sirirutbunkajorn, N., Khachonkham, S., Pattaranutaporn, P., & Wongsawat, Y. (2021). Biological dosiomic features for the prediction of radiation pneumonitis in esophageal cancer patients. Radiation Oncology, 16(1), 220. doi: 10.1186/s13014-021-01950-y	12/1	2021
Published research work	Jatupornpoonsub, T., Thimachai, P., Supasyndh, O., & Wongsawat, Y. (2021). Background Activity	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Findings in End-Stage Renal Disease With and Without Comorbid Diabetes: An Electroencephalogram Study. Frontiers in Human Neuroscience, 15. doi: 10.3389/fnhum.2021.741446		
Published research work	Aung, S. T., & Wongsawat, Y. (2021). Prediction of epileptic seizures based on multivariate multiscale modified-distribution entropy. PeerJ Computer Science, 7, e744. doi: 10.7717/peerj-cs.744	12/1	2021
Published research work	Piluek, S., Ngamrassameewong, S., Jatupornpoonsub, T., Tiawongsuwan, L., Puanhvuan, D., Prasertsakul, T., Chanubol, R., Tirakotai, W., & Wongsawat, Y. (2021). Portable Facial Stimulator Design and Standardization: IEC 60601-1-2. 2021 18th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON), 1121–1124, May 19-22, 2021, Phuket, Thailand. doi: 10.1109/ECTI-CON51831.2021.9454836	11/0.4	2021
Published research work	Wijam, B., & Wongsawat, Y. (2021). An Investigation on Alpha-Beta Ratio of EarEEG System. 2021 18th International Conference on Electrical Engineering/Electronics, Computer,	11/0.4	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Telecommunications and Information Technology (ECTI-CON), 1117–1120, May 19-22, 2021, Phuket, Thailand. doi: 10.1109/ECTI-CON51831.2021.9454746		
Published research work	Siribunyaphat, N., Punsawad, Y., & Wongsawat, Y. (2021). Development of Flicker Visual Stimulus by Mixing Fundamental and Its Harmonie Frequencies for SSVEP-based Brain-Computer Interface. 2021 18th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON), 1113–1116, May 19-22, 2021, Phuket, Thailand. doi: 10.1109/ECTI-CON51831.2021.9454936	11/0.4	2021
Published research work	Punsawad, Y., Siribunyaphat, N., & Wongsawat, Y. (2021). Exploration of illusory visual motion stimuli: An EEG-based brain-computer interface for practical assistive communication systems. Heliyon, 7(3), e06457. doi: 10.1016/j.heliyon.2021.e06457	12/1	2021
Published research work	Aung, S. T., & Wongsawat, Y. (2021). Analysis of EEG Signals Contaminated With Motion Artifacts Using Multiscale Modified-Distribution Entropy. IEEE Access, 9, 33911–33921. doi: 10.1109/ACCESS.2021.3061692	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Aung, S. T., & Wongsawat, Y. (2020). Modified-Distribution Entropy as the Features for the Detection of Epileptic Seizures. Frontiers in Physiology, 11. doi: 10.3389/fphys.2020.00607	12/1	2020
Published research work	Chatthong, W., Khemthong, S., & Wongsawat, Y. (2020). Brain Mapping Performance as an Occupational Therapy Assessment Aid in Attention Deficit Hyperactivity Disorder. American Journal of Occupational Therapy, 74(2), 7402205070p1. doi: 10.5014/ajot.2020.035477	12/1	2020
Published research work	Ngamrassameewong, S., Manatchinapisit, V., & Wongsawat, Y. (2020). Improvement of Motor Imagery BCI using Silent Speech. 2020 17th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON), 840–843, 24-27 June 2020, Phuket, Thailand. doi: 10.1109/ECTI-CON49241.2020.9158081	11/0.4	2020
Published research work	Chatthong, W., Khemthong, S., & Wongsawat, Y. (2020). A Design Thinking Model Based on Quantitative Electroencephalography in Social Emotional Learning for Attention Deficit Hyperactivity Disorder. Mind, Brain, and	12/1	2020

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Education, 14(2), 104–113. doi: 10.1111/mbe.12235		
Published research work	Sanguantrakul, J., Soontreekulpong, N., Trakoolwilaiwan, T., & Wongsawat, Y. (2020). Development of BCI System for Walking Substitution via Humanoid Robot. 2020 8th International Electrical Engineering Congress (IEECON), 1–4, March 4-6, 2020, Chiang Mai, Thailand. doi: 10.1109/iEECON48109.2020.232736	11/0.4	2020

Current Teaching Load

1. EGBE 522 Biomedical Signal Processing 3(3-0-6)
2. EGBE 624 Brain-computer Interface 3(3-0-6)
3. EGBE 644 Neural Interfacing 3(3-0-6)
4. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1. EGBE 522 Biomedical Signal Processing 3(3-0-6)
2. EGBE 624 Brain-computer Interface 3(3-0-6)
3. EGBE 644 Neural Interfacing 3(3-0-6)
4. EGBE 698 Thesis 12(0-36-0)
5. EGBE 696 Independent Study 6(0-24-0)

6. Name: Assistant Professor Dr.Chamras Promptmas

Education

Degree	Field of Study	Graduated From		
		Institution	Country	Year
Ph.D.	Biochemistry	Mahidol University	Thailand	1994
M.Sc.	Biochemistry	Chulalongkorn University	Thailand	1980
B.Sc.	Medical Technology	Mahidol University	Thailand	1976

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Development of Micro-fluidic System, Micro-Total Analysis System and Biosensors for Medical Applications

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Suvanasuthi, R., Chimnaronk, S., & Promptmas, C. (2022). 3D printed hydrophobic barriers in a	12/1	2022

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	paper-based biosensor for point-of-care detection of dengue virus serotypes. Talanta, 237, 122962. doi: 10.1016/j.talanta.2021.122962		
Published research work	Deb, H., Srisuai, N., Bonruang, S., Jolivot, R., Promptmas, C., & Mohammed, W. S. (2021). 3D-printed Guided Mode Resonance Readout System for Biomedical and Environmental Applications. Engineering Journal, 25(6), 35–43. doi: 10.4186/ej.2021.25.6.35	12/1	2021
Published research work	Khemthongcharoen, N., Uawithya, P., Chanasakulniyom, M., Yasawong, M., Jeamsaksiri, W., Sripumkhai, W., Pattamang, P., Juntasaro, E., Houngkamhang, N., Thienthong, T., & Promptmas, C. (2021). Polydimethylsiloxane (PDMS) microfluidic modifications for cell-based immunofluorescence assay. Journal of Adhesion Science and Technology, 35(9), 955–972. doi: 10.1080/01694243.2020.1831837	12/1	2021
Published research work	Kamnerdsook, A., Juntasaro, E., Khemthongcharoen, N., Chanasakulniyom, M., Sripumkhai, W., Pattamang, P., Promptmas, C., Atthi, N., & Jeamsaksiri, W. (2021). Formation of double emulsion micro-droplets in a microfluidic device using a partially	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	hydrophilic–hydrophobic surface. RSC Advances, 11(56), 35653–35662. doi: 10.1039/D1RA06887C		
Published research work	Wint, N. Y., Han, K. K., Yamprayoonswat, W., Ruangsuj, P., Mangmool, S., Promptmas, C., & Yasawong, M. (2021). A Novel Nucleic Lateral Flow Assay for Screening phaR -Containing Bacillus spp. Journal of Microbiology and Biotechnology, 31(1), 123–129. doi: 10.4014/jmb.1907.07045	12/1	2021
Published research work	Khemthongcharoen, N., Uawithya, P., Yookong, N., Chanasakulniyom, M., Jeamsaksiri, W., Sripumkhai, W., Pattamang, P., Juntasaro, E., Houngkamhang, N., Thienthong, T., & Promptmas, C. (2021). Microfluidic system evaluation for the semi-automatic detection of MOG-IgG in serum samples. Sensing and Bio-Sensing Research, 34, 100458. doi: 10.1016/j.sbsr.2021.100458	12/1	2021
Published research work	Thienthong, T., Juntasaro, E., Sripumkhai, W., Houngkamhang, N., Chanasakulniyom, M., Khemthongcharoen, N., Pattamang, P., Atthi, N., Promptmas, C., Uawithya, P., & Jeamsaksiri, W. (2021). Mixing-Performance Evaluation of a Multiple Dilution Microfluidic Chip for a Human	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Serum Dilution Process. Engineering Journal, 25(9), 67–87. doi: 10.4186/ej.2021.25.9.67		
Published research work	Saengdee, P., Promptmas, C., Thanapitak, S., Srisuwan, A., Pankiew, A., Thornyanadacha, N., Chaisriratanakul, W., Chaowicharat, E., & Jeamsaksiri, W. (2020). Optimization of 3-aminopropyltriethoxysilane functionalization on silicon nitride surface for biomolecule immobilization. Talanta, 207, 120305. doi: 10.1016/j.talanta.2019.120305	12/1	2020
Published research work	Deb, H., Srisuai, N., Jolivot, R., Promptmas, C., Mohammed, W. S., & Boonruang, S. (2020). Enhanced sensitivity of guided mode resonance sensor through super-mode excitation at near cut-off diffraction. Optics & Laser Technology, 132, 106517. doi: 10.1016/j.optlastec.2020.106517	12/1	2020

Current Teaching Load

1. EGBE 604 Biosensors 3(3-0-6)
2. EGBE 625 Bioelectronics 3(3-0-6)
3. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1. EGBE 604 Biosensors	3(3-0-6)
2. EGBE 698 Thesis	12(0-36-0)
3. EGBE 696 Independent Study	6(0-24-0)
4. EGBE 625 Bioelectronics	3(3-0-6)

7. Name: Assistant Professor Dr. Phornphop Naiyanetr

Education

Degree	Major	Graduated From		
		Institution	Country	Year
Dr.scient.med	Biomedical Engineering	Medical University of Vienna	Austria	2010
M.Eng.	Biomedical Engineering	Mahidol University	Thailand	2000
B.Eng.	Electrical Engineering	Mahidol University	Thailand	1997

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Cardiovascular Engineering, Artificial Organs, Bioprinting

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Iamsamang, J., & Naiyanetr, P. (2021). Computational method and program for generating a porous scaffold based on implicit surfaces. Computer Methods and Programs in Biomedicine, 205, 106088. doi: 10.1016/j.cmpb.2021.106088	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Iamsamang, J., Subannajui, K., Tawonsawatruk, T., & Naiyanetr, P. (2019). Premixed Calcium Phosphate Cement for Extrusion-based 3D Printing: Planetary Centrifugal Mixer and Homogeneity Evaluation. 2019 12th Biomedical Engineering International Conference (BMEiCON), 1–5, November 19-22, 2019, Ubon Ratchathani, Thailand. doi: 10.1109/BMEiCON47515.2019.8990241	11/0.4	2019
Published research work	Leelanukrom, P., Gesprasert, G., Kasantikul, T., & Naiyanetr, P. (2019). The Renal Vascular Resistance and Renal Blood Flow of Hypothermic Machine Perfusion and Cold Storage in porcine slaughterhouse kidneys. 2019 12th Biomedical Engineering International Conference (BMEiCON), 1–5, November 19-22, 2019, Ubon Ratchathani, Thailand. doi: 10.1109/BMEiCON47515.2019.8990299	11/0.4	2019
Published research work	Cen, P., DeLong, W., Amatanon, V., Iamsamang, J., & Naiyanetr, P. (2019). Intelligence ECG Monitoring System: Wireless platform and Arrhythmia classification using Residual neural network. 2019 12th Biomedical Engineering International Conference (BMEiCON), 1–5, November 19-22, 2019, Ubon Ratchathani,	11/0.4	2019

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Thailand. doi: 10.1109/BMEiCON47515.2019.8990196		
Published research work	Rattanasomrerk, S., Honglertsakul, C., Gesprasert, G., Chantakanakakorn, N., & Naiyanetr, P. (2019). Development of tele-home uroflowmetry system with NB-IoT implementation. 2019 12th Biomedical Engineering International Conference (BMEiCON), 1–4, November 19-22, 2019, Ubon Ratchathani, Thailand. doi: 10.1109/BMEiCON47515.2019.8990277	11/0.4	2019
Published research work	Naiyanetr, P. (2019). Effect of Left-Right Heart During Biventricular Assist Device Support by Speed Synchronization: A Computer Study. L. Lhotska, L. Sukupova, I. Lacković, & G. S. Ibbott (Eds.), World Congress on Medical Physics and Biomedical Engineering 2018 (pp. 617–622). June 3-8, 2018, Prague, Czech Republic.	11/0.4	2019

Current Teaching Load

1. EGBE 643 Cardiovascular Systems 3(3-0-6)
2. EGBE 647 Cardiovascular Engineering and Artificial Organs 3(3-0-6)
3. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1. EGBE 643 Cardiovascular Systems 3(3-0-6)
2. EGBE 647 Cardiovascular Engineering and Artificial Organs 3(3-0-6)
3. EGBE 698 Thesis 12(0-36-0

8. Name: Assistant Professor Dr.Warakorn Charoensuk

Education

Degree	Field of Study	Graduated From		
		Institution	Country	Year
Ph.D.	Electrical Engineering	Vanderbilt University	USA	2001
M.S.	Electrical Engineering	Vanderbilt University	USA	1998
B.Eng.	Control Engineering	King Mongkut's Institute of Technology Ladkrabang	Thailand	1991

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Sport innovation technology, Physiological System Modeling and Identification, Human Motion Analysis and Postural Sway, Rehabilitation Engineering, Development of Human Upper Limb Prostheses and Orthoses

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Prasertsakul, T., Kaimuk, P., Chinjenpradit, W., & Charoensuk, W. (2020). Correlational study of the center of pressure measures of postural steadiness on five different standing tasks in	12/1	2020

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	overweight adults. Biomedical Engineering / Biomedizinische Technik, 65(3), 367–378. doi: 10.1515/bmt-2018-0115		
Published research work	Vijittrakarnrung, C., Manupibul, U., Charoensuk, W., Tanthuwapathom, R., Jarumethitanont, W., & Sa-Ngasoongsong, P. (2020). Effectiveness of a Simple Auditory Feedback Insole (Sim-Insole) for Touchdown Weight-Bearing Training in At-Risk Volunteers with Poor Compliance: A Crossover Study. Surgical Technology International, 37. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/32819025	12/1	2020
Published research work	Vijittrakarnrung, C., Manupibul, U., Charoensuk, W., Wongsak, S., & Sa-Ngasoongsong, P. (2020). Reliability and Correlation of the Force-PRO Device and Computer-Assisted Navigation System for Measurement of Acetabular Cup Position in Total Hip Arthroplasty. Surgical Technology International, 36, 438–442. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/32372404	12/1	2020
Published research work	Manupibul, U., Vijittrakarnrung, C., Sa-ngasoongsong, P., Fuangfa, P., Jaovisidha, S., & Charoensuk, W. (2020). Innovative Force-PRO device to measure force and implant position in	12/1	2020

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	total hip arthroplasty. Physical and Engineering Sciences in Medicine, 43(1), 109–117. doi: 10.1007/s13246-019-00824-8		

Current Teaching Load

1. EGBE 609 Fundamental of Biomedical Engineering 3(3-0-6)
2. EGBE 654 Nonlinear Dynamics in Physiology 3(3-0-6)
3. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1. EGBE 609 Fundamental of Biomedical Engineering 3(3-0-6)
2. EGBE 654 Nonlinear Dynamics in Physiology 3(3-0-6)
3. EGBE 698 Thesis 12(0-36-0)
4. EGBE 696 Independent Study 6(0-24-0)

9. Name: Lecturer Dr. Pornpat Athamanolap

Education

Degree	Major	Graduated From		
		Institution	Country	Year
Ph.D.	Biomedical Engineering	Johns Hopkins University	USA	2019
M.Sc.Eng.	Biomedical Engineering	Johns Hopkins University	USA	2013
B.Eng.	Computer Engineering	Kasetsart University	Thailand	2007

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Molecule diagnostics, High-Resolution met, Digital PCR, Microfluidics, Epigenetics

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Chaibun, T., Puenpa, J., Ngamdee, T., Boonapatcharoen, N., Athamanolap, P., O'Mullane, A. P., Vongpunsawad, S., Poovorawan, Y., Lee, S. Y., & Lertanantawong, B. (2021). Rapid electrochemical detection of coronavirus SARS-CoV-2. Nature	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Communications, 12(1), 802. doi: 10.1038/s41467-021-21121-7		
Published research work	Haque, F., Fisseha, S., Athamanolap, P., Tower, R., Ortega, J., Dominguez, C., Maruca, T., Torpey, D., Myers, R., & Laksanalamai, P. (2020). Reduction of the Carbapenemase Inactivation Method (CIM) assay time by real-time PCR. Journal of Microbiological Methods, 178, 106072. doi: 10.1016/j.mimet.2020.106072	12/1	2020
Published research work	Miller, B. F., Pisanic II, T. R., Margolin, G., Petrykowska, H. M., Athamanolap, P., Goncearenco, A., Osei-Tutu, A., Annunziata, C. M., Wang, T.-H., & Elnitski, L. (2020). Leveraging locus-specific epigenetic heterogeneity to improve the performance of blood-based DNA methylation biomarkers. Clinical Epigenetics, 12(1), 154. doi: 10.1186/s13148-020-00939-w	12/1	2020

Current Teaching Load

1. EGBE 518 Engineering Mathematics for Research 3(3-0-6)
2. EGBE 681 BioMEMS and Medical Microdevices 3(3-0-6)
3. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1.	EGBE 603 Molecular Diagnostics for Clinical Applications	3(3-0-6)
2.	EGBE 518 Engineering Mathematics for Research	3(3-0-6)
3.	EGBE 681 BioMEMS and Medical Microdevices	3(3-0-6)
4.	EGBE 698 Thesis	12(0-36-0)

10. Name: Lecturer Dr. Songpol Ongwattanakul

Education

Degree	Major	Graduated From		
		Institution	Country	Year
Ph.D.	Computer Engineering	University of Alabama	USA	2003
M.S.	Computer Engineering	University of Alabama	USA	1997
B.Eng.	Computer Engineering	King Mongkut's University of Technology Thonburi	Thailand	1994

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

IoT, Data Analytics, Computer Vision

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Academic Article	Suthakorn J, Kishore M, Ongwattankul S, Matsuno F, Svinin M, & M. Pillai B. (2022, January 25). Stereo Vision-based Object Detection and Depth Estimation from 3D Reconstructed Scene for an Autonomous Multi	11/0.4	2022

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Robotic Rescue Mission. 25-27 Jnuary, 2023, Beppu, Japan. pp 1643-1647		
Academic Article	Saengdee, P., Thanapitak, S., Ongwattanakul, S., Srisuwan, A., Pankiew, A., Thornyanadacha, N., Chaisriratanakul, W., Jeamsaksiri, W., & Promptmas, C. (2021). A silicon nitride ion sensitive field effect transistor□based immunosensor for determination of urinary albumin. Electrochemical Science Advances. doi: 10.1002/elsa.202100078	12/1	2021
Published research work	Meesattham, S., Charoensiritanasin, P., Ongwattanakul, S., Liang, Z., Tontiwachwuthikul, P., & Sema, T. (2020). Predictions of equilibrium solubility and mass transfer coefficient for CO2 absorption into aqueous solutions of 4-diethylamino-2-butanol using artificial neural networks. Petroleum, 6(4), 385–391. doi: 10.1016/j.petlm.2018.09.005	12/1	2020

Current Teaching Load

1. EGBE 698 Thesis 12(0-36-0)
2. EGBE 623 Pattern Recognition 3(3-0-6)
3. EGBE 652 Bioimage Informatics 3(3-0-6)

Assigned Teaching Load for the Proposed Program

1.	EGBE 698 Thesis	12(0-36-0)
2.	EGBE 696 Independent Study	6(0-24-0)
3.	EGBE 623 Pattern Recognition	3(3-0-6)
4.	EGBE 652 Bioimage Informatics	3(3-0-6)

11. Name: Lecturer Dr. Soracha Dechaumphai (Thamphiwatana)

Education

Degree	Major	Graduated From		
		Institution	Country	Year
Ph.D.	NanoEngineering	University of California, San Diego	USA	2014
M.S.	NanoEngineering	University of California, San Diego	USA	2011
M.E.	Biomedical Engineering	Colorado State University	USA	2010
B.Pharm.	Pharmaceutical Sciences	Prince of Songkla University	Thailand	2006

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Design and development of targeted nanotherapeutics and nanodiagnostics to address different medical problems, including the infectious disease, and cancer.

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Patent	Liangfang Zhang, Che-Ming Jack Hu, Ronnie H Fang, Brian T Luk, & Soracha Thamphiwatana. (2022). Treating infection by a platelet-	12/1	2022

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	targeting microbe using nanoparticles (No. 11224577).		
Published research work	Samae H, Thamphiwatana S, Phairatana T. The Contribution of Polyaniline and Gold Nanoparticles for Enhancing Current Signals of Streptavidin Based Immunosensors. ECS Transactions. 2022 Apr 24;107(1):827.	12/1	2022
Published research work	Zhu, Y., Yu, X., Thamphiwatana, S. D., Zheng, Y., & Pang, Z. (2020). Nanomedicines modulating tumor immunosuppressive cells to enhance cancer immunotherapy. Acta Pharmaceutica Sinica B. doi: 10.1016/j.apsb.2020.08.010	12/1	2020

Current Teaching Load

1. EGBE 524 Research Methodology 3(3-0-6)
2. EGBE 665 Nanomedicine 3(3-0-6)
3. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1. EGBE 524 Research Methodology 3(3-0-6)
2. EGBE 665 Nanomedicine 3(3-0-6)
3. EGBE 698 Thesis 12(0-36-0)
4. EGBE 696 Independent Study 6(0-24-0)

12. Name: Lecturer Dr.Titipat Achakulvisut

Education

Degree	Major	Graduated From		
		Institution	Country	Year
Ph.D.	Bioengineering	University of Pennsylvania	USA	2021
M.S.	Biomedical Engineering	Northwestern University	USA	2017
B.Eng.	Electrical Engineering	Chulalongkorn University	Thailand	2012

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Science of Science, Applied Machine Learning, Text Mining, Natural Language Processing, Content-based and Personalized Recommendation System, Medical Electronic Health Records

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Polpanumas, C., Achakulvisut, T., Limkonchotiwat, P., Matupumanon, B., Chaksangchaichot, C., Chumlek, N., Phaphoom, N., Siwatammarat, P., Laohapiengsak, P., Amornpornwiwat, S.,	12/1	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Daroontham, W., Chuangsuwanich, E., Kulruchakorn, K., & Nutanong, S. (2021). "AI Builders: Teaching Thai Students to Build End-to-End Machine Learning Projects Online," Proceeding of 2021 IEEE International Conference on Engineering, 5-8 December 2021, Wuhan, Hubei Province, China, 565–572.		
Published research work	Aung, Z. H., Srithaworn, K., & Achakulvisut, T. (2022). "Multitask learning via pseudo-label generation and ensemble prediction for parasitic egg cell detection: IEEE ICIP Challenge 2022," Proceeding of 2022 IEEE International Conference on Image Processing (ICIP), 16-19 October 2022, Bordeaux, France, 4273–4277.	12/1	2022

Current Teaching Load

1. EGBE601 Medical Signal Processing and Instrumentations 3(3-0-6)
2. EGBE698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1. EGBE613 Machine learning and data science for Biomedical Engineering 3(3-0-6)
2. EGBE614 Deep learning for biomedical engineering 3(3-0-6)
3. EGBE601 Medical Signal Processing and Instrumentations 3(3-0-6)

4. EGBE698 Thesis 12(0-36-0)
5. EGBE696 Independent Study 6(0-24-0)

Full time instructors

1. **Name: Lecturer Dr.Jetsada Arnin**

Education

Degree	Major	Graduated From		
		Institution	Country	Year
Ph.D.	Biomedical Engineering	University of Strathclyde	UK	2022
M.Eng.	Biomedical Engineering	Mahidol University	Thailand	2013
B.Eng.	Biomedical Engineering	Mahidol University	Thailand	2011

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Digital Signal Processing and Image Processing, Real- time Implementation and Optimization, Parallel Computing and Cloud Computing, Embedded System and Internet of Things, Machine Learning and Deep Learning, Big Data Analytics

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Arnin, J., & Ruthiraphong, P. (2021). Cloud-based Gait Analysis Using a Single IMU for Parkinson Disease. 2021 18th International Conference on Electrical	11/0.4	2021

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON), 1129–1132. May 19-22, 2021, Phuket, Thailand. doi: 10.1109/ECTI-CON51831.2021.9454716		
Published research work	Autthasan, P., Du, X., Arnin, J., Lamyai, S., Perera, M., Itthipuripat, S., Yagi, T., Manoonpong, P., & Wilaiprasitporn, T. (2020). A Single-Channel Consumer-Grade EEG Device for Brain–Computer Interface: Enhancing Detection of SSVEP and Its Amplitude Modulation. IEEE Sensors Journal, 20(6), 3366–3378. doi: 10.1109/JSEN.2019.2958210	12/1	2020

Current Teaching Load

1. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1. EGBE 698 Thesis 12(0-36-0)
2. EGBE 696 Independent Study 6(0-24-0)

2. Name: Lecturer Dr. Pracha Yambangyang

Education

Degree	Major	Graduated From		
		Institution	Country	Year
Ph.D.	Biomedical Engineering	University of Glasgow	UK	2019
M.Eng.	Biomedical Engineering	Mahidol University	Thailand	2003
B.Eng.	Electrical Engineering	King Mongkut's University of Technology North Bangkok	Thailand	1994

Faculty/Institute/College

Department of Biomedical Engineering, Faculty of Engineering, Mahidol University

Interesting Research Topics or Specialties

Biomedical Instrumentation, Clinical Engineering and Hospital Engineering

Academic work as not part of the study for degree certificate and published and disseminated in accordance with the stipulated criteria regarding academic rank appointment in five retrospective years *

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Yambangyang, P., Wilson, R., Reboud, J., Cooper, J. M., & Demčenko, A. (2022). Ultrasonic evaluation of aging kinetics in amorphous polymer. Applied Physics Letters,	12/1	2022

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
	121(7), 072202. https://doi.org/10.1063/5.0102398		
Published research work	Ngamratanapaiboon, S., & Yambangyang, P. (2021). Quantification of antipsychotic biotransformation in brain microvascular endothelial cells by using untargeted metabolomics. Drug Discoveries & Therapeutics, 15(6), 2021.01101. doi: 10.5582/ddt.2021.01101	12/1	2021

Current Teaching Load

1. EGBE 648 Respiratory Engineering System 3(3-0-6)
1. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

1. EGBE 648 Respiratory Engineering System 3(3-0-6)
2. EGBE 552 Ultrasound Technology and Application 3(3-0-6)
3. EGBE 698 Thesis 12(0-36-0)
4. EGBE 696 Independent Study 6(0-24-0)

Part time instructors

1. Name: Associate Professor Panya Kaimuk

Education

Degree	Major	Graduated From		
		Institution	Country	Year
M.D.		Chiang Mai University	Thailand	1973

Faculty/Institute/College

Retired

Interesting Research Topics or Specialties

Sports Science, Golf and Orthopedic Surgery

Publication that are not parts of doctoral dissertation and are complied with the criteria for academic position appointment within 5 Years

Types of Academic Work	Title	Standard Criteria and Weights	Year of Publication
Published research work	Prasertsakul, T., Kaimuk, P., Chinjenpradit, W., & Charoensuk, W. (2020). Correlational study of the center of pressure measures of postural steadiness on five different standing tasks in overweight adults. Biomedical Engineering / Biomedizinische Technik, 65(3), 367–378. doi: 10.1515/bmt-2018-0115	12/1	2020

Current Teaching Load

1. EGBE 698 Thesis 12(0-36-0)

Assigned Teaching Load for the Proposed Program

2. EGBE 698 Thesis	12(0-36-0)
3. EGBE 696 Independent Study	6(0-24-0)

Appendix C

Curriculum Mapping

Appendix C

Curriculum Mapping

 Major responsibility **O** Minor responsibility

Subjects	Knowledge			Skills				Ethics				Character			
	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4
1.Core courses															
EGBE 517 Physiology for Biomedical Engineering	●	●	●	●	●	o	o	o	o	●	●	o	o	●	o
EGBE 518 Engineering Mathematics for Research	●	●	●	●	●	o	o	o	o	●	●	o	o	●	●
EGBE 524 Research Methodology	●	●	●	●	●	o	●	●	o	●	●	●	●	●	●
EGBE 601 Medical Signal Processing and Instrumentation	●	●	●	●	●	o	o	o	o	●	●	o	o	●	●
EGBE 607 Materials and Mechanics in Medicine	●	●	●	●	●	o	o	o	o	●	●	o	o	●	●
EGBE 609 Fundamental of Biomedical Engineering	●	●	●	●	●	o	●	●	o	●	●	●	●	●	●

Subjects	Knowledge			Skills				Ethics				Character			
	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4
EGBE 657 Research Seminar for Biomedical Engineers	●	●	o	o	●	●	●	●	o	●	●	●	●	●	●
2. Elective courses															
EGBE 522 Biomedical Signal Processing	●	●	●	●	●	o	●	o	o	●	●	o	●	●	●
EGBE 523 Advanced Biomedical Image Processing	●	●	●	●	●	o	●	o	o	●	●	o	o	●	●
EGBE 551 Computational Methods for Biomedical Engineering	●	●	●	●	●	o	●	o	o	●	●	●	o	●	●
EGBE 552 Ultrasound Technology and Application	●	●	●	●	●	o	o	o	●	●	●	●	o	●	●
EGBE 553 Intelligent Wearable Biosensors	●	●	●	●	●	●	●	o	●	●	●	●	o	●	●
EGBE 554 Healthcare Automation and Robotics	●	●	●	●	●	●	●	o	●	●	●	o	o	●	●
EGBE 555 Metaverse in Medicine	●	●	●	●	●	●	●	o	●	●	●	o	o	●	●

Subjects	Knowledge			Skills				Ethics				Character			
	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4
EGBE 556 Biomedical Cyber-Physical Systems	●	●	●	●	●	o	o	o	o	●	●	o	o	●	●
EGBE 558 Assistive Technologies for Enhancing Human Movement and Rehabilitation	●	●	●	●	●	o	●	●	o	●	●	●	●	●	●
EGBE 557 Nonlinear System Identification and Control in Biomedical Engineering	●	●	●	●	●	o	●	O	o	●	●	●	o	●	●
EGBE 610 Neural Networks	●	●	●	●	●	●	o	●	o	●	●	o	o	●	●
EGBE 611 Advanced Medical Imaging	●	●	●	●	●	●	●	O	o	●	●	o	o	●	●
EGBE 614 Deep Learning for Biomedical Engineering	●	●	●	●	●	●	●	O	o	●	●	o	●	●	●
EGBE 617 IC Design for Wireless Medical Device and Health Care	●	●	●	●	●	o	o	O	o	●	●	●	o	●	●
EGBE 626 Molecular Diagnostics for Clinical Applications	●	●	●	●	●	o	o	O	o	●	●	o	o	●	●

Subjects	Knowledge			Skills				Ethics				Character			
	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4
EGBE 627 Machine learning and data science for Biomedical Engineering	●	●	●	●	●	●	●	O	o	●	●	o	●	●	●
EGBE 635 Biotechnology for Biomedical Engineering	●	●	●	●	●	o	o	O	o	●	●	●	o	●	●
EGBE 642 Advanced Biomechanics	●	●	●	●	●	o	●	●	o	●	●	●	o	●	●
EGBE 648 Respiratory Engineering System	●	●	●	●	●	o	o	O	o	●	●	●	o	●	●
EGBE 653 Intelligent Systems	●	●	●	●	●	o	o	o	o	●	●	o	o	●	●
EGBE 664 Nanobiotechnology	●	●	●	●	●	●	●	o	●	●	●	o	o	●	●
EGBE 683 Special Topics in Biomedical Engineering	●	●	●	●	●	o	o	o	o	●	●	o	o	●	●
3. Thesis or Independent Study															
EGBE 698 Thesis	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Subjects	Knowledge			Skills				Ethics				Character			
	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4
EGBE 696 Independent Study	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Descriptions:

* Please specify all courses for the proposed program.

* Please analyze and specify expected learning outcomes of the courses also mark major or minor responsibility in the curriculum mapping.

* Please mark for major responsibility and for minor responsibility.

* Regarding core courses, at least one major responsibility must be marked. Please describe expected learning outcomes that match with core value of the university in the table of relationship between learning outcomes of the program and core value of the university as below.

Table of Relationship between Learning Outcomes of the Program and Core Value of Mahidol University

Learning Outcomes (as stated in Section 5, item no. 2)	Core value of Mahidol University
1. Knowledge	
1.1 Explain how to apply the theories and techniques for inquiring, probing, and solving the challenges in biomedical engineering	Mastery
1.2 Provide a reasonable idea for designing and developing innovations for Biomedical Engineering.	Mastery
1.3 Comply the techniques of research and development to translate the knowledge in biomedical engineering rationally.	Originality
2. Skills	
2.1 Solve the problems in engineering efficiently.	Originality
2.2 Conduct the research process by themselves.	Mastery

2.3 Present the result of research to the academic society, i.e., oral presentation, academic conference, and national or international publication.	Originality
2.4 Effectively use the suitable information technology for searching analyzing, creating, and presenting the academic reports or research results.	Mastery
3. Ethics 3.1 Respect for the other rights, their beliefs, and their points of view. 3.2 Be punctual, have discipline. 3.3 Do not plagiarize the work of others. 3.4 Follow morality and ethics in academic and research works.	 Harmony Altruism Leadership Integrity
4. Character 4.1 Foster strong relationships in biomedical teams through collaborative activities that promote empathy and understanding. 4.2 Lead interdisciplinary teams effectively, leveraging engineering expertise to tackle complex biomedical challenges.	 Harmony Leadership

4.3 Critique and improve biomedical engineering concepts, designs, and methodologies, fostering innovation.	Determination
4.4 Ensure accountability for individual and collective outcomes in biomedical projects, upholding ethical and professional standards.	Mastery

Appendix D

Program Learning Outcomes

Appendix D

Program Learning Outcomes

Table 1: Comparison between before and after revised objective of the program

Objectives of the Program 2017	Revised Objectives of the Program 2023
๑. มีคุณธรรม จริยธรรม รวมทั้งเจตคติที่ดี ทั้งทางวิชาการและวิชาชีพ	1. Design and develop medical innovations that resolves the current societal healthcare challenges by applying the principles of biomedical engineering.
๒.มีความรู้ความเข้าใจศาสตร์ทางวิศวกรรมชีวการแพทย์ติดตามความรู้และประมวลความรู้เพื่อพัฒนาองค์ความรู้ทางวิศวกรรมชีวการแพทย์	2. Demonstrate effective communication, teamwork, and leadership skills, as well as engage in life-long learning and continuous self-development in biomedical engineering, or other related fields, through professional development.
๓. ประยุกต์องค์ความรู้แบบพหุวิทยาการ เพื่อแก้ปัญหาทางวิศวกรรมชีวการแพทย์ได้อย่างมีประสิทธิภาพ รวมถึงทักษะทางปัญญา ที่สามารถสร้างสรรค์งานวิจัยและพัฒนานวัตกรรมทางวิศวกรรมศาสตร์เพื่อพัฒนาการแพทย์และสาธารณสุขได้ด้วยตนเอง	3. Commit to a high standard of moral, ethical responsibility, and professional integrity in both industries, academic and research.
๔. มีทักษะในการสร้างความสัมพันธ์ และทำงานร่วมกับผู้อื่นรวมถึงทักษะในการจัดการด้านส่วนรวมให้บรรลุผลสำเร็จได้	4. Be resilient professionals, adept in teamwork, leadership, constructive criticism, and accountability, while driving innovation in the ever-evolving landscape of biomedical engineering field.

Objectives of the Program 2017	Revised Objectives of the Program 2023
๕. มีทักษะในการวิเคราะห์เชิงตัวเลข และนำมาประมวลผลเพื่อพัฒนาองค์ความรู้ทางวิศวกรรมชีวการแพทย์ได้อย่างเหมาะสม รวมถึงทักษะในการใช้เทคโนโลยีการสื่อสารโดยใช้อิเล็กทรอนิกส์ เพื่อสื่อสารกับกลุ่มบุคคลต่างๆ และนำเสนอผลงานทางวิศวกรรมชีวการแพทย์ได้อย่างเหมาะสมและมีประสิทธิภาพ	

Table 2: Relationship between objective of the program and program learning outcome

Objective of the Program	Program Learning Outcome*					
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
1. Design and develop medical innovations that resolves the current societal healthcare challenges by applying the principles of biomedical engineering.	√	√				
2. Demonstrate effective communication, teamwork, and leadership skills, as well as engage in life-long learning and continuous self-development in biomedical engineering, or other related fields, through professional development.		√	√		√	√
3. Commit to a high standard of moral, ethical responsibility, and professional integrity in both and research.				√	√	

Objective of the Program	Program Learning Outcome*					
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
4. Be resilient professionals, adept in teamwork, leadership, constructive criticism, and accountability, while driving innovation in the ever-evolving landscape of biomedical engineering field.		√		√	√	√

PLO1 Apply knowledge of biomedical engineering to the solution of complex biomedical engineering problems

PLO2 Design, conduct appropriate experiments using proper research methodology, analyze and interpret data for biomedical engineering innovation.

PLO3 Communicate and function effectively within multi-disciplinary teams.

PLO4 Comprehend professional, ethical and moral responsibility.

PLO5 Provide leadership, be capable of working in diverse environments, and create a collaborative and inclusive environment.

PLO6 Recognize the need for, and have the ability to engage in life-long learning.

Table 3: Standard domains of learning outcome and Program Learning Outcomes

Domains	Standard Learning Outcomes (TQF)	Program Learning Outcomes					
		PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
Knowledge	1.1 Explain how to apply the theories and techniques for inquiring, probing, and solving the challenges in biomedical engineering	√					
	1.2 Provide a reasonable idea for designing and developing innovations for Biomedical Engineering.		√				
	1.3 Comply the techniques of research and development to translate the knowledge in biomedical engineering rationally.	√	√				
Skills	2.1 Solve the problems in engineering efficaciously.		√	√			
	2.2 Conduct the research process by themselves.		√			√	
	2.3 Present the result of research to the academic society, i.e., oral presentation, academic conference, and national or international publication.			√			
	2.4 Effectively use the suitable information technology for searching analyzing, creating, and presenting						√

Domains	Standard Learning Outcomes (TQF)	Program Learning Outcomes					
		PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
	the academic reports or research results.						
Ethics	3.1 Respect for the other rights, their believes, and their points of view.				√		
	3.2 Be punctual, have disciplines.				√		
	3.3 Do not plagiarism the work of others.				√		
	3.4 Follow morality and ethics in academic and research works.				√		
Character	4.1 Foster strong relationships in biomedical teams through collaborative activities that promote empathy and understanding.			√		√	
	4.2 Lead interdisciplinary teams effectively, leveraging engineering expertise to tackle complex biomedical challenges.			√	√	√	
	4.3 Critique and improve biomedical engineering concepts, designs, and methodologies, fostering innovation.				√		√
	4.4 Ensure accountability for individual and collective outcomes in biomedical projects, upholding ethical and professional standards.				√	√	√

Table 4: Learning and Assessment Strategies for Program Learning Outcomes Evaluation

PLOs	Learning Method	Assessment
PLO1 Apply knowledge of biomedical engineering to the solution of complex biomedical engineering problems	1. Class activities 2. Class project 3. Conduct the research	1. Grading 2. Proposal exam 3. Defense exam
PLO2 Design, conduct appropriate experiments using proper research methodology, analyze and interpret data for biomedical engineering innovation.	1. Class project 2. Conduct the research	1. Grading 2. Proposal exam
PLO3 Communicate and function effectively within multi-disciplinary teams.	1. Class project 2. Conduct the research	1. Grading 2. Proposal exam
PLO4 Comprehend professional, ethical and moral responsibility.	1. Class activities 2. Class project 3. Conduct the research	1. Grading 2. Proposal exam 3. Defense exam
PLO5 Provide leadership, be capable of working in diverse environments, and create a collaborative and inclusive environment.	1. Class project 2. Conduct the research	1. Grading 2. Proposal exam 3. Defense exam
PLO6 Recognize the need for, and have the ability to engage in life-long learning.	1. Class activities 2. Class project 3. Conduct the research	1. Grading 2. Proposal exam 3. Defense exam

Table 5: Relationship between Courses of the Program and Program Learning Outcomes

No.	Code	Name	Credits	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
Required Courses									
1)	EGBE 517	Physiology for Biomedical Engineering	3(3-0-6)	I		I		I	I
2)	EGBE 518	Engineering Mathematics for Research	3(3-0-6)	I			I		
3)	EGBE 524	Research Methodology	2(2-0-4)	I	P	I	I		I
4)	EGBE 601	Medical Signal Processing and Instrumentation	3(3-0-6)	I	I		I	I	
5)	EGBE 607	Materials and Mechanics in Medicine	3(3-0-6)	I	P		I	I	
6)	EGBE 609	Fundamental of Biomedical Engineering	3(3-0-6)	I			I	I	I
7)	EGBE 657	Research Seminar for Biomedical Engineers	1(1-0-2)	I	I	I			I
Elective Courses									
1)	EGBE 522	Biomedical Signal Processing	3(3-0-6)	R	P	R	R		R
2)	EGBE 523	Advanced Biomedical Image Processing	3(3-0-6)	R			R		P
3)	EGBE 551	Computational Methods for Biomedical Engineering	3(3-0-6)	R	P		R		R

No.	Code	Name	Credits	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
4)	EGBE 552	Ultrasound Technology and Application	3(3-0-6)	R		R	R	R	R
5)	EGBE 553	Intelligent Wearable Biosensors	3(3-0-6)	R	P	R	R	P	R
6)	EGBE 554	Healthcare Automation and Robotics	3(3-0-6)	R	P	R	R	P	R
7)	EGBE 555	Metaverse in Medicine	3(3-0-6)	R		R	R	R	R
8)	EGBE 556	Biomedical Cyber-Physical Systems	3(3-0-6)	R		R	R	R	R
9)	EGBE 558	Assistive Technologies for Enhancing Human Movement and Rehabilitation	3(3-0-6)	R		R	R	R	R
10)	EGBE 557	Nonlinear System Identification and Control in Biomedical Engineering	3(3-0-6)	R		R	R	R	R
11)	EGBE 610	Neural Networks	3(3-0-6)	R		R	R	R	R
12)	EGBE 611	Advanced Medical Imaging	3(3-0-6)	R		R	R	R	R
13)	EGBE 614	Deep Learning for Biomedical Engineering	3(3-0-6)	R		R	R	R	R

No.	Code	Name	Credits	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
14)	EGBE 617	IC Design for Wireless Medical Device and Health Care	3(3-0-6)	R	P	R	R	P	R
15)	EGBE 626	Molecular Diagnostics for Clinical Applications	3(3-0-6)	R		R	R	R	R
16)	EGBE 627	Machine learning and data science for Biomedical Engineering	3(3-0-6)	R	P	R	R	P	R
17)	EGBE 635	Biotechnology for Biomedical Engineering	3(3-0-6)	R		R	R	R	R
18)	EGBE 642	Advanced Biomechanics	3(3-0-6)	R	P	R	R	P	R
19)	EGBE 648	Respiratory Engineering System	3(3-0-6)	R		R	R	R	R
20)	EGBE 653	Intelligent Systems	3(3-0-6)	R		R	R	R	R
21)	EGBE 664	Nanobiotechnology	3(3-0-6)	R		R	R	R	R
22)	EGBE 683	Special Topics in Biomedical Engineering	3(3-0-6)	R	P	R	R	P	R
23)	EGBE 698	Thesis	12(0-36-0)	M	M	M	M	M	M
24)	EGBE 696	Independent Study	6(0-24-0)	M	M	M	M	M	M

I = ELO is introduced & assessed R = ELO is reinforced & assessed

P = ELO is practiced & assessed M = Level of Mastery is assessed

Table 6: The expectation of learning outcomes at the end of the academic year

Plan 1.2 Academic (Course work and Research)

Year of study	Knowledge, skills, and any other expected learning outcomes	PLO
1st	- Understand biomedical engineering princleples - Analyze, synthesize and evaluate the efficient research methodology to create the biomedical engineering innovation and deep technology - Pass proposal examination	PLO 1 PLO 2 PLO 3
2nd	- Design and create the device or experiment to acquire data in the biomedical engineering trends or to draw a conclusion according to the biomedical engineering problem to be solved, as well as, critically evaluate scientific merit of up-to-date Biomedical Engineering knowledge - Submit Thesis - Publish Research Article - Pass thesis defense	PLO 4 PLO 5 PLO 6

Plan 2 Profession

Year of study	Knowledge, skills, and any other expected learning outcomes	PLO
1st	- Understand biomedical engineering princleples - Analyze, synthesize and evaluate the efficient research methodology to create the biomedical engineering innovation and deep technology - Pass proposal examination	PLO 1 PLO 2 PLO 3

2nd	- Critically evaluate scientific merit of up-to-date Biomedical Engineering knowledge and literature - Submit Independent Study - Pass Independent Study presentation	PLO 4 PLO 5 PLO 6

Appendix E

The Revised Curriculum

Appendix E

(For only Revised Curriculum)

The Revision of Master Program

in Biomedical Engineering Volume B.E.2017

Faculty of Engineering

and Faculty of Graduate Studies, Mahidol University

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1. **The Curriculum was approved by the Office of the Higher Education Commission on** .....

2. **The Mahidol University Council has approved this revised curriculum in the 592 meeting on** 24 May 2023

3. **The revised curriculum will be effective with student class 2023 from the 1 semester of the Academic Year 2023 onwards.**

4. **Rationale of revision**

   4.1 The curriculum is revised to be in accordance with Thai Qualification Framework for Higher Education B.E. 2552.

   4.2 The curriculum is revised to update the courses more modern.

5. **The details of the revision**

   5.1. Add Plan 2 Profession (Course work and Independent Study)

   5.2 Revive all information in English

   5.3 Cancel Elective Courses

   5.4 Add Elective Courses

   5.5 Revising the list of Charge of the Program and Full time instructors of the curriculum

Name	Previous		Revising	
	Charge of the Program	Full time instructors	Charge of the Program	Full time instructors
Associate Professor Dr. Benchaporn Lertanantawong	-	√	-	√
Associate Professor Dr. Jackrit Suthakorn	√	√	√	√
Associate Professor Dr. Norased Nasongkla	-	√	-	√
Associate Professor Dr. Panrasee Ritthipravat	-	√	-	√
Associate Professor Dr. Soontorn Oraintara	-	√	-	-
Associate Professor Dr. Yodchanan Wongsawat	√	√	√	√
Assistant Professor Dr. Chamras Promptmas	-	√	-	√
Assistant Professor Dr. Phornphop Naiyanetr	-	√	-	√
Assistant Professor Dr. Warakorn Charoensuk	-	√	-	√
Lecturer Dr. Sanitta Thongpang	-	√	-	-
Lecturer Dr. Songpol Ongwattanakul	√	√	√	√
Lecturer Dr. Soracha Dechaumphai (Thamphiwatana)	√	√	√	√
Lecturer Dr. Pornpat Athamanolap	√	√	√	√
Lecturer Dr. Titipat Atchakulvisut	-	-	-	√

The Comparison Table of Courses between the Current Program and Revising Program

Courses of the Current Program	Courses of the Revising Program	Remark
(1) Required Course **For Plan A** 20 credits	**(1) Required Course** **For Plan 1.2 Academic (Course work and Research)** 18 credits **For Plan 2 Profession (Course work and Independent Study)** 18 credits	**Add** **Plan 2 Profession (Course work and Independent Study)** 20 credits **Teaching Schedule** - Weekend or After Hour
EGBE 517 Physiology for Biomedical Engineering 3(3-0-6) วศชพ ๕๑๗ สรีรวิทยาสำหรับวิศวกรรมชีวการแพทย์	EGBE 517 Physiology for Biomedical Engineering 3(3-0-6) วศชพ ๕๑๗ สรีรวิทยาสำหรับวิศวกรรมชีวการแพทย์	No Change
EGBE 518 Engineering Mathematics for Research 3(3-0-6) วศชพ ๕๑๘ คณิตศาสตร์วิศวกรรมเพื่อการวิจัย	EGBE 518 Engineering Mathematics for Research 3(3-0-6) วศชพ ๕๑๘ คณิตศาสตร์วิศวกรรมเพื่อการวิจัย	No Change
EGBE 524 Research Methodology 3(3-0-6) วศชพ ๕๒๔ วิทยาระเบียบวิธีวิจัย	EGBE 524 Research Methodology 2(2-0-4) วศชพ ๕๒๔ วิทยาระเบียบวิธีวิจัย	Reduced credits
EGBE 601 Medical Signal Processing and Instrumentation 3(3-0-6) วศชพ ๖๐๑ การประมวลผลสัญญาณและเครื่องมือทางการแพทย์	EGBE 601 Medical Signal Processing and Instrumentation 3(3-0-6) วศชพ ๖๐๑ การประมวลผลสัญญาณและเครื่องมือทางการแพทย์	No Change
EGBE 607 Materials and Mechanics in Medicine 3(3-0-6) วศชพ ๖๐๗ วัสดุและกลศาสตร์ทางการแพทย์	EGBE 607 Materials and Mechanics in Medicine 3(3-0-6) วศชพ ๖๐๗ วัสดุและกลศาสตร์ทางการแพทย์	No Change
EGBE 609 Fundamental of Biomedical Engineering 3(3-0-6) วศชพ ๖๐๙ มูลฐานวิศวกรรมชีวการแพทย์	EGBE 609 Fundamental of Biomedical Engineering 3(3-0-6) วศชพ ๖๐๙ มูลฐานวิศวกรรมชีวการแพทย์	No Change
EGBE 692 Research Seminar for Biomedical Engineering I 1(1-0-3) วศชพ ๖๙๒ สัมมนาวิจัยเพื่อวิศวกรชีวการแพทย์ ๑	EGBE 657 Research Seminar for Biomedical Engineers 1(1-0-3) วศชพ ๖๕๗ สัมมนาวิจัยเพื่อวิศวกรชีวการแพทย์	ปรับรหัสรายวิชา เนื่องจากปรับชื่อรายวิชาภาษาอังกฤษ
EGBE 693 Research Seminar for Biomedical Engineering II 1(1-0-3) วศชพ ๖๙๓ สัมมนาวิจัยเพื่อวิศวกรชีวการแพทย์ ๒	-	ปิดรายวิชา

Courses of the Current Program	Courses of the Revising Program	Remark
(2) Elective Course **For Plan A** 6 credits	**(2) Elective Course** **Plan 1.2 Academic (Course work and Research) 6 credits** **Plan 2 Profession (Course work and Independent Study) 12 credits**	**Add Plan 2 Profession (Course work and Independent Study)**
วศชพ ๕๒๒ การประมวลผลสัญญาณชีวการแพทย์ 3(3-0-6) EGBE 522 Biomedical Signal Processing	วศชพ ๕๒๒ การประมวลผลสัญญาณชีวการแพทย์ 3(3-0-6) EGBE 522 Biomedical Signal Processing	Adjusted course description
วศชพ ๕๒๓ การประมวลผลภาพทางชีวการแพทย์ขั้นสูง 3(3-0-6) EGBE 523 Advanced Biomedical Image Processing	วศชพ ๕๒๓ การประมวลผลภาพทางชีวการแพทย์ขั้นสูง 3(3-0-6) EGBE 523 Advanced Biomedical Image Processing	Adjusted course description
วศชพ ๕๕๑ วิธีคำนวณสำหรับวิศวกรรมชีวการแพทย์ 3(3-0-6) EGBE 551 Computational Methods for Biomedical Engineering	วศชพ ๕๕๑ วิธีคำนวณสำหรับวิศวกรรมชีวการแพทย์ 3(3-0-6) EGBE 551 Computational Methods for Biomedical Engineering	No Change
วศชพ ๖๐๔ อุปกรณ์รับรู้ทางชีววิทยา 3(3-0-6) EGBE 604 Biosensors	-	Canceled
วศชพ ๖๐๕ การสร้างภาพทางการแพทย์ 3(3-0-6) EGBE 605 Medical Imaging	-	Canceled
วศชพ ๖๑๐ เครือข่ายระบบประสาท 3(3-0-6) EGBE 610 Neural Networks	วศชพ ๖๑๐ เครือข่ายระบบประสาท 3(3-0-6) EGBE 610 Neural Networks	No Change
วศชพ ๖๑๑ การสร้างภาพทางการแพทย์ขั้นสูง 3(3-0-6) EGBE 611 Advanced Medical Imaging	วศชพ ๖๑๑ การสร้างภาพทางการแพทย์ขั้นสูง 3(3-0-6) EGBE 611 Advanced Medical Imaging	No Change
-	วศชพ ๖๑๔ การเรียนรู้เชิงลึกสำหรับวิศวกรรมชีวการแพทย์ 3(3-0-6) EGBE 614 Deep Learning for Biomedical Engineering	New Course
วศชพ ๖๑๕ การระบุและการจำลองแบบระบบสรีรวิทยา 3(3-0-6) EGBE 615 Physiological System Modeling and Identification		Canceled
วศชพ ๖๑๖ วิธีการหาค่าเหมาะที่สุด 3(3-0-6) EGBE 616 Optimization Methods	-	Canceled
วศพช ๖๑๗ การออกแบบวงจรรวมสำหรับระบบสื่อสารไร้สายทางการแพทย์ 3(3-0-6) EGBE 617 IC Design for Wireless Medical Device and Health Care	วศพช ๖๑๗ การออกแบบวงจรรวมสำหรับระบบสื่อสารไร้สายทางการแพทย์ 3(3-0-6) EGBE 617 IC Design for Wireless Medical Device and Health Care	คงเดิม
วศชพ ๖๒๐ การวิเคราะห์เวฟเลตและเวลากับความถี่ 3(3-0-6)	-	Canceled

Courses of the Current Program	Courses of the Revising Program	Remark
EGBE 620 Wavelets and Time-Frequency Analysis		
วศชพ ๖๒๑ การวิเคราะห์สเปรคตรัมอันดับสูงขึ้น 3(3-0-6) EGBE 621 Higher-Order Spectral Analysis	-	Canceled
วศชพ ๖๒๒ คอมพิวเตอร์กราฟฟิกส์ทางการแพทย์ 3(3-0-6) EGBE 622 Computer Graphics in Medicine	-	Canceled
วศชพ ๖๒๓ การรู้จำรูปแบบ 3(3-0-6) EGBE 623 Pattern Recognition	-	Canceled
วศชพ ๖๒๔ การเชื่อมต่อคอมพิวเตอร์กับสมอง 3(3-0-6) EGBE 624 Brain-computer Interface	-	Canceled
วศพช ๖๒๕ อิเล็กทรอนิกส์ชีวภาพ 3(3-0-6) EGBE 625 Bioelectronics	-	Canceled
-	วศชพ ๖๒๖การประยุกต์ใช้เทคนิคอณูชีววิทยาทางการแพทย์ 3(3-0-6) EGBE 626 Molecular Diagnostics for Clinical Applications	New Course
-	วศชพ ๖๒๗ การเรียนรู้ของเครื่องและวิทยาศาสตร์ข้อมูลสำหรับวิศวกรรมชีวการแพทย์ 3(3-0-6) EGBE 627 Machine learning and data science for Biomedical Engineering	New Course
วศชพ ๖๓๐ วิศวกรรมเนื้อเยื่อและเซลล์ 3(3-0-6) EGBE 630 Cell and Tissue Engineering	-	Canceled
วศชพ ๖๓๑ การนำส่งยาขั้นสูง 3(3-0-6) EGBE 631 Advanced Drug Delivery	-	Canceled
วศชพ ๖๓๒ ปรากฏการณ์การขนส่งทางสรีรวิทยา 3(3-0-6) EGBE 632 Physiological Transport Phenomena	-	canceled
วศชพ ๖๓๓ พอลิเมอร์ทางชีวการแพทย์ 3(3-0-6) EGBE 633 Biomedical Polymer	-	Canceled
วศชพ ๖๓๔ ชีววัสดุและความเข้ากันได้ทางชีววิทยา 3(3-0-6) EGBE 634 Biomaterials and Biocompatibility	-	Canceled
วศชพ ๖๓๕ เทคโนโลยีชีวภาพสำหรับวิศวกรรมชีวการแพทย์ 3(3-0-6) EGBE 635 Biotechnology for Biomedical Engineering	วศชพ ๖๓๕ เทคโนโลยีชีวภาพสำหรับวิศวกรรมชีวการแพทย์ 3(3-0-6) EGBE 635 Biotechnology for Biomedical Engineering	No Change

Courses of the Current Program	Courses of the Revising Program	Remark
วศชพ ๖๓๙ การเตรียมชิ้นงานชีวภาพ 3(3-0-6) EGBE 639 Biofabrication		Canceled
วศชพ ๖๔๑ กลศาสตร์ของไหลเชิงสรีรวิทยา 3(3-0-6) EGBE 641 Physiological Fluid Mechanics	-	canceled
วศชพ ๖๔๒ ชีวกลศาสตร์ขั้นสูง 3(3-0-6) EGBE 642 Advanced Biomechanics	วศชพ ๖๔๒ ชีวกลศาสตร์ขั้นสูง 3(3-0-6) EGBE 642 Advanced Biomechanics	No Change
วศชพ ๖๔๓ ระบบหัวใจร่วมหลอดเลือด 3(3-0-6) EGBE 643 Cardiovascular Systems	-	canceled
วศชพ ๖๔๔ การเชื่อมกับระบบประสาท 3(3-0-6) EGBE 644 Neural Interfacing	-	Canceled
วศชพ ๖๔๕ กายอุปกรณ์ทางชีวการแพทย์ 3(3-0-6) EGBE 645 Biomedical Prosthetics	-	Canceled
วศชพ ๖๔๖ การออกแบบและการผลิตอุปกรณ์ชีวการแพทย์ 3(3-0-6) EGBE 646 Design and Manufacture of Biomedical Devices	-	Canceled
วศชพ ๖๔๗ วิศวกรรมหัวใจร่วมหลอดเลือดและอวัยวะประดิษฐ์ 3(3-0-6) EGBE 647 Cardiovascular Engineering and Artificial Organs		Canceled
วศชพ ๖๔๘ ระบบวิศวกรรมการหายใจ 3(3-0-6) EGBE 648 Respiratory Engineering System	วศชพ ๖๔๘ วิศวกรรมทางระบบหายใจ 3(3-0-6) EGBE 648 Respiratory Engineering System	Adjusted course description
วศชพ ๖๔๙ การทดสอบและการรับรองวัสดุอุปกรณ์ทางการแพทย์ขั้นสูง 3(3-0-6) EGBE 649 Advanced Medical Device Testing and Certifying	-	Canceled
วศชพ ๖๕๑ ชีวสารสนเทศ 3(3-0-6) EGBE 651 Bioinformatics	-	canceled
วศชพ ๖๕๒ สารสนเทศทางภาพถ่ายชีวภาพ 3(3-0-6) EGBE 652 Bioimage Informatics	-	Canceled
วศชพ ๖๕๓ ระบบอัจฉริยะ 3(3-0-6) EGBE 653 Intelligent Systems	วศชพ ๖๕๓ ระบบอัจฉริยะ 3(3-0-6) EGBE 653 Intelligent Systems	No Change
วศชพ ๖๕๔ พลวัตแบบไม่เป็นเชิงเส้นทางสรีรวิทยา 3(3-0-6) EGBE 654 Nonlinear Dynamics in Physiology	-	canceled
วศชพ ๖๕๕ การเชื่อมต่อระหว่างมนุษย์กับคอมพิวเตอร์ขั้นสูง 3(3-0-6)	-	Canceled

Courses of the Current Program	Courses of the Revising Program	Remark
EGBE 655 Advanced Human Computer Interface		
วศชพ ๖๕๖ การจัดการห่วงโซ่อุปทานและโลจิสติกส์ในการดูแลสุขภาพ 3(3-0-6) EGBE 656 Healthcare Logistic and Supply Chain Management	-	canceled
วศชพ ๖๖๐ ศัลยศาสตร์บูรณาการคอมพิวเตอร์ขั้นสูง 3(3-0-6) EGBE 660 Advanced Computer-Integrated Surgery	-	Canceled
วศชพ ๖๖๑ การผ่าตัดโดยใช้หุ่นยนต์ช่วย 3(3-0-6) EGBE 661 Robot-Assisted Surgery	-	canceled
วศชพ ๖๖๒ การออกแบบและการควบคุมของการเชื่อมต่อแฮพติก 3(3-0-6) EGBE 662 Design and Control of Haptic Interfaces	-	Canceled
วศชพ ๖๖๔ เทคโนโลยีชีวภาพระดับนาโน 3(3-0-6) EGBE 664 Nanobiotechnology	วศชพ ๖๖๔ เทคโนโลยีชีวภาพระดับนาโน 3(3-0-6) EGBE 664 Nanobiotechnology	No Change
วศชพ ๖๖๕ เวชศาสตร์นาโน 3(3-0-6) EGBE 665 Nanomedicine	3(3-0-6)	Canceled
วศชพ ๖๘๐ หุ่นยนต์ทางการแพทย์ขั้นสูง 3(3-0-6) EGBE 680 Advance Medical Robotics	-	Canceled
วศชพ ๖๘๑ ระบบเครื่องกลไฟฟ้าจุลภาคทางชีวภาพและอุปกรณ์จุลภาคทางการแพทย์ 3(3-0-6) EGBE 681 BioMEMS and Medical Microdevices	-	Canceled
วศชพ ๖๘๒ การออกแบบและบริหารจัดการโครงการในงานวิศวกรรมชีวการแพทย์ 3(3-0-6) EGBE 682 Design and Project Management in Biomedical Engineering	-	Canceled
	EGBE552 Ultrasound Technology and Application 3(3-0-6) วศชพ๕๕๒ เทคโนโลยีอัลตราซาวด์และการนำไปใช้งาน	New Course
	EGBE553 Intelligent Wearable Biosensors 3(3-0-6) วศชพ๕๕๓ อุปกรณ์รับรู้ชีวภาพอัจฉริยะที่สวมใส่ได้	New Course

Courses of the Current Program	Courses of the Revising Program	Remark
	EGBE554 Healthcare Automation and Robotics 3(3-0-6) วศชพ๕๕๔ ระบบอัตโนมัติด้านการดูแลสุขภาพและวิทยาการหุ่นยนต์	New Course
	EGBE555 Metaverse in Medicine 3(3-0-6) วศชพ๕๕๕ เมตาเวิร์สทางการแพทย์	New Course
	EGBE556 Biomedical Cyber-Physical Systems 3(3-0-6) วศชพ๕๕๖ ระบบไซเบอร์กายภาพชีวการแพทย์	New Course
	EGBE557 Nonlinear System Identification and Control in Biomedical Engineering 3(3-0-6) วศชพ๕๕๗ การระบุเอกลักษณ์และควบคุมระบบแบบไม่เชิงเส้นในทางวิศวกรรมชีวการแพทย์	New Course
	EGBE 558 Assistive Technologies for Enhancing Human Movement and Rehabilitation 3(3-0-6) วศชพ ๕๕๘ เทคโนโลยีสิ่งอำนวยความสะดวกเพื่อการเสริมสร้างการเคลื่อนไหวของมนุษย์และการฟื้นฟูสมรรถภาพ	New Course
วศชพ ๖๘๓-๖๘๙ หัวข้อพิเศษวิศวกรรมชีวการแพทย์ 3(3-0-6) EGBE 683-689 Special Topics in Biomedical Engineering	วศชพ ๖๘๓ หัวข้อพิเศษทางวิศวกรรมชีวการแพทย์ 3(3-0-6) EGBE 683 Special Topics in Biomedical Engineering	Adjusted name Thai and course description
(3) Thesis/Thematic Paper	**(3)Thesis/Independent Study**	
วศชพ ๖๙๘ วิทยานิพนธ์ 12(0-36-0) EGBE 698 Thesis	วศชพ ๖๙๘ วิทยานิพนธ์ 12(0-36-0) EGBE 698 Thesis	No Change
-	วศชพ ๖๙๖ การค้นคว้าอิสระ 6(0-24-0) EGBE 696 Independent Study	New Course
	BE 913 MRes Project (120 Credits) Only for students who choose Dual Degree Program	New Course

6. The Comparison Table of the Curriculum Structure between the Current Program and Revised Program Based on Criteria on Graduate Studies B.E. 2565 (set by the Commission of Higher Education Standard, Ministry of Higher Education, Science, Research and Innovation)

Plan 1.2 Academic (Course work and Research)

Course Category	Credits		
	Criteria on Graduate Studies B.E. 2558	Curriculum Structure of the Current Program	Curriculum Structure of the Revised Program
1. Required courses 2. Elective courses	Not less than 12	20 Not less than 6	18 Not less than 6
3. Thesis	12	12	12
Total credits (not less than)	**36**	**38**	**36**

Plan 2 Profession (Course work and Independent Study)

Course Category	Credits		
	Criteria on Graduate Studies B.E. 2558	Curriculum Structure of the Current Program	Curriculum Structure of the Revised Program
1. Required courses 2. Elective courses	Not less than 30	- -	18 Not less than 12
3. Independent Study	6	-	6
Total credits (not less than)	**36**	-	**36**

Appendix F

Agreement to Establish a Double Master's Degree Program

COLLABORATIVE ARTICULATION AGREEMENT

between

Faculty of Engineering, University of Strathclyde

and

Faculty of Engineering, Mahidol University, Thailand

Faculty of Engineering
University of Strathclyde
Glasgow
Scotland, UK
G1 1XW

COLLABORATIVE ARTICULATION AGREEMENT

Between

University of Strathclyde, incorporated by Royal Charter, a charitable body registered in Scotland with registration number SC015263 and having its Principal Office at 16 Richmond Street, Glasgow, G1 1XQ acting through its faculty of Engineering (hereinafter referred to as the "Strathclyde");

and

Faculty of Engineering, Mahidol University MU, an autonomous higher education institution established under the laws of Thailand and having its President Office at 999, Phuttamonthon 4 Road, Salaya, Phuttamonthon, Nakhon Pathom, 73170 Thailand (hereinafter referred to as the "Partner Institution")

Collectively known as the 'Parties' and each a 'Party'.

WHEREAS

A. The Parties agree to collaborate in arrangements whereby students from the Partner Institution may be admitted to degree courses at Strathclyde in accordance with the terms of this Agreement.The parties entered into an Articulation Agreement dated 1st February 2017 ("Articulation Agreement") and the said Articulation Agreement is set to expire on 31st January 2022.

B. The Parties hereby agree to continue the collaboration of arrangement the students from the Partner Institution may be admitted to degree courses at Strathclyde.

C. The Parties acknowledge and agree that the collaborative articulation arrangement is where students, who have reached an agreed standard on a particular course of study designed and delivered by an external agency, in this case the Partner Institution, may enter a specific Strathclyde course, usually with advanced standing and where the Partner Institution has the primary responsibility for assuring the quality of its own course and the standard of any award given to the student before entry to Strathclyde.

WHEREBY IT IS AGREED AS FOLLOWS:

1. DEFINITIONS AND INTERPRETATION

1.1 In this Agreement, unless the context otherwise require or permits:-

"Agreement" means this agreement between the Parties including the Schedule consisting of three parts;

"Confidential Information" means each Party's confidential information disclosed by that Party to the other for use in the Course and for the purposes of this Agreement and identified as confidential before or at the time of disclosure;

"Course(s)" means a programme of study of Strathclyde as detailed in Part 1 of the Schedule to this Agreement.

"Entry Requirements" means the minimum entry requirement of Strathclyde which students of the Partner Institution must achieve before being admitted onto a Course(s) and as detailed in Part 1 of the Schedule hereto.

"Intellectual Property" means any patents, trade marks, registered designs, copyright, data, software, materials unregistered design right, database right or semi-conductor topography

right, rights in and to trade or business names, know-how or Confidential Information, and any similar or analogous rights or forms of protection in any part of the world.

"Standard Terms and Conditions" means Strathclyde's standard terms and conditions set out at Part 3 of the Schedule to this Agreement and which are supplemental to this Agreement.

"Student(s)" means students admitted onto a Course under this Agreement.

1.2 The headings in this Agreement are included for convenience only and shall be ignored in construing this Agreement.

1.3 The Schedule in three Parts shall form part of this Agreement and shall have the same force and effect as if set out in the body of this Agreement and references to this Agreement include the Schedule.

2. NATURE OF COLLABORATION

2.1 The Parties hereby agree that students of the Partner Institution who have achieved the Entry Requirements may articulate onto the Course(s).

2.2 The language of instruction at Strathclyde is English. Students will be required to have a level of proficiency in English as detailed in the Entry Requirements.

2.3 The Partner Institution has responsibility for ensuring the quality of its own courses and the standard of any award given to the Student prior to entry onto the Course(s).

2.4 Each Party will identify a main point/points of contact within its organisation who will take overall responsibility for the arrangements provided for in this Agreement and shall advise the other party of the details of this contact/contacts.

2.5 This Agreement is supplemented by the Standard Terms and Conditions which the Parties shall comply with during the term of this Agreement and which shall govern the activities contemplate by this Agreement.

3. DURATION OF AGREEMENT

This Agreement is valid for 5 years of intake of Students starting from the last date of signature of this Agreement unless terminated in accordance with Clause 9 of the Standard Terms and Conditions or extended by written agreement of both Parties.

4. FINANCIAL ARRANGEMENTS

4.1 Each Student admitted to the Course under this Agreement will be required to pay the tuition fees for the Course at the standard overseas rate set annually by Strathclyde and published on the Strathclyde website, unless otherwise agreed in writing.

4.2 Any financial arrangements between the Parties in support of this agreement will be negotiated separately and will be subject to annual review. The current financial arrangements are detailed in Part 2 of the Schedule.

5. STUDENT ADMISSIONS

5.1 Strathclyde, through the Faculty of Engineering, will make the final selection of applicants for the Courses(s) in consultation with the Partner Institution. Applicants will be selected in accordance with the Entry Requirements. Strathclyde reserves the right to accept or refuse the admission of applicants.

5.2 The Partner Institution will provide a statement of academic results which will be submitted by the applicant when making their application to Strathclyde prior to a decision on whether to admit such applicants to the Course(s).

6. ASSESSMENT AND GRADUATION

6.1 Student assessment will be conducted in accordance with the ordinances, regulations, policies and procedures of Strathclyde. Strathclyde will provide a statement of academic results which the student can use to communicate their results to the Partner Institution.

6.2 Strathclyde will be responsible for the organisation of the graduation ceremony for the Course. Students will be invited to enrol for and attend the appropriate graduation ceremony at Strathclyde, which will be organised in accordance with the practice and academic dress of Strathclyde. Strathclyde will be responsible for maintaining an archive of student results in accordance with its normal practice. These results, subject to the students' permission, shall be made available to the Partner Institution.

6.3 Graduating students may join the Graduate/Alumni Association of both Parties on payment of the appropriate fee, where applicable. Each Party will be entitled to include details of graduating Students on their alumni database.

IN WITNESS WHEREOF this Agreement consisting of this and the preceding 3 pages and the Schedule in three (3) parts attached to it is signed as follows:

Signed for and on behalf of **Strathclyde**

at GLASGOW

on 19th JAN 20[23]

By PROFESSOR SIR JIM MCDONALD

sign.....

PRINCIPAL AND VICE CHANCELLOR
UNIVERISTY OF STRATHCLYDE

Signed for and on behalf of **Mahidol University**

at Mahidol University, Thailand

on 16 Feb 2023 20[ ]

by PROF. BANCHONG MAHAISAVARIYA, M.D.

sign.....

PRESIDENT
MAHIDOL UNIVERSITY

By PROFESSOR STEPHEN MCARTHUR

(witness)

sign.....

ASSOCIATE PRINCIPAL AND EXECUTIVE DEAN, UNIVERSITY OF STRATHCLYDE

Date 27 / JANUARY / 2023

by ASSOC PROF. JACKRIT SUTHAKORN

witness)

sign.....

DEAN OF FACULTY OF ENGINEERING, MAHIDOL UNIVERSITY

Date 13 Feb 2023

THIS IS THE SCHEDULE REFERRED TO IN THE FOREGOING ARTICULATION AGREEMENT

BETWEEN UNIVERSITY OF STRATHCLYDE AND MAHIDOL UNIVERSITY

PART 1

THE COURSES AND THE ENTRY REQUIREMENTS

Annex 1

Undergraduate Students 2+(2) Articulation

Applicants to the Course, who have undertaken a course of study at the Partner Institution (as detailed below), will be required to meet the Entry Standards as set out below in order to be admitted onto the Course(s).

The Course(s)

Transfer from the Partner Institution and entry into Level 3 of the following Course(s):

- BEng (Hons) Biomedical Engineering
- BEng (Hons) Chemical Engineering
- BEng (Hons) Mechanical Engineering

Entry Requirements

The Parties agree that the following Entry Requirements must be achieved for applicants to be considered for the Course(s):-

- Satisfactory completion of two years of study on the relevant BEng degree programme at MU with a minimum GPA of 3.0
- MU applicants satisfy Strathclyde's English language proficiency requirements. These entry requirements are normally IELTS 6.0 (with no individual component below 5.5) or equivalent
- Start date: September each year
- Duration at Strathclyde: Two years/ 4 semesters

Annex 2

Postgraduate student 4+(1) Articulation

Applicants to the Course, who have undertaken a course of study at MU, will be required to meet the Entry Standards as set out below in order to be admitted onto the Course(s).

The Course(s)

Transfer from MU and entry onto the following Master's courses at Strathclyde:

- MSc Biomedical Engineering
- MSc Advanced Chemical Engineering
- MSc Advanced Mechanical Engineering

Entry Requirements

The Parties agree that the following Entry Requirements must be achieved for applicants to be considered for the Course(s):

- Satisfactory completion of the relevant BEng course at MU with a minimum GPA average of 3.2. MU students who are studying the Master of Engineering programme at MU and completed the required coursework credits are also eligible to apply.
- MU applicants satisfy Strathclyde's English language proficiency requirements. These entry requirements are normally IELTS 6.5 (no individual element below 5.5)
- Start date: September and January each year
- Duration at Strathclyde: One year

Annex 3

Collaborative Masters Programme 1+(1) Articulation

Applicants to the Course, who have undertaken a course of study at MU, will be required to meet the Entry Standards as set out below in order to be admitted onto the Course(s).

The Course(s)

Transfer from MU and entry onto the following Master's courses at Strathclyde:

- MSc Biomedical Engineering
- MSc Advanced Chemical Engineering
- MSc Advanced Mechanical Engineering

Entry Requirements

The Parties agree that the following Entry Requirements must be achieved for applicants to be considered for the Course(s):

- Satisfactory completion of the relevant MEng course at MU with a minimum GPA average of 3.2. MU students who are studying the Master of Engineering programme at MU and completed the required coursework credits are also eligible to apply.
- MU applicants satisfy Strathclyde's English language proficiency requirements. These entry requirements are normally IELTS 6.5 (no individual element below 5.5)
- Start date: September each year
- Duration at Strathclyde: One year

Annex 4

Jointly Supervised PhD Programmes

Graduate students and academic staff from MU may enrol at Strathclyde and benefit from the Jointly Supervised PhD programme as outlined below.

Entry requirements

- Achieve a minimum BEng (Hons) degree in a relevant discipline with at least First Class or equivalent
- Satisfy Strathclyde's English language proficiency requirements. These entry requirements are normally IELTS 6.5 (no individual element below 5.5)
- Complete a Pro Forma giving full details of the topic to be undertaken, specifying the field of research and the supervision arrangements.

Duration of Study

ii. Minimum of 36 months with at least 12 months being resident at Strathclyde in Glasgow. The candidates must visit the Strathclyde once per year, with at least one (1 month) duration.

Supervision

The main supervisor will be from Strathclyde. A second supervisor in MU who is acceptable to the Strathclyde will be identified for each candidate. In addition, Strathclyde must be satisfied with the adequacy of research facilities at MU and the overall arrangement of supervision.

Progress report

Each candidate will undergo an annual PhD monitoring review conducted Strathclyde as per the regulations governing its research programmes. As part of this review, each candidate will be required to submit a report detailing their progress and the outcomes of their research programme to date. Progress to future years of the PhD is dependent on the outcome of this annual review.

Venue of PhD viva

The Viva will be conducted within the premises of Strathclyde in Glasgow.

Others

Other conditions may be applicable and will be listed in the letter of offer to the candidate.

Annex 5

Academic Visitors

Academic staff (Faculty members) from MU may apply to visit Strathclyde as an Academic Visitor. Their acceptance on attachment to research groups within the appropriate Department at Strathclyde will depend on their academic research interests, English Language proficiency and the availability of research facilities and vacancy at Strathclyde.

Academic staff (Faculty members) from Strathclyde may also apply to visit MU as an Academic Visitor. Their acceptance on attachment to research groups within the appropriate Department at MU will depend on their academic research and the availability of research facilities and vacancy at MU.

Duration of Study
Normal duration of attachment will not exceed 12 months.

Visit Programme
Details of the visit programme will be finalised with the appropriate academic supervisor in the appropriate Department of the Faculty of Engineering at Strathclyde or at MU prior to the arrival of the Academic Visitor.

Financial arrangements
Academic Visitors are responsible for all their expenses.

PART 2

FINANCIAL ARRANGEMENTS

Tuition fees for international students studying in the Faculty of Engineering at Strathclyde will be at the standard overseas rate that is agreed annually by the University Court and will be paid by the student to the University. For courses registered for a period of less than 12 months duration, a pro-rata fee will be paid.

The Faculty of Engineering will award a scholarship equating to 15% of the standard overseas fee rate annually to each student registering in the Faculty from MU under the terms of this articulation agreement in Annex 1, 2 and 3. This includes each period of study at Strathclyde.

For the Jointly Supervised PhD Programmes in Annex 4, the tuition fee EACH YEAR will consist of two parts: (i) a first part consisting of ten percent (10%) of the full-time tuition fee; (ii) a second part based on a pro rata basis of the full-time tuition fee on the amount of time the candidate spent in residence at Strathclyde.

No scholarship will be awarded to students from MU registering in the Faculty out with the terms of this articulation agreement.

Tuition fees for international students studying in the Faculty of Engineering at the MU will be at the standard overseas rate.

PART 3

STANDARD TERMS AND CONDITIONS

1. QUALITY ASSURANCE AND STANDARDS

1.1 Strathclyde is responsible for the quality of the Student learning experience at Strathclyde and the academic standard of the Course(s) and the Partner Institution acknowledges that Strathclyde's academic frameworks and regulations and quality assurance processes shall apply to the Courses, the Students and all academic matters relating to this Agreement.

1.2 The Parties have agreed appropriate general levels of performance and a level of proficiency in English Language required for progress to the Course(s) and the Partner Institution is responsible for maintaining these agreed standards.

1.3 The Parties hereby agree to co-operate in any review proposed by the UK Quality Assurance Agency for Higher Education or equivalent in the Partner country as may be notified to it from time to time by a Party and to provide each other with appropriate information or statistical data that may be required for submissions to funding councils or professional statutory regulatory bodies.

2. COURSE APPROVAL

2.1 Strathclyde will only admit Students to Courses approved by the Senate of Strathclyde.

2.2 The Parties will exchange information on curriculum and syllabus developments in order to maintain compatibility of their courses and to ensure a continuing smooth transition for students from the Partner Institution to Strathclyde.

3. COURSE MARKETING AND DELIVERY

3.1 Marketing and advertising of the Agreement will be conducted by both Parties within their respective institutions. The Parties will each be entitled to use the other's crest, name and related promotional material in marketing activities under this Agreement but for no other purpose. All promotional material, publications and any subsequent revisions pertaining to the carrying out of activities under this Agreement must be approved by the other Party prior to publication or issue.

3.2 Strathclyde will be responsible for the production of appropriate Course information and its delivery to Students in accordance with its normal level of delivery of education to students of Strathclyde. The Parties acknowledge that Strathclyde will not sub-contract any of its obligations under this Agreement to a third party and that all elements of the Course(s) will be delivered by Strathclyde. Where it is proposed that any sub-contracting arrangements are put in place for the Course(s), the Partner Institution shall be provided with prior written notice of such arrangements.

4. STUDENT SUPPORT, COMPLAINTS AND DISCIPLINE

4.1 Each Party will be responsible for providing advice, guidance and facilities for Students as appropriate. A representative of Strathclyde will visit Partner Institution at agreed times each year during the term of this Agreement to advise students and carry out any other duties under this Agreement.

4.2 While Students are based at Strathclyde complaints by or about Students, including allegations of harassment, will be dealt with in accordance with the policies and procedures of Strathclyde. When Students are based at the Partner Institution complaints by or about Students, including allegations

of harassment, will be dealt with in accordance with the policies and procedures of the Partner Institution.

4.3 Student conduct will be subject to the discipline procedures of the Parties. In the event of allegations being made against a Student, Strathclyde and the Partner Institution(s) shall consult on the actions to be taken and the discipline code/procedures that shall apply.

5. STATUTORY OBLIGATIONS

5.1 Strathclyde adheres to current Health and Safety, Equal Opportunities, Racial Equality, Disability Discrimination, Data Protection, Modern Slavery, Immigration and Environmental legislation pertaining to the United Kingdom and the Partner Institution hereby agrees to reasonably co-operate with Strathclyde as and when required in relation to these statutory obligations which may involve entering into separate contractual arrangements, for example, data sharing agreements.

5.2 The Partner Institution shall be responsible for ensuring that any and all appropriate legal, ethical and regulatory approvals required in relation to its carrying out of any activities under this Agreement are granted prior to carrying out any activities under this Agreement.

5.3 The Parties agree to only process personal data of registered Students for the purposes of registering students onto a Course, allowing Students to carry out a Course and allowing Students to graduate from a Course. Each Party must process such personal data in compliance with applicable Data Protection Laws at all times during the term of this Agreement. In the event that the applicable data protection law of each Party conflict, the requirements of the country that necessitates stricter or additional requirements to protect individuals' privacy and personal data shall be applied. In the context of this Agreement, Data Protection Laws shall mean while they remain in force the Data Protection Act 1998, the European Data Protection Directive (95/46/EC), the Regulation of Investigatory Powers Act 2000, the Telecommunications (Lawful Business Practice) (Interception of Communications) Regulations 2000, the Electronic Communications Data Protection Directive, the Privacy and Electronic Communications (EC Directive) Regulations 2003, once it comes into force the General Data Protection Regulations and any other laws and regulations relating to the processing of personal data and privacy which apply to a Party and, if applicable, the guidance and codes of practice issued by the relevant data protection or supervisory authority.

6. CONFIDENTIALITY

6.1 Any Confidential Information will not without prior written consent of the owning Party be used, published or disclosed.

6.2 The foregoing obligations relating to confidentiality shall not apply to information which is within or subsequently enters the public domain through no fault of the Party receiving such information.

6.3 The Partner Institution acknowledges that Strathclyde must comply with the terms of the Freedom of Information (Scotland) Act 2002 or any analogous regulations in respect of Confidential Information (or any other information) relating to this Agreement and before making a disclosure of such information it shall make an analysis as to whether the Confidential Information or other information requested is capable of benefiting from an exemption from disclosure. In the event that Strathclyde considers that disclosure is legally required and makes the requested disclosure, no liability shall attach thereto.

7. LIABILITY

7.1 The Partner Institution will indemnify Strathclyde and keep it fully and effectively indemnified against each and every claim made against Strathclyde as a result of the Partner Institution's delivery or failure of delivery of any activities under this Agreement or any part thereof.

7.2 This indemnity does not apply to the extent that any claim arises as a result of Strathclyde's negligence or deliberate breach of this Agreement.

7.3 Nothing in this Agreement limits or excludes either Party's liability for

a. death or personal injury;

b. any fraud or any sort of liability that by law cannot be limited or excluded; or

c. any loss or damage caused by a deliberate breach of this Agreement.

7.4 Subject to Clause 7.3, the liability of either Party to the other for any breach of this Agreement, or any negligence shall not extend to any indirect damages or losses.

8. INTELLECTUAL PROPERTY

The Parties acknowledge that ownership of each Party's Intellectual Property introduced by a Party for the purposes of this Agreement shall remain with the owning Party.

9. TERMINATION

9.1 Either Party may terminate this Agreement at any time by notice in writing to the other Party ("Other Party"), such notice to take effect as specified in the notice:

(i) if the Other Party is in material breach of this Agreement and, in the case of a breach capable of remedy within 30 days, the breach is not remedied within 30 days of the Other Party receiving notice specifying the breach and requiring its remedy. For the avoidance of doubt, a material breach would include the Partner Institution failing to comply with administrative obligations required by Strathclyde in relation to Students and the Course; or

(ii) if: (A) the Other Party becomes insolvent or unable to pay its debts as and when they become due, (B) an order is made or a resolution is passed for the winding up of the Other Party (other than voluntarily for the purpose of solvent amalgamation or reconstruction), (C) a liquidator, administrator, administrative receiver, receiver or trustee is appointed in respect of the whole or any part of the Other Party's assets or business, (D) the Other Party makes any composition with its creditors, (E) the Other Party ceases to continue its business, or (F) as a result of debt and/or maladministration the Other Party takes or suffers any similar or analogous action.

9.2 This Agreement may be terminated by the written agreement of Strathclyde and the Partner Institution(s) provided that a minimum of one year's notice is given. Any decision to terminate this Agreement under this Clause 9 will be subject to satisfactory arrangements being made for existing Students to complete a Course and be assessed for any award for which they have registered. Such arrangements will be determined by written agreement of Strathclyde and the Partner Institution(s) where termination is not at the fault of the Partner Institution. Where termination is at the fault of the Partner Institution, Strathclyde shall make any and all decision in relation to existing Students completing a Course.

10 FORCE MAJEURE

Neither Party shall be deemed to be in breach of this Agreement if it is unable to carry out any provision of it for any reason beyond its control including (without limiting the generality of the

foregoing) acts of God, legislation, fuel shortages, war, fire, flood, drought, failure of power supply embargo, civil commotion, epidemic, pandemic, international health emergency and employee action.

11 ASSIGNATION

Except as expressly provided for in this Agreement neither Party shall be entitled to:-

(i) assign or transfer any or all of its rights and/or obligations under this Agreement (or purport to do so); or

(ii) sub-license or sub-contract any or all of its obligations under this Agreement(or purport to do so);

save, in either case, with the prior written consent of the other Party.

12 GENERAL

12.1 Except as otherwise expressly provided in this Agreement none of the terms and conditions of this Agreement shall be enforceable by any person who is not a Party to it.

12.2 Each provision of this Agreement shall be construed separately and, save as otherwise expressly provided herein, none of the provisions hereof shall limit or govern the extent, application or construction of any other of them and the remaining provisions of this Agreement shall continue in full force and effect.

12.3 No waiver by either Party of any of the requirements hereof or of any of its rights hereunder shall be effective unless given in writing and signed by or on behalf of that Party and no forbearance, delay or indulgence by either Party in enforcing the provisions of this Agreement shall prejudice or restrict the rights of that Party nor shall any waiver by either Party of any of the requirements hereof or any of its rights hereunder release the other from full performance of its obligations stated herein.

12.4 This Agreement constitutes the entire understanding between the Parties and supersedes and extinguishes all (if any) prior drafts, agreements, understandings, undertakings, representations, warranties and/or arrangements of any nature whatsoever (whether or not in writing) between the Parties in connection therewith.

12.5 Nothing in this Agreement shall be construed as establishing or implying any partnership or joint venture between the Parties and nothing in this Agreement shall be deemed to constitute one of the Parties as the agent of the other.

12.6 The Parties shall be entitled to amend any details of this Agreement at any time provided that any such amendment is recorded in writing by both Parties.

13. COUNTERPARTS

This Agreement may be executed in two counterparts which, taken together, shall constitute one and the same document. Either Party may enter into this Agreement by signing either of such counterparts.

14. SURVIVAL

Those provisions of this Agreement which by their nature or implication are required to survive expiry or termination of this Agreement shall so survive and continue in full force and

effect, together with any other provisions of this agreement necessary to give effect to such provisions.

15. DISPUTE RESOLUTION AND GOVERNING LAW

15.1 Any dispute between the Parties arising out of any matter relating to this Agreement which cannot be resolved by the named contacts in respect of the collaborative arrangements referred to in this Agreement shall be referred to a Senior Officer (or equivalent) of each of the Parties.

15.2 If after all possible avenues of negotiation have been exhausted and the dispute cannot be resolved then (i) any proceedings relating to any claim or matter arising under or in connection with this Agreement or the legal relationships established by this Agreement instituted against University of Strathclyde by the Partner Institution shall be brought in the Scottish courts and shall be governed by and construed in accordance with Scots law and (ii) any proceedings relating to any claim or matter arising under or in connection with this Agreement or the legal relationships established by this Agreement instituted against Partner Institution by Strathclyde shall be brought in the courts of Thailand and shall be governed by and construed in accordance with the laws of Thailand.