Master Program in Biomedical Technology

Program Specification

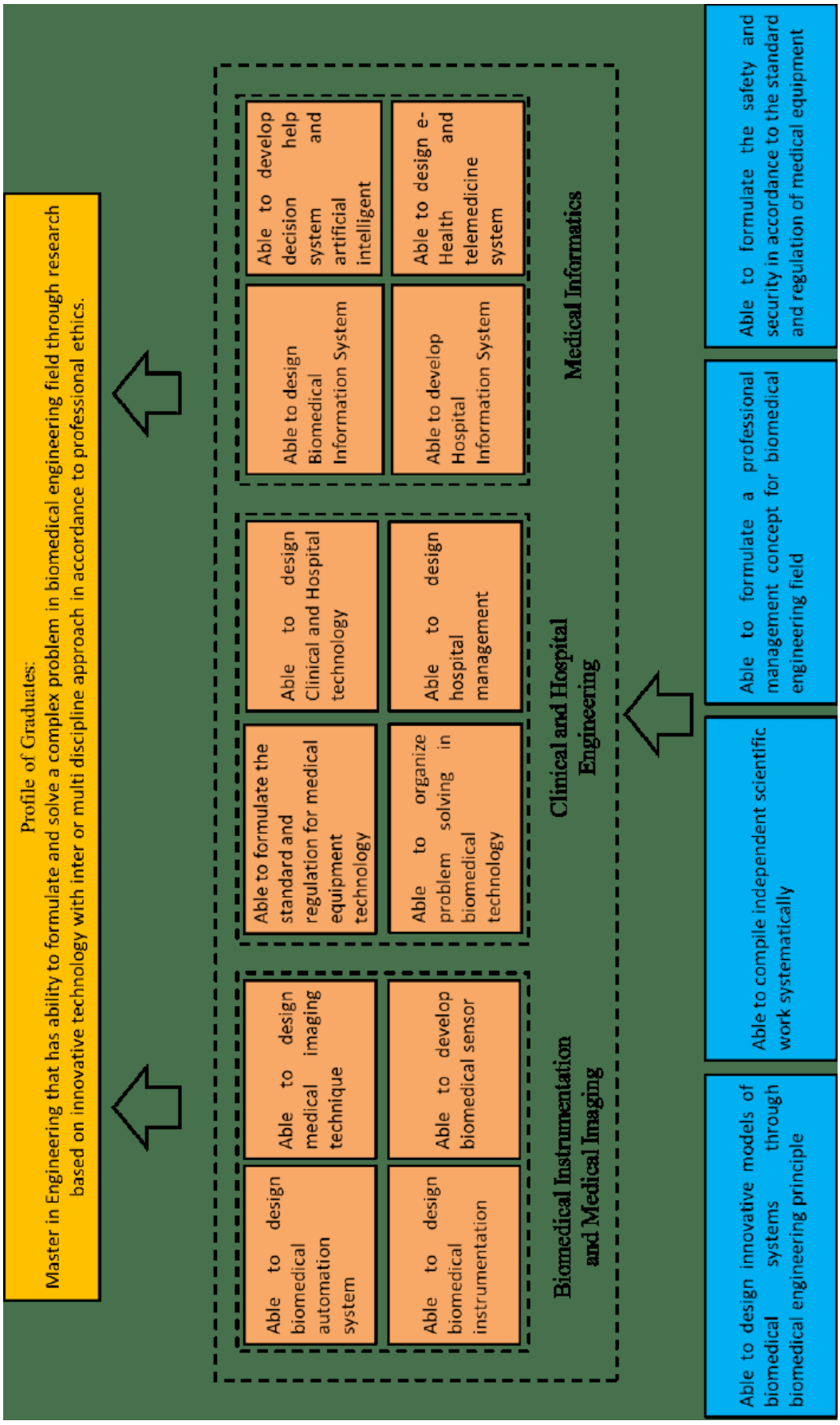
1.	**Awarding Institution**	Universitas Indonesia	
2.	**Teaching Institution**	Universitas Indonesia	
3.	**Faculty**	Engineering	
4.	**Programme Title**	Master Program in Biomedical Technology	
5.	**Program Vision and Mission**	To become a superior study program in education, research and community service in the field of Biomedical Technology and be able to contribute to the development of Indonesian and Global society.	
6.	**Class**	Reguler	
7.	**Final Award**	Magister Teknik (MT.)	
8.	**Accreditation / Recognition**	BAN-PT: Accreditation B	
9.	**Language (s) of Instruction**	Bahasa / English	
10.	**Study Scheme (Full Time / Part-Time)**	Full Time	
11.	**Entry Requirements**	Pass the entrance exam, graduate from Bachelor/Diploma 4 in Biomedical Engineering, Medical, Engineering, Science, Computer, Pharmacy, and other subjects of equal.	
12.	**Study Duration**	Designed for 2 years	
	Type of Semester	Number of semester	Number of weeks/semesters
	Reguler	4	16
	Short (opsional)	**1**	**8**
13.	**Aims of the programme:** Producing Masters who are able to design systems, components, or processes in the field of Biomedical Technology through the design, analysis, development and application of the latest technological concepts in dealing with problems in the field of biomedical technology.		
14.	**Profile of Graduates:** Master in Engineering that has ability to formulate and solve a complex problem in biomedical engineering field through research based on innovative technology with inter or multi discipline approach in accordance to professional ethics.		
15.	**Expected Learning Outcomes /Expected Learning Outcomes (ELO) :** Master in Biomedical Technology graduates are expected to have the following competence: 1. Able to design innovative models of biomedical systems through biomedical engineering principle (C6) 2. Able to compile independent scientific work systematically (C6) 3. Able to formulate a professional management concept for biomedical engineering field (C6) 4. Able to formulate the safety and security in accordance to the standard and regulation of medical equipment (C6) Beside the above competence, a Master in Biomedical Engineering should also have the following specialized competence: Specialization in Biomedical Instrumentation and Medical Imaging: 1. Able to design biomedical instrumentation (C6) 2. Able to develop biomedical sensor (C6) 3. Able to design biomedical automation system (C6) 4. Able to design medical imaging technique (C6) Specialization in Medical Informatics: 1. Able to develop Hospital Information System (C6) 2. Able to design e-Health and telemedicine system (C6) 3. Able to design Biomedical Information System (C6) 4. Able to develop decision help system and artificial intelligent (C6) Specialization in Clinical and Hospital Engineering: 1. Able to organize problem solving in biomedical technology (C6) 2. Able to design hospital management (C6) 3. Able to formulate the standard and regulation for medical equipment technology (C6) 4. Able to design Clinical and Hospital technology (C6)		

16.	Composition of Subjects		
No.	**Classification**	**Credit Hours (SKS)**	**Percentage**
I	**Core Subjects**	**16**	**36,36%**
II	**Majoring Subject**	**12**	**27,27%**
III	**Special Subject**	**10**	**22,73%**
IV	**Elective Subject**	**6**	**13,64%**
	Total	**44**	**100 %**
	Total Credit Hours to Graduate		**44 Credits**

Career Prospects

Graduates from Biomedical Engineering Study Program can work in various types of companies and health industries, information technology, education, government or regulator, and other industries related to health facilities, such as hospitals and health clinics.

Learning Outcomes



Course Flowchart for Master Program in Program Study of Biomedical Technology

Biomedical Instrumentation and Medical Imaging Specialization

No.	Learning Outcomes	Semester 1	Semester 2	Semester 3	Semester 4
1	Able to design innovative models of biomedical systems through biomedical engineering principle	Anatomy and Modelling in Physiology Design and Prototyping Biomedical System			Scientific Publication Thesis
2	Able to compile independent scientific work systematically	Research Methodology 1	Research Methodology 2		Scientific Publication Thesis
3	Able to formulate a professional management concept for biomedical engineering field	Project Management for Biomedical Engineering			
4	Able to formulate the safety and security in accordance to the standard and regulation of medical equipment	Patient Safety Standards and Regulations			
5	Able to design biomedical instrumentation		Biomedical Instrumentation		
6	Able to develop biomedical sensor		Biomedical Sensor		
7	Able to design biomedical automation system		Biomedical System Automation		
8	Able to design medical imaging technique		Medical Imaging and Image Processing		

Medical Informatics Specialization

No.	Learning Outcomes	Semester 1	Semester 2	Semester 3	Semester 4
1	Able to design innovative models of biomedical systems through biomedical engineering principle	Anatomy and Modelling in Physiology Design and Prototyping Biomedical System			Scientific Publication Thesis
2	Able to compile independent scientific work systematically	Research Methodology 1	Research Methodology 2		Scientific Publication Thesis
3	Able to formulate a professional management concept for biomedical engineering field	Project Management for Biomedical Engineering			
4	Able to formulate the safety and security in accordance to the standard and regulation of medical equipment	Patient Safety Standards and Regulations			
5	Able to develop Hospital Information System		Hospital Information System		
6	Able to design e-Health and telemedicine system		*e-Health* and Telemedicine		
7	Able to design Biomedical Information System		Computational Biology and Bioinformatics		
8	Able to develop decision help system and artificial intelligent		Decision Making System and Artificial		

Clinical and Hospital Engineering Specialization

No.	Learning Outcomes	Semester 1	Semester 2	Semester 3	Semester 4
1	Able to design innovative models of biomedical systems through biomedical engineering principle	Anatomy and Modelling in Physiology Design and Prototyping Biomedical System			Scientific Publication Thesis
2	Able to compile independent scientific work systematically	Research Methodology 1	Research Methodology 2		Scientific Publication Thesis
3	Able to formulate a professional management concept for biomedical engineering field	Project Management for Biomedical Engineering			
4	Able to formulate the safety and security in accordance to the standard and regulation of medical equipment	Patient Safety Standards and Regulations			
5	Able to organize problem solving in biomedical technology		Hospital Medical Equipment		
6	Able to design hospital management		Clinical Asset and Equipment Management System		
7	Able to formulate the standard and regulation for medical equipment technology		Hospital Engineering		
8	Able to design Clinical and Hospital technology		Design of Hospital and Healthcare Facilities		

Curriculum Structure

Biomedical Instrumentation and Medical Imaging Specialization Subject

Code	Subject	SKS
	1st Semester	
ENBE801001	Anatomy and Modelling in Physiology	3
ENBE801002	Research Methodology 1	2
ENBE801003	Patient Safety Standards and Regulations	3
ENBE801004	Design and Prototyping Biomedical System	3
ENBE801005	Project Management for Biomedical Engineering	**3**
	Subtotal	**14**
	2nd Semester	
ENBE802006	Research Methodology 2	2
ENBE802101	Biomedical Instrumentation	3
ENBE802102	Biomedical Sensors	3
ENBE802103	Medical Imaging and Image Processing	3
ENBE802104	Biomedical System Automation	**3**
	Subtotal	**14**
	3rd Semester	
	Elective Course	3
	Elective Course	3
	Subtotal	**6**
	4th Semester	
ENBE804007	Scientific Publication	2
ENBE804008	Final Project	8
	Sub Total	**10**
	Total	**44**

Medical Informatics Specialization

Code	Subject	SKS
	1st Semester	
ENBE801001	Anatomy and Modelling in Physiology	3
ENBE801002	Research Methodology 1	2
ENBE801003	Patient Safety Standards and Regulations	3
ENBE801004	Design and Prototyping Biomedical System	3
ENBE801005	Project Management for Biomedical Engineering	**3**
	Subtotal	**14**
	2nd Semester	
ENBE802006	Research Methodology 2	2
ENBE802201	Hospital Information System	3
ENBE802202	Decision Making System and Artificial Intelligent	3
ENBE802203	e-Health and Telemedicine	3
ENBE802204	Computational Biology and Bioinformatics	**3**
	Subtotal	**14**
	3rd Semester	
	Elective Course	3
	Elective Course	3
	Subtotal	**6**
	4th Semester	
ENBE804007	Scientific Publication	2
ENBE804008	Final Project	8
	Sub Total	**10**
	Total	**44**

Clinical and Hospital Engineering Specialization

Code	Subject	SKS
	1st Semester	
ENBE801001	Anatomy and Modelling in Physiology	3
ENBE801002	Research Methodology 1	2
ENBE801003	Patient Safety Standards and Regulations	3
ENBE801004	Design and Prototyping Biomedical System	3
ENBE801005	Project Management for Biomedical Engineering	**3**
	Subtotal	**14**
	2nd Semester	
ENBE802006	Research Methodology 2	2
ENBE802301	Hospital Medical Equipment	3
ENBE802302	Hospital Engineering	3
ENBE802303	Design of Hospital and Healthcare Facilities	3
ENBE802304	Clinical Asset and Equipment Management System	**3**
	Subtotal	**14**
	3rd Semester	
	Elective Course	3
	Elective Course	3
	Subtotal	**6**
	4th Semester	
ENBE804007	Scientific Publication	2
ENBE804008	Final Project	8
	Sub Total	**10**
	Total	**44**

Transition Rules

1. Curriculum of 2020 is implemented starting in the Odd Semester 2020/2021. After Curriculum of 2020 is implemented, only subjects in Curriculum of 2020 will be opened.
2. Class of 2019 and previous class followed the Curriculum of 2020 with transitional rules.
3. A transitional period of 1 year, in the academic year 2020/2021, is implemented for subjects where the semester changes (from Even to Odd, or vice versa), if necessary, the class will be opened in both semesters during the transition period (Academic Year 2020 / 2021).
4. For students who have not passed the compulsory subjects in Curriculum of 2018 are required to take the same or equivalent subjects in the 2020 Curriculum.
5. If there is a change in the credit (SKS) for the course, the number of credit (SKS) taken in graduation is the number of the SKS at the time the course was taken. If students are repeated or newly taken same or equal subjects with different credit (SKS), will be listed with a new name and calculated with new credit (SKS).
6. If the compulsory subjects in Curriculum of 2018 are removed and there is no equivalence in Curriculum of 2020, students who have passed these courses, it will still be counted as compulsory subjects in the graduation calculation of 44 credits. For students who have not passed the course, they can take new compulsory subjects or elective courses in Curriculum of 2020 to complete 44 credits.

Equivalence Course in Masters in Biomedical Technology

No	Name of courses in the curriculum 2018	SKS 2018	Name of courses in the curriculum 2020	SKS 2020
1	Human Body Physiological System Modelling	3	Anatomy and Modelling in Physiology	3
2	Research Methodology	2	Research Methodology 1	2
3			Research Methodology 2	2
Required Specialization Courses				
4	Biomedical Instrumentation 1	3	Biomedical Instrumentation	3
5	Medical Imaging	3	Medical Imaging and Image Processing	3
6	Biomedical Instrumentation 2	3	-	
7	Special Topic on Biomedical Instrumentation	3	-	
8	Hospital Medical Equipment I	3	Hospital Medical Equipment	3
9	Hospital Medical Equipment II	3	Hospital Engineering	
10	Regulation and Policy of Clinical Technology	3	-	
11	Planning and Design of Health Service Building	3	Design of Hospital and Healthcare Facilities	3
12	Clinical Engineering Management System	3	Clinical Asset and Equipment Management System	3
13	Planning and Design of Health Service Utility	3	Healthcare Technology Management System	3
14	Hospital Information System and Medical Record	3	Hospital Information System	3
15	Medical Automation	3	-	
16	Telemedicine	3	e-Health and Telemedicine	3
17	Information System-Based Management Skill	3	Hospital Information Management	3
18	Medical Informatics Consultancy	3		
19			Computational Biology and Bioinformatics	3

Subject Syllabus

Study Program Obligatory Subject

Anatomy and Modelling in Physiology
ENBE801001
3 SKS
Learning Outcome:

After completing this course, students are able to:

1. Analyze the results of molecular computing related to the physiology of the human body (C4)
2. Design biomedical system models based on engineering principles in accordance with the anatomy and physiology of the human body (C6).

Syllabus:

Complexity of physiology, central dogma of molecular biology, introduction to bioinformatics, molecular docking, principles of data modeling and modeling, neural systems, bioelectric phenomena, system modeling, introduction to MATLAB simulink, and case studies.

Prerequisite: None

Reference Book:
1. Cobelli C and Carson ER, Introduction to Modeling in Physiology and Medicine. 1st ed. A volume in Biomedical Engineering. 2008
2. Thieman, W. J., M. A. Palladino, Introduction to Biotechnology, Pearson 2012
3. Ibrahim, K. S., G. Gurusubramanian, Zothansanga, R. P. Yadav, N. S. Kumar, S. K. Pandian, P. Borah, S. Mohan, Bioinformatics – A Student's Companion, Springer 2017
4. Tortora, G. J., Derrickson, B., Principles of Anatomy and Physiology, Wiley 2017
5. Enderle, J. D., Bioelectric Phenomena, Elsevier 2012
6. https://www.mathworks.com/support/learn-with-matlab-tutorials.html

Research Methodology 1
ENBE801002
2 SKS
Learning Outcome:

- After completing this course, students will be able to formulate a research proposal (C6)

Syllabus:

Writing the formulation of the research problem and its background, SotA and Hypotheses, Data collection methods, abstracts, conclusions, and research proposals..

Prerequisite: None

Reference Book:
1. Novikov, A. M. and D. A. Novikov. Research methodology from philosophy of science to research design. CRC Press. 2013
2. Deb, D., R. Dey, V. E. Balas. Engineering Research Methodology A Practical Insight for Researchers. Springer. 2019
3. John D. Enderle, David C. Farden, And Daniel J. Krause; Advanced Probability Theory for Biomedical Engineers; Morgan&Claypool; 2006
4. Kristina M. Ropella, Introduction to Statistics for Biomedical Engineers, Morgan&Claypool; 2007

Patient Safety Standards and Regulations
ENBE801003
3 SKS
Learning Outcome:

Students are able to formulate standards and regulations for biomedical technology in health care facilities.

Syllabus:

In term of focusing the discussion on patient's safety in term of the implementation of clinical technology in health care service and the discussion of the role and function of clinical engineers in hospital's patient's safety, this subject will present the following topics of discussion: Patient safety and the biomedical engineer; Risk management; Patient safety best practices model; Hospital safety program; System approach to medical device safety; Electromagnetic interference in the hospital; Electrical safety in the hospital; Accident investigation; Medical devices Failure modes, accidents and liability.

Prerequisite: None

Reference Book:
1. Joseph Dyro (ed.), Clinical Engineering Handbook, Elsevier Academic Press, 2004
2. Myer Kutz, Biomedical Engineering and Design Handbook (Volume 2: Applications), McGraw Hill, New York, 2nd edition, 2009.
3. Improving Patient safety: Insights from American, Australian and British Healthcare, ECRI Europe, 2012.
4. Elizabeth Mattox, Medical Devices and Patient Safety, AACN Journals Vol. 32, No.4 August 2014.

Design and Prototyping Biomedical System
ENBE801004
3 SKS
Learning Outcome:

After completing this course, students are able to develop innovative prototypes.

Syllabus:

Fundamental of Problems and Prototype Design Process; Working as a Team in Design; Design Process Planning; Understanding the Problem and Engineering Specifications Development; Concept Generation, Evaluation and Selection; Product Design Phase; Engineering Economic, Product/ Prototype Design for manual assembly and automatic assembly design.

Prerequisite: None

Reference Book:
1. G.Ullman: The Mechanical Design Process, 4th ed. McGraw-Hill. 2009.
2. G. Dieter, Engineering Design: A Material and Processing Approach, 3rd ed. McGraw-Hill. 2000.
3. G. Pahl and W.Beitz, Engineering Design: A Systematic Approach, 3rd ed. Springer, 2007.
4. G. Boothroyd, P. Dewhurst, W.A. Knight: Product Design for Manufac ture and Assembly, 3rd Ed. CRC Press, 2011.

Project Management of Biomedical Engineering
ENBE802005
3 SKS
Learning Outcome:

- Students are able to design a professional management for biomedical engineering field
- Students are able to design project economics aspect, so students are expected to understand the basic theories

to support feasibility analysis for investment and service development/application for biomedical technology.

Syllabus:

Organization in project management, characteristics of the project cycle and project phases, project management processes including project management during planning, execution (monitoring), and control, project scope (WBS), time management, cost management, Gant Chart, S curve, and analysis economy.

Prerequisite: None

Reference Book:

1. Project management institute. A Guide to the project management body of knowledge fifth edition. 2013
2. Kerzner, H. Project management A System Approach to Planning, Scheduling, and Controlling. Willey Ohio 2002
3. Newnan, D. G., T. G. Eschenbach, J. P. Lavelle. Engineering Economic Analysis. Oxford University Press: Oxford. 2004

Research Methodology 2
ENBE801006
2 SKS
Learning Outcome:

After completing this course, students will be able to compile scientific papers from research results (C6)

Syllabus:

How to get research topics (digging information), appropriateness of research topics, looking for references, mapping references and sota), how to do our research, simulation and experiment-based research, continuity of research objects with realization, research data processing, research proposal writing methods, and methods scientific writing.

Prerequisite: None

Reference Book:

1. Novikov, A. M. and D. A. Novikov. Research methodology from philosophy of science to research design. CRC Press. 2013
2. Deb, D., R. Dey, V. E. Balas. Engineering Research Methodology A Practical Insight for Researchers. Springer. 2019
3. John D. Enderle, David C. Farden, And Daniel J. Krause; Advanced Probability Theory for Biomedical Engineers; Morgan&Claypool; 2006
4. Kristina M. Ropella, Introduction to Statistics for Biomedical Engineers, Morgan&Claypool; 2007

Specialization Subject

Biomedical Instrumentation And Medical Imaging Specialization

Biomedical Intrumentation
ENBE802101
3 SKS
Learning Outcome:

After completing this course, students are able to design medium and high technology biomedical instrumentation designs in diagnostic and therapeutic services from patients in health care facilities (C6).

Syllabus:

Compression therapy, cryosurgery, auto spirometry device, test stress cardiopulmonary, LabVIEW, clinical chemistry analyzer, hematology analyzer, EEG, EMG, ECG, dan cardiac defibrillators.

Prerequisite: None

Reference Book:

1. BCarr, J. J., & Brown, J. M. (2001). Introduction to Biomedical Technology (4th edition). New Jersey: Prentice Hall.
2. Enderle, J., Blanchard, S., & Bronzino, J. (2000). Introduction to Biomedical Engineering. San Diego, CA: Academic Press.
3. Wang, P., & Liu, Q. (2011). Biomedical Sensors and Measurement. Hangzhou, Heidelberg: Springer Berlin Heidelberg.
4. Webster, J. G. (2010). Medical Instrumentation: Application and Design (4th edition). New Jersey: John Wiley & Sons, Inc.

Biomedical Sensor
ENBE802102
3 SKS
Learning Outcome:

After completing this course, students will be able to design biosensors for medical applications (C6).

Syllabus:

The basis of the sensor which includes sensor characteristics, sensor calculation technology, and biocompatibility of the sensor, Physical sensor which includes resistance sensor, inductive sensor, capacitive sensor, piezoelectric sensor, magnetoelectric sensor, photoelectric, and thermoelectric sensor, optical sensor, Chemical sensor includes ion sensor , gas sensors, humidity sensors, sensor arrays, and sensor networks, and biosensors including catalytic biosensors, affinity biosensors, cell and tissue biosensors, biochips, and nano-biosensors.

Prerequisite: None

Reference Book:

1. Enderle J., Bronzino J. - Introduction to biomedical engineering-AP (2011).
2. Wang, P. Q. Liu. Biomedical Sensor and Measurement. Springer (2011)

Medical Imaging and Image Processing
ENBE802008
3 SKS
Learning Outcome:

Students are able to design medical imaging systems for certain applications in the medical field.

Syllabus:

Introduction to Medical Imaging Technologies (X-Ray and CT, MRI, Ultrasound, PET and SPECT, Electrical Impedance Tomography), Image formation and Reconstruction (Acquisition, Digitization, Image Reconstruction Methods), Image Enhancement (Fundamentals of enhancement techniques, Image enhancement with linear, nonlinear, fixed, adaptive, and pixel-based methods), Image Segmentation and Analysis (Fundamentals of Medical Image Segmentation, Image pre-processing and acquisition artefacts, Thresholding, Edge-based techniques, Region-based segmentation, Classification, Morphological Methods for Biomedical Image Analysis), Image Visualization (2-dimensional visualization, 3-dimensional visualization methods: surface rendering, volume rendering, Algorithm for 3-D visualization), Image Management (Fundamentals of Standards Compression Storage

and Communication, Image archive and retrieval, three-dimensional compression), visual imaging and digital, image transformation, colour representation, image enhancement (domain spatial), image enhancement (frequency domain), convolution and correlation, image segmentation, object feature characteristics, image compression, pattern recognition, image restoration, image morphology.

Prerequisite: None

Reference Book:
1. Handbook of Medical Imaging: Processing and Analysis Management, Isaac Bankman, Academic Press 2000, CA, USA.
2. Handbook of Medical Imaging, Vol. 2: Medical Image Processing and Analysis, M. Sonka & J.M. Fitzpatrick, SPIE Press, 2009, Washington, USA.
3. R.C. Gonzalez, R.E. Woods, and S.L. Eddins, "Digital Image Processing using MATLAB", 2nd Edition, Gatesmark Publishing, 2009.

Biomedical System Automation
ENBE803105
3 SKS
Learning Outcome:

After completing this course, students are able to:

1. Analyze stability, transient response and steady-state error in a control system (C4).
2. Recommend a control system design method (C5)
3. Design controllers in a biomedical system (C6)

Syllabus:

Introduction, discusses the definition of control systems, configurations, theoretical history and application examples; Mathematical models of systems in the biomedical field that can be designed for automated control systems; Mathematical model simulation using MATLAB/Simulink or SCILAB/Xcos; Derivation of mathematical models of continuous and discrete linear systems using linearization, laplace transform and z methods; Transient response, stability and steady state error (error at steady state); Frequency response analysis; Root positioning technique; PID controller design; Design of controllers for biomedical applications.

Prerequisite: None

Reference Book:
1. Automatic Control Systems in Biomedical Engineering, Springer Verlag, 2018
2. Control Systems Engineering 6th ed, John Wiley & Sons, 2011
3. Feedback Control of Dynamic Systems 7th, Pearson, 2015
4. Control Engineering: MATLAB Exercises, Springer Verlag, 2019
5. Control Theory In Biomedical Engineering: Applications in Physiology and Medical Robotics, Academic Pres, 2020

Medical Informatics Specialization

Hospital Information System
ENBE802201
3 SKS
Learning Outcome:

After completing this course, students are able to develop hospital information systems.

Syllabus:

Hospital Law, Regulation from the Ministry of Health regarding Hospital, Regulation from the World Health Organization, Hospital Clinical Information System, Hospital Management Information System, Regulation from the Ministry of Health regarding Medical Record, ICD 10, Coding, In-CBGs.

Prerequisite: None

Reference Books:
1. Sabarguna, B.S, Sistem Informasi pada Peralatan Medis Rumah Sakit, UI Press, Jakarta, 2016
2. Carnivero, J & Fernandez, A, e-Health Handbook, SEIS Technical Secretary's Of fice: CEFIC Enrique Larreta St., 5, bajo izda. 28036 –Madrid (Spain)

Decision Making System and Artificial Intelligence
ENBE802202
3 SKS
Learning Outcome:

After completing this course, students are able to:

- Students are able to assess the results of intelligent decision support.
- Students are able to design intelligent decision support based on the knowledge they have gained.

Syllabus:

Complexity of real-world systems or domains, the need of decision support tools, Evolution of Decision Support Systems, Intelligent Decision Support Systems (IDSS), Knowledge Discovery in an IDSS: from Data to Models, Post-Processing and Model Validation.

Prerequisite: None

Reference Book:
1. Intelligent decision support methods: the science of knowledge work - DHAR, Vasant; STEIN, Roger, Prentice Hall, 1997. ISBN: 978-0135199350
2. Decision Support Systems in the Twenty-first Century. - MARAKAS, G.M., Upper Saddle River, NJ: Prentice-Hall, 2003. ISBN: 978-0130922069
3. Decision Support Systems and Intelligent Systems - TURBAN, E.; ARONSON, J.E.; LIANG T-P, Pearson/Prentice Hall, 2005.Decision Support Systems: concepts and resources for managers - POWER, Daniel J., Greenwood Publishing Group, 2002.

e-Health and Telemedicine
ENBE802203
3 SKS
Learning Outcome:

Students are able to design and develop an e-health and telemedicine system so that it can be used as an innovative model in the development of the biomedical technology industry.

Syllabus:

Students will learn medical robotics; telesurgery; microsurgery system; e-health and telemedicine; health for personal; health for emergency systems; information, databases and global and local health networks; electronic medical record; health record for remote areas; e-healthcare opportunities and challenges; mhealth user interface design strategy; virtual doctor system for medical applications.

Prerequisite: None

Reference Books:
1. Eren H and Webster JG, 2016, Telehealth and Mobile Health, CRC Press

Computational Biology and Bioinformatics

ENBE802204
3 SKS
Learning Outcome:

Students are able to design a system related to biological and bioinformatics computing so that it can be used as an alternative method in solving problems related to biomedical data.

Syllabus:

Students will learn the basics of computational biology and bioinformatics related to gene regulation; biological computing for predictive enhancers; analysis of gene expression using R package; decoding non-coding RNA; hypothetical protein annotation; protein interactions; regulation of transcription with statistical modeling; quality control in genomic analysis; modeling non-linear biological phenomena with S-systems; metabolic engineering; topology assessment for protein.

Prerequisite: None

Reference Books:
1. Wong KC, 2016, Computational Biology and Bioinformatics: Gene Regulation, CRC Press

Clinical and Hospital Engineering Specialization

Hospital Medical Equipment

ENBE802301
3 SKS
Learning Outcome:

After completing this course, students are able to organize general medical equipment technology for hospital needs.

Syllabus:

Major equipment used by health professional in Hospital. This study includes physiology principles for each clinical technology equipment, operation principles, main features, method for testing and evaluation for work display and equipment security, a review on the equipment population currently available in market. The clinical technology equipment that will be discussed in this session are as follow:

- Fundamental of medical instrumentation system;
- Vital sign monitoring;
- External defibrillator;
- Cardiac Defibrillator;
- Ventilator system;
- Anaesthesia machine;
- Clinical laboratory equipment

Prerequisite: None

Reference Books:
1. John G. Webster (ed.), Encyclopedia of Medical Devices and Instrumentation, A John Wiley & Sons, 2nd edition, 2006.
2. Myer Kutz, Biomedical Engineering and Design Handbook (Volume 1: Fundamen tals), McGraw Hill, New York, 2nd edition, 2009.
3. Myer Kutz, Biomedical Engineering and Design Handbook (Volume 2: Applica tions), McGraw Hill, New York, 2nd edition, 2009.
4. Yadin David (ed.), Clinical Engineering, CRC Press, Washington DC, 2005.

Hospital Engineering

ENBE802302
3 SKS
Learning Outcome:

After completing this course, students are able to formulate standards, regulations, and safety of medical equipment in medical facilities.

Syllabus:

Introduction to medical technology; Cleanliness and safety of medical electrical devices; studies used in hospitals in support of nystamography diagnostic, audiometry, digital radiography, tomography, MRI, spectroscopy, defibrillators and heart and lung machines: artificial hand designs and limb tools for prosthesis applications.

Prerequisite: None

Reference Books:
1. Myer Kutz, "Biomedical Engineering and Design Handbook (Volume 2: Applications)", McGraw Hill, New York, 2nd edition, 2009.
2. Rudiger K., Klaus-Peter H., Robert P., "Handbook of Medical Technology', Springer, Berlin, 2011

Design of Hospital and Healthcare Facilities

ENBE802303
3 SKS
Learning Outcome:

After completing this course, students are able to design utilities and buildings for health services.

Syllabus:

Patient's safety in health care facilities is the main topic of the planning and designing building utility program in clinical environment. In this perspective, a proactive management program is very important to ensure a safe environment for the patient, visitor and hospital staff. The topic that will be discussed includes: Physical Plant; Heating, Ventilation and Air Conditioning; Electrical Power in Healthcare Facilities; Medical Gas System; Radiation Safety; Sanitation; Water System in Healthcare facilities; Fire System in Healthcare Facilities; Disaster Planning.

Prerequisite: None

Reference Books:
1. G. D. Kunders, Hospitals Facilities Planning and Management, Tata Mc-Graw-Hill, 2005.
2. American Institute of Architects. Guidelines for Design and Construction of Hospital and Health CarenFacilities. Washington, DC, American Institute of Architects, 2001.
3. Kemenkes RI, Pedoman Teknis Bangunan Rumah Sakit Kelas B, 2012. Kementerian Kesehatan RI, Permenkes No. 2306 Tahun 2011 tentang Persyaratan Teknis Prasarana Instalasi Elektrikal Rumah Sakit.

Clinical Asset And Equipment Management System

ENBE802304
3 SKS
Learning Outcome:

After completing this course, students are able to design management of asset safety and hospital equipment.

Syllabus:

Health system, National Health policy, Equipment maintenance management, logistic support and reliability, Electromagnetic Induction(EMI) to Hospital Equipments .

Prerequisite: None

Reference Books:
1. Antonny Kelly, Maintenance Planning and Control, Butterworth, London 1984.
2. Hans Pleiff veradammann (ed) `Hospital Engineering in developing countries, GTZ report , Eschborn, 1986.

Special Course

Scientific Publication
ENBE804007
2 SKS
Learning Outcome:

After completing this course, students are able to arrange independent scientific works systematically.

Syllabus:

Scientific writing systematics, the use of good and proper language in scientific writing, proofread, paper submission system, review process and scientific paper publishing.

Prerequisite: None

Reference Books:
1. How to Write & Publish a Scientific Paper, Robert A. Day, Publisher: Oryx Press 5th Ed., 1998.
2. Technical Guidance for Universitas Indonesia Students' Final Project
3. IEEE - Publish a Paper with IEEE (www.ieee.org)

Thesis
ENBE804008
4 SKS
Learning Outcome:

After completing this course,

- Students are directed to develop an independent research under the guidance of a supervisor.
- Students are expected to be able create a research concept by involving existing theory.
- Students are expected to be able to design, integrate, implement and analyse that concept and compile the research in a systematic scientific work in the form of thesis book

Syllabus: None

Prerequisite: Have taken and passed a minimum of 24 credits

Reference:
1. Pedoman Teknis Penulisan Tugas Akhir Mahasiswa Universitas Indonesia
2. IEEE Citation Reference
3. IEEE Transactions on Parallel and Distributed Systems, Vol. 21, No. 2, February 2010, "How To Write Research Articles in Computing and Engineering Disciplines"

Elective Course

Cell and Tissue Engineering
ENB803009
3 SKS
Learning Outcome:

After completing this course, students are able to summarize the latest developments in cell and tissue engineering technology to treat diseases, especially degenerative diseases.

Syllabus:

Introduction to tissue engineering; Scaffolding for tissue engineering; Basic cell culture and immunochemical engineering for biomaterials and tissue engineering; Cells and biomolecules for tissue engineering; Transport and vascularization in tissue engineering and body response to graphs; Clinical application of tissue engineering; Bioreactors for tissue engineering; Introduction to artificial cells, Design of artificial cells: liposomes and nanoparticles; Embryonic Stem Cells and Induced Pluripotent Stem Cells; Mesenchymal stem cells; Cell engineering for the treatment of diseases; Stem Cells and Regenerative Medicine: Commercialization and Treatment Implications.

Prerequisite: None

Reference:
1. Larry L.H and Julian R.J, "Biomaterials, Artificial Organs and Tissue Engineering", CRC Press, USA, 2005.
2. Steward S, "Stem Cells Handbook", Humana Press, New Jersey, 2004.
3. Dong L.S, "Introduction to Biomaterials", Tsinghua University Press, China, 2005.
4. S.Prakash, "Artificial Cells, Cell Engineering and Therapy", CRC Press, USA, 2007

Hospital Information Management
ENB803010
3 SKS
Learning Outcome:

After completing this course, students are able to develop sistematic thinking skills and innovative thinking in supporting professional behavior

Syllabus:

Health informatics, Electronics patient records and standarss, Bioinformatics and Technologies, JAVA programming, and Medical networks.

Prerequisite: None

Reference:
1. Lukas K Baehler, Bioinformatics – Basics, Applications in Biological Sciences and Medicine, Taylor & Francis, London, 2005. Deitel, "Java How to Program", Pearson Education / PHI, 2006.
2. Herbert Schildt, The Complete Reference – JAVA, Tata McGraw Hill Publishing Company, New Delhi, 2005
3. John P Woodward, Biometrics – The Ultimate Reference, Dreamtech Publishers, New Delhi, 2003.
4. Orpita Bosu, Bioinformatics – Databases, Tools and Algorithms, Oxford University Press, 2007.

Healthcare Technology Management System
ENB803011
3 SKS
Learning Outcome:

Students are able to design clinical technology management strategies by using the basic concepts of strategy management in a health care system.

Syllabus:

The material to be studied includes the following topics: Clinical engineering: evolution of a discipline; Overview of engineering & engineering services; Introduction to Medical Technology Management Practices; Strategic planning; Quality & safety management in clinical engineering department; Risk factors, safety, and managemet of medical equipment; Inventory & asset management; Contract & vendor management; Technology needs assessment of medical technology; Technology acquisition; System maintenance management & technical support; Financial Management of Clinical Engi-

neering Services; Personal Management;Cost-Effectiveness and Productivity; Clinical engineering program indicators.

Prerequisite: None

Reference:
1. Joseph Dyro (ed.), Clinical Engineering Handbook, Elsevier Academic Press, 2004.
2. Joseph Bronzino, Management of Medical Technology: A Primer for Clinical Engineers. Boston, Butterworth/ Heinemann, 1992.
3. Cram, N. Using Medical Technology Assessment as a Tool for Strategic Planning, J Clin Eng 24(2): 113-123, 1999.
4. AAMI, Recommended Practice for a Medical Equipment Management Program, American National Standard ANSI/AAMI EQ56, 1999

Medical Information Consultation Technique

ENB803012
2 SKS
Learning Outcome:

After completing this course, students are able to facilitate consultation requests in the biomedical industry.

Syllabus:

Health service ecosystem; to build sustainable cooperation and education; Operational flow: practice of medicine as a business; business marketing/ medical informatics consulting services (business plan).

Prerequisite: None

Reference:
1. Patrick W and Scott McEvoy., "Health IT JumpStart: The Best First Step Toward and IT Career in Health Information Technology", Wiley, USA, 2012
2. Susan Nash, "Be A Successful Consultant: An Insider Guide to Setting Up and Running a Consultancy Practice', How To Books Ltd, UK, 2003.

Biostatistic Intermediate

ENB803013
2 SKS
Learning Outcome:

After completing this course, students are able to design research data processing using advanced biostatistics combined with specific statistical software.

Syllabus:

Introduction and biostatistics data; Descriptive method; Probability distribution; Research design; Interval Estimation; Hoptesis test; Variance Analysis; Presentation and summary of data; Parametric test hypothesis; Non-parametric test hypothesis

Prerequisite: None

Reference:
1. Joaquim P.M, "Applied Statistics Using SPSS, Statistica, MATLAB and R", Springer, Berlin, 2007.
2. Ronald N.F., Eun S.L., Michael H, "Biostatistoocs: A Guide to Design, Analysis, and Discovery, Elsevier, USA, 2007.

Intelligent Medical Systems Engineering

ENB803014
3 SKS
Learning Outcome:

After completing this course,

1. Students are able to analyze the performance of specific models as applied to biomedical problems
2. Students are able to validate the performance of specific models of medical system intelligence.
3. Students are able to develop a computational model in its application in biomedicine.

Syllabus:

The basis of Artificial Intelligence (AI) with further emphasis on machine learning and applying it to medicine, health services, and medical equipment. This includes clinical risk stratification, phenotype and biomarker discovery, time series analysis of physiological data, disease progression modeling, and patient outcome prediction.

Prerequisite: None

Reference:
1. Stuart Russell and Peter Norvig. 2009. Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall Press, Upper Saddle River, NJ, USA.
2. Toby Segaran. 2007. Programming Collective Intelligence (First ed.). O'Reilly.
3. Tony J. Cleophas and Aeilko H. Zwinderman. 2015. Machine Learning in Medicine - a Complete Overview. Springer.
4. Sunila Gollapudi, S. 2016. Practical Machine Learning. Packt Publishing Ltd.
5. Peter Harrington. 2012. Machine Learning in Action. Manning Publications Co., Greenwich, CT, USA.
6. Selected seminal and contemporary readings from peer-reviewed literature such as Proceedings of Machine Learning in Healthcare, Artificial Intelligence in Medicine, IEEE Transactions on Biomedical and Health Informatics, and other relevant venues.

Health Economic Management

ENB803015
2 SKS
Learning Outcome:

- Students are able to use economic concepts and principles in the health industry.
- Students are able to combine the fundamentals of management, economics and risk in decision making in the health economics market.

Syllabus:

Basic economics tools, Information and Insurance Market, Key players in the health care sectors, Health and Social insurance, Trade in Health Service, Health economics evaluation.

Prerequisite: None

Reference:
1. SThe economics of health and health care / by Sherman Folland, Allen C. Goodman, Miron Stano.
2. Trade in health services : global, regional, and country perspectives / editors, Nick Drager, Desar Vieira.
3. Health economics: an introduction to economic evaluation / Gisela Kobelt.

Biomedical Signal Processing

ENB803016
3 SKS
Learning Outcome:

After completing this course, students are expected to be able to design the basis of digital signal processing and to do basic simulations of signal or image processing and be familiar with functions in the signal or image processing toolbox (for example Matlab). Students are expected to be able to design medical imaging and image processing techniques.

Syllabus:

Signal recognition, visual and digital imaging, image transformation, color representation, image enhancement (spatial domain), image enhancement (frequency domain), convolution and correlation, image segmentation, object feature properties, image compression, pattern recognition, image restoration, image morphology , Wavelet transformation.

Prerequisite: None

Reference:

1. R.C. Gonzalez and R.E. Woods, "Digital Image Processing", 2nd Edition, Prentice-Hall, 2002
2. 2. J.W. Leis, "Digital Signal Processing Using Matlab for Students and Researchers," John Wiley & Sons, 2011.
3. 3. R.C. Gonzalez, R.E. Woods, and S.L. Eddins, "Digital Image Processing using MATLAB", 2nd Edition, Gatesmark Publishing, 2009.
4. 4. E.S. Gopi, "Digital Signal Processing for Medical Imaging Using Matlab," Springer, 2013.