Subject Description Form

Subject Code	BME21151
Subject Title	**Engineering Design & Biomechatronics**
Credit Value	3
Level	2
Prerequisite / Co-requisite	BME21301 / IC2135 Material Processing and Technical Communication (**Pre-requisite / Co-requisite)**; and BME21149 Biomaterials Science and Engineering (**Co-requisite)**
Objectives	This subject aims to provide students with fundamental concepts and methodologies to solve engineering problem systematically and analytically. Students shall comprehend the design and integration of innovation and functionality during engineering planning to develop a technical solution that underpins good practice for professional engineering. It also aims to equip students with fundamental concepts in biomechatronics design, prototyping, sensors and actuators relevant to BME applications. Students shall develop hands-on ability to create and analyze an engineering design product in computer-aided design / engineering software. They shall also be competent to practice and analyze sensors and signals for BME investigations.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Describe and develop technical solutions to BME problems systematically and analytically in accordance with professional engineering practice and process; b. Create and analysis BME design solutions through computer-aided design and simulation software; c. Demonstrate understanding on the fundamentals of machine design, including statics, strength of materials, machine components, and principles of kinematic synthesis; d. Describe and explain the principles of various sensors and actuators, appreciate their advantages and limitations for BME investigation; e. Demonstrate an ability to use appropriately and safely the techniques, sensors, and selected modern engineering tools necessary (such as LabVIEW and MATLAB) for bioengineering practice and in experimental investigation. f. Apply analytical skills for the interpretation of experimental data.

Contribution to Programme Outcomes (Refer to Part I Section 10)	▪ Programme Outcome 1: Demonstrate an ability to apply knowledge of mathematics, science, and engineering appropriate to the Biomedical Engineering (BME) discipline. (Teach and Practice) ▪ Programme Outcome 2: Demonstrate an ability to design and conduct BME experiments, as well as to analyze and interpret data. (Teach and Practice) ▪ Programme Outcome 3: Demonstrate an ability to design a system, component, or process relevant to BME to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability. (Teach, Practice and Measure) ▪ Programme Outcome 4: Demonstrate an ability to identify, formulate, and solve BME problems. (Teach, Practice and Measure) ▪ Programme Outcome 5: Demonstrate an ability to understand the impact of BME solutions in a global and societal context, especially the importance of health, safety, and environmental considerations to both workers and the general public. (Teach and Practice) ▪ Programme Outcome 7: Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for BME practice. (Teach, Practice and Measure) ▪ Programme Outcome 8: Demonstrate an ability to use the computer / IT tools relevant to the BME discipline along with an understanding of their processes and limitations. (Teach, Practice and Measure) ▪ Programme Outcome 9: Demonstrate an ability to function in multi- disciplinary teams. (Practice)
Subject Synopsis / Indicative Syllabus	▪ Engineering design process: identification of design problems; opportunity analysis; Voice of Customer; KANO model; Quality Function Deployment; Basics of Quality Management; Functional and physical decomposition; specifications; concept generation and evaluation; design for X; product evaluation; prototyping; human factors and ergonomics; modeling and simulation in design. ▪ Machine design: structural design and static analysis; design for strength; mechanism design; failure criterion; fundamental of machine components; degree of freedom; Kutzback Equation; Grashof's Criterion; principles of kinematic synthesis; computer-aided design and engineering; finite element method. ▪ Handle various types of sensors and actuators used commonly in BME investigation; working principles and the design of sensing systems for measuring biosignals; various biomedical devices and example use of sensors and actuators; and related safety issues.

Teaching and Learning Methodology

There will be lectures about the principles and fundamentals of engineering design process and machine design. Hands-on sections are to facilitate students to acquire the necessary skills to create and analyze engineering design using computer-aided design and simulation software.

Students will learn in lectures the working principles of various sensors and actuators used commonly in BME investigation. Students will write a report on how to solve a practical healthcare problem using latest technologies in bioinstrumentation and sensors. Students will learn additional example problems in laboratory sessions to facilitate students learning. Students will also practice real examples of bioinstrumentation and sensors in laboratory.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)							
		a	b	c	d	e	f	g	
1. Quizzes	30%					√	√	√	
2. Project presentation	50%	√		√	√				
3. Lab performance & reports	20%	√	√	√	√	√	√	√	
Total	100%								

Note: To pass this subject, students must obtain grade D or above in every tasks listed in the table above.

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Continuous assessment during lab sessions ensures that the student can acquire the needed skills and knowledge in understanding the use of sensors for BME investigation. Lab reports are used to assess the student's ability to analyze and report experimental findings.

Project work and quizzes are used to assess student's understanding and ability to develop technical solutions to BME problems systematically and analytically in accordance with professional engineering practice and process.

Student Study Effort Expected

Class contact:	
▪ Lectures	17 Hrs.
▪ Training laboratories	22 Hrs.
Other student study effort:	
▪ Self-study	34 Hrs.
▪ Assignments and report	44 Hrs.

	Total student study effort	117 Hrs.
Reading List and References	▪ Ullman DG, The Mechanical Design Process, 6th ed., BVT Publishing, ISBN: 978-1-5178-1582-0, 2018. ▪ Ullman DG, The Mechanical Design Process Case Studies, 2nd ed., BVT Publishing, ISBN: 978-1-5178-1582-0, 2020. ▪ Juvinall RC and Marshek KM, Fundamentals of Machine Component Design, 7th ed., Wiley, 2020. ▪ Salvendy G. and Karwowski W, Handbook of Human Factors and Ergonomics, 5th ed., Wiley, ISBN: 978-1-119-63608-3, 2021. ▪ William H and Musto J, Introduction to Solid Modeling Using Solidworks 2023, 19th ed., McGraw-Hill Education, ISBN: 978-1-266-66660-5, 2024. ▪ Nudehi SS and John RS, Analysis of Machine Elements Using SOLIDWORKS Simulation 2022, 1st ed., SDC Publications, ISBN: 978-1-63057481-9, 2022. ▪ Prakash et al. Biomedical Sensors Data Acquisition with LabVIEW: Effective Way to Integrate Arduino with LabView (English Edition), BPB Publications, ISBN: 978-9-38984599-0, 2020.	
Date of Last Major Revision	28 December 2021	
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