Subject Description Form

Subject Code	BME42154
Subject Title	**Digital Design and Fabrication for Healthcare Services**
Credit Value	3
Level	4
Prerequisite and Co-Requisite	**Prerequisites** ABCT2332 Human Biology for Biomedical Engineering II / ABCT2334 Human Pathophysiology; and BME21301 / IC2135 Material Processing and Technical Communication; and BME21149 Biomaterials Science and Engineering; and **Co-requisites** BME31125 Biomechanics
Objectives	The objective of this subject is to equip students with the concepts and practical skills in applying CAD / CAM (computer-aided-design and computer-aided-manufacture including 3D printing) technology in provision of prosthetic and orthotic (P&O) services. Students shall be competent to determine appropriate methods and materials to fabricate prostheses and orthoses using CAD / CAM technology.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Recognize the development and concept of CAD / CAM method in the practice of P&O services; b. Practice P&O clinical assessment, measurement and digitalization of human body parts or casts from the patients; c. Reconstruct computer models from digitalized data, and design and rectify the models from clinical and manufacturing perspectives; d. Fabricate prostheses and orthoses using CAD/CAM methods; and e. Fit and evaluate the CAD/CAM prostheses and orthoses on the patients.

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, Practice and Measure) ▪ Programme Outcome 3: Demonstrate an ability to design a system, component, or process relevant to BME to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability. (Teach, Practice and Measure) ▪ Programme Outcome 4: Demonstrate an ability to identify, formulate, and solve BME problems. (Teach, Practice and Measure) ▪ 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 limitation (Teach, Practice and Measure). ▪ Programme Outcome 10: Demonstrate an ability to communicate effectively and advise clients, professional colleagues and other members of the community (Teach and Practice).
Subject Synopsis/ Indicative Syllabus	▪ Developments of CAD / CAM, CNC and 3D printing in P&O. ▪ Basic P&O clinical assessment, measurement, design, fabrication, fitting, education, & evaluation. ▪ Basic P&O CAD / CAM software operation. ▪ Digitalization & 3D scanning for P&O models. ▪ Concept of additive manufacturing (3D Printing) and material selection for P&O. ▪ Digitalization, design and rectification of human body parts such as: o Foot, trunk or transtibial residual limb ▪ Fabrication (CNC craving & 3D printing) and fitting of healthcare devices such as: o Foot orthosis o Spinal orthosis o Transtibial prosthetic socket o Surgical guide

<table>
<tr><td>Teaching and Learning Methodology</td><td>
Lecture: The definitions, histories, concepts, and theories of CAD/CAM will be explained. The students will also learn various CAD/CAM technique, patient assessment and the consideration of materials. Guidelines and suggestions will be given to students to select group project on cutting edge applications of design & manufacturing technique in P&O taking the clinical perspectives into account.

Group Project (w/ Assessment): The group projects will be used to guide the students towards the subject contents and to engage them in life-long learning. Students will be aware of the state-of-the-art developments in the field and are expected to demonstrate their knowledge in clinical and manufacturing considerations.

Laboratory Practice (w/Assessment): Students need to demonstrate clinical assessment, measurement and communication. Students will learn to use 3D scanner to digitalize the geometry or morphology of body parts and cast. Students will learn how to clean the scanned data, reconstruct geometry, rectify model, and generate a read-to-use CAD file for CNC craving and 3D printing. Students will have the opportunities to operate the CNC and 3D printing machine, and fabricate the P&O devices. They will need to fit on the patients and evaluate the P&O devices.
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<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="8">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td></td><td></td><td></td></tr>
<tr><td>1. Student presentation</td><td>20%</td><td>√</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2. Practical assignment</td><td>60%</td><td></td><td>√</td><td>√</td><td>√</td><td>√</td><td></td><td></td><td></td></tr>
<tr><td>3. Quiz</td><td>20%</td><td>√</td><td>√</td><td>√</td><td>√</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="8"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Continuous assessments (student presentation, quiz and practical assignments) are conducted to assess the intended outcome of this subject comprehensively.
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Student Study Effort Expected	Class contact:	
	▪ Lecture	12 Hrs.
	▪ Clinical and laboratory teaching	27 Hrs.
	Other student study effort:	
	▪ Laboratory work and presentation preparation	39 Hrs.
	▪ Self-study	39 Hrs.
	Total student study effort:	117 Hrs.
Reading List and References	▪ Canadian Prosthetics & Orthotics Journal ▪ Chui KC et al. Orthotics and Prosthetics in Rehabilitation, 4th Ed., St. Louis, MO; Elsevier, 2020. ▪ Chui KC, Yen S-C, Jorge M, Lusardi MM. Orthotics and Prosthetics in Rehabilitation, 4th Ed., St. Louis: Elsevier; 2020. ▪ Journal of Prosthetics and Orthotics. ▪ Journal of Prosthetics and Orthotics International. ▪ Krajbich JI, Pinzur MS, Potter BK, Stevens PM. Atlas of amputations and limb deficiencies: surgical, prosthetic, and rehabilitation principles, 4th Ed., Rosemont, IL: American Academy of Orthopaedic Surgeons; 2016. ▪ LeMoyne R. Advances for prosthetic technology: from historical perspective to current status to future application. Tokyo: Springer; 2016. ▪ Maniruzzaman M. 3D and 4D Printing in Biomedical Applications: Process Engineering and Additive Manufacturing: Wiley-VCH; 2018. ▪ Muralidhara HB, Banerjee S. 3D printing technology and its diverse applications. First edition. ed. Palm Bay, FL, USA, Apple Academic Press; 2022. ▪ Sandhu K, Singh S, Prakash C, Subburaj K, Ramakrishna S. 3D printing in podiatric medicine, 1st Ed., Academic Press; 2022. ▪ Webster JB, Murphy DP. Atlas of Orthoses and Assistive Devices, 5th Ed., Philadelphia: Elsevier; 2019.	
Date of Last Major Revision	28 December 2021	
Date of Last Minor Revision	29 June 2023	