Subject Description Form

Subject Code	BME11101 (for 42470)
Subject Title	Bionic Human and the Future of Being Human
Credit Value	3
Level	1
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To introduce, in a multidisciplinary and interactive approach, the various ways through which defective body parts can be replaced or augmented by artificial devices. The focus is to illustrate how modern biomedical engineering technologies deal with diseases, trauma, and ageing. These technology-enabled medical advancements are discussed along with the associated philosophical and ethical issues.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Describe some of the amazing designs in human body and their potential damages due to injuries, diseases, and ageing; b. Give examples on how engineering has helped in reconstructing damaged body parts and/or body functions, such as hearing, seeing, movement, etc.; c. Reflect on our human imagination about the bionic human of the future; d. Discuss some of the philosophical, societal and ethical issues associated with such technological developments; and e. Fulfill the CAR reading and writing requirements in English.
Contribution of the Subject to the Attainment of the Programme Outcomes	**Programme Outcomes:** <u>Category A: Professional/academic knowledge and skills</u> ▪ Programme Outcomes 1: Understand the fundamentals of science and engineering, and have the ability to apply them. ▪ Programme Outcomes 6: Know the contemporary issues, and understand the impact of engineering solutions in a global and societal context. <u>Category B: Attributes for all-roundedness</u> ▪ Programme Outcomes 8: Recognize social, professional and ethical responsibility. ▪ Programme Outcome 9: Communicate effectively.

Subject Synopsis/ Indicative Syllabus	Human life is both amazing and vulnerable. Amazing – the designs and working of our human bodies are the envies of engineering science. Vulnerable – the best and the strongest are still mortal. We are susceptible to trauma, diseases, ageing and finally death. Advances in life science and engineering are bringing to us in fast cadence and big strides innovative breakthroughs and new possibilities in healing and rejuvenation, functional recoveries and health enablement. Powered intelligent prostheses for subjects with amputation, fully implantable artificial hearts for subjects with heart failures, tissue engineered skin for severely burnt subjects, stem cells therapies for impaired brain tissues are examples that our body can be fixed by replacing the defective components with artificial "spare parts" and other augmentative measures. At the same time, research laboratories are developing intelligent robots that can see, hear, smell, talk, walk, dance, think, and feel like human – following a centuries-long human quest for "living" machines. The mechanistic implications of these biomedical and engineering advances seem apparent – Is human a robot? Can robot one day become human? The artists among us are quick to perceive and even exploit these implications. The entertainment media have imaginatively presented many kinds of human- robotic hybrids, both as heroes and villains, often with power and abilities beyond those of a human. What could we tell about ourselves from our quests, pursuits, and dreams? How may one define the borderline between human and robot? What does it mean to be a human? This subject derives from the instructors' teaching and research in biomedical engineering, prosthetics, robotics, etc. and their well-round reflections in the realms of science, technology and humanity. The subject starts by illustrating the many amazing designs in our human body and yet how vulnerable we are in terms of injuries, diseases and ageing. Examples on how modern biomedical engineering helps us face our human conditions are given. The topics "intelligence and artificial intelligence" and "senses and artificial senses then follows, along with a historical account of human quest for "living" machine, including a brief coverage of modern movies on bionic human. The subject wraps up with some social, ethical and philosophical reflections on the above issues and on the meaning of being human, opening up questions concerning the perennial human quest of becoming super human. All students keen in the above issues are welcome to take this subject. **Indicative Syllabus** The Amazing Human Body The Vulnerable Human Body The State of Science in Biomedical Engineering ▪ Musculoskeletal Prosthetics and Orthotics

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Cardiovascular Implants
Other Artificial Organs
Stem Cell and Tissue Engineering
Bio-Nano-Robotics
Senses & Artificial Senses
Intelligence & Artificial

Bionic Human – Science Fiction or Reality
Human versus Bionic Human versus Robot
Ethical & Social Concerns
The Meaning of Being Human
Future Super Human - a Human Quest
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<tr><td>Teaching/Learning Methodology</td><td>
<u>Lectures/ Videos/ Group Discussion</u>
Students are required to participate in writing instructional activities: online lectures on (1) integrating sources in writing; (2) developing cohesion and coherence in extended texts; and (3) developing an appropriate style for writing, as well as 2 writing consultation sessions for feedback, suggestions, and improvement on the book report writing by ELC staff. To fulfill the ER and EW requirements, students have to read a selected book (suggested by the instructor, total reading not less than 200 pages or 100,000 words) and write a book report (~2,500 words in length). Students will submit the first draft of the book report (700-word continuous/ extended piece of writing) in the middle of the semester. Shortly afterward, ELC staff will provide detailed written feedback and discuss with the students their first drafts in the first consultation session. Close to the end of the semester, students will submit a revised draft (with changes made based on ELC staff's comments plus 800 more words) and attend the second consultation session to discuss the extent to which the students have revised the draft and how well. Students will receive further suggestions for improvement before they submit the final draft.
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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="6">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></tr>
<tr><td>Short Quizzes on
Lectures 40
Readings 20</td><td>60 %</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td></td></tr>
<tr><td>Book Report
Content 30
English Writing 10</td><td>40 %</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td></td></tr>
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<tr><td>Total</td><td>100 %</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:
Short quizzes will assess students' understanding of the lecture and reading materials related to all intended learning outcomes. Book report can also assess students' ability in all intended learning outcomes, especially the CAR English writing requirement.
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<tr><td rowspan="8">Student Study Effort Expected</td><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>34 Hrs.</td></tr>
<tr><td>▪ Short Quizzes</td><td>3 Hrs.</td></tr>
<tr><td>▪ Writing Consultation Sessions (ELC)</td><td>1 Hr.</td></tr>
<tr><td>▪ Tutorial for report writing</td><td>1 Hr.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Online Writing Instructional Activities, Reading, and Book Report Writing</td><td>87 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>126 Hrs.</td></tr>
<tr><td>Reading List and References</td><td colspan="2">Selected Books for Book Report (for Er and Ew Requirements):
(Students will be asked to read <u>one of the following</u> books and complete a book report of ~2,500 words)
▪ Koops, Bert-Jaap., et al. Engineering the Human Human Enhancement Between Fiction and Fascination. 2013.
▪ Barfield, Woodrow. Cyber-Humans : Our Future with Machines. 2015.
References:
▪ Lin P, Abney K and Bekey GA, Robot Ethics: The Ethical and Social Implications of Robotics, The MIT Press, 2011.
▪ Gunkel DJ, The Machine Question: Critical Perspectives on AI, Robotics, and Ethics, The MIT Press, 2012.
▪ Johnson FE and Virgo KS, Bionic Human: Health Promotion for People with Implanted Prosthetic Devices, Human Press, 2005.
▪ Naam R, More Than Human: Embracing the Promise of Biological Enhancement, Lulu
▪ Franchi S Guzeldere G, Mechanical Bodies, Computational Minds. MIT Press, 2005.</td></tr>
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	▪ Clark A, Natural-Born Cyborgs: Minds, Technologies, and the Future of Human Intelligence, Oxford Press, 2003. ▪ George TM, Digital Soul: Intelligent Machines and Human Values, Westview Press, 2003. ▪ Brook RA, Flesh and Machines: How Robots will Change Us, Pantheon Books, 2002. Selected articles and video clips.