

Design of a Practice Fundamentals of Engineering Exam for Undergraduate Biomedical Engineering Students

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Introduction: Currently, there are no common standardized tests taken by biomedical engineers prior to practicing in the field. Employers and other constituents rely on universities to create and maintain biomedical engineering curriculum that is consistent with some expected norm. However, biomedical engineering tends to cover a wide subject area and often an interpretation of its coverage can lead to inconsistencies. Further, the level of depth and competency in any given subject area remains ambiguous. To remedy these shortcomings, the authors propose - and have implemented within their own program – a practice version of such an exam, which attempts to define (as a starting point) some basic fundamental knowledge all bachelor level biomedical engineering students should achieve.

Materials and Methods: A total of 37 bachelor-level programs (“Biomedical” or “Bioengineering”) were randomly selected from the student chapter’s link provided at BMES.org. Fourteen subject areas were rated as 0, 0.5, or 1 based on the level of coverage (eg. 1 = full 3+ unit course in the area; electives ignored). The totals were summed to provide the percentage of schools offering the subject. We then compared high percentage areas with the content covered in the “Other Disciplines” version of the Fundamentals of Engineering (FE) examination. The FE is the first of two exams required for professional engineering licensure in the US. The FE exam, which is administered by the National Council of Examiners for Engineering and Surveying (NCEES.org) is discipline specific and currently does not have a biomedical version. However, the “Other Disciplines” version has some basic engineering content which we used as basis for a biomedical version – see Ref [1] and Table 1.

Results and Discussion: Based on 37 US programs researched, the most common biomedical-specific content areas were biomechanics (90%), materials (90%), physiology (88%), circuits (81%), bio-instrumentation (76%), fluids (73%), thermal/heat (62%), and bioimaging (60%). The authors compared this data with California Baptist University (CBU) biomedical engineering program and looked for overlap with the FE Other Disciplines exam. An exam was then created with 40 problems spanning the content shown in Table 1. The relevant CBU course descriptions are available at www.calbaptist.edu. Briefly, the subject of these courses (with content beyond the FE) are Bioengineering Fundamentals, Biomechanics, Engineering Physiology, Biofluid Mechanics and Relevant Technologies, Bioimaging, and Biomaterials.

Table 1: Cross Reference of Knowledge Areas in CBU’s Biomedical Engineering Practice FE Exam

Content from NCEES's OTHER DISCIPLINES	Knowledge Area	Chapters / Topics from [1]
Math	1 (Same as NCEES OTHER DISC.)	Ch's 1-5 (Topic I)
Statistics	2 (Same as NCEES OTHER DISC.)	Ch 6 (Topic II)
Chemistry	3 (Same as NCEES OTHER DISC.)	Ch 34 (Topic IX)
Ethics	4 (5 in NCEES OTHER DISC.)	Ch's 46-48 (Topic XIV)
Engineering Economics	5 (7 in NCEES OTHER DISC.)	Ch 45 (Topic XIII)
Statics	6 (8 in NCEES OTHER DISC.)	Ch's 7-10 (Topic III)
Strength of Materials	7 (10 in NCEES OTHER DISC.)	Ch's 16-19 (Topic V)
BME-Specific Content		Ch's from [1] + CBU Course
Biomechanics	8	Ch's 11,12,13 + EGR 361
Materials in Medicine	9	Ch's 20,21 + EGR 462
Fluids / Thermal Engineering	10	Ch's 22-24, 28, 29, 33 + EGR 363
Electric Circuits / Egr Physiology	11	Ch 36 + EGR 262, EGR 362
Bioimaging	12	EGR 364

Conclusions: A practice FE exam has been created and implemented in CBU’s Biomedical Engineering B.S. program that includes relevant topics from the FE Other Disciplines and also incorporates subjects common to most US Bachelor level programs in biomedical engineering.

Reference:

[1] Lindeburg, Michael R., FE Other Disciplines Review Manual, Professional Publications, Inc, (PPI), 2014.