

10 000 mechanics problems at the press of a button

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Problem solving is at the heart of the mechanics curriculum, and developing problem solving skills is an important learning objective in basic and advanced mechanics courses at the undergraduate level. In alignment with this tradition, written examinations are mainly designed to test problem solving capabilities. Despite the fact that students spend most of their mechanics studies solving mechanics problems, an alarming fraction of them fail the written examination. One possible explanation is that a problem solving infrastructure, e.g. answers to problems and opportunities for collaboration with fellow students, is provided during the study period of courses, but missing during the examination.

We propose that computer-generated, individualized send-in exercises could be used as a learning activity or examination that develop or test the problem solving capability on an individual basis. Each student is assigned a *unique* set of mechanics problems, which are solved without any collaboration. Since each problem is unique, the students cannot benefit from sharing answers. Only the answers to the problems are handed in to the examiner. If an answer is incorrect, a different problem of the same type is handed out, thus avoiding an iterative solution process.

To make this possible, an expert system is implemented which automates the formulation of a range of mechanics problems. In the present implementation, single- and multi-body, plane, static equilibrium problems can be generated (Fig. 1), as well as problems concerning center of mass calculations and area moment of inertia calculations for plane, composite bodies. The system generates a problem text and vector graphics in one PDF document that is handed out to the student. The answer, produced using symbolic computation, is written in a separate PDF document to be used by the examiner. The rate at which these problems are generated is limited by the time it takes to compile a L^AT_EX document. This means that about 10 000 problems can be generated over-night.

This new learning activity will be tested during autumn 2015 and spring 2016. In the first phase, solving these computer-generated problems will render bonus points on the written examination.

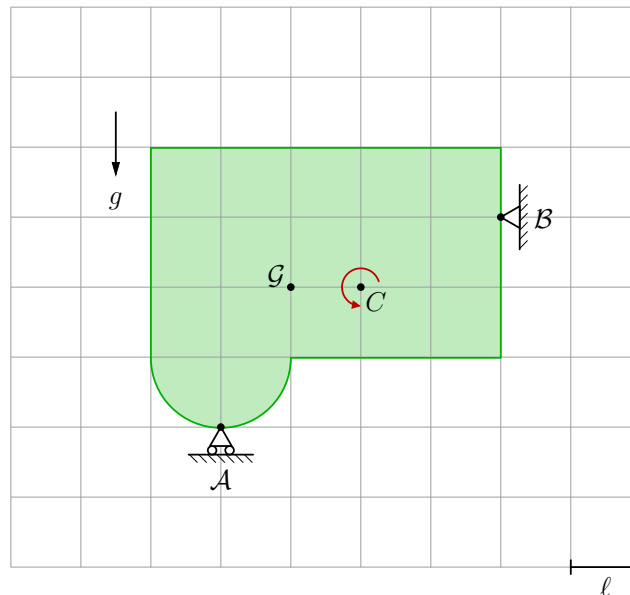


Figure 1: Low difficulty mechanics problem. *Problem text:* A plane body of mass m and center of mass G is supported at two points A and B . A couple $C = 5mgl$ is acting on this body. Compute the magnitude of the force acting on the body at A . *Answer:* $F_A = 2mg$.