Practical exercise sections for the lecture - Control Systems: Theory and Design

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The course “Control Systems: Theory and Design”, which is a fundamental course for many engineering streams, is currently structured as lectures and exercise classes. The key idea behind this teaching innovation project is that by including practical exercise session in the course, the students can be trained to design control systems for the real-world applications. These sessions are made credit less, as the sole purpose of this educational project is to motivate and inspire the students by engaging them through practical sessions in demonstrating how the concept learned in the classrooms are applied in solving the real-world problems. These concepts include - linearizing a non-linear model of a real system, designing feed-back controller to test the validity of the linearized model, designing Linear Quadratic Regulator (LQR) and Linear Quadratic Gaussian (LQG) controller and discretising continuous-time model of a real system. Two such practical exercise sessions, one (dealing with continuous time-period) in the mid-semester and the other (dealing with discrete time-period) in the end of the semester, are planned to be conducted.

Firstly, the students are asked to form small groups; each group with students who are comfortable to work with each other. By working in groups, it is intended that each student is benefitted from peer learning. The tasks are announced one week prior to the scheduled practical exercise sessions by making sure the preparation time is enough to design without time pressure. The intended task is to design a control system for a two wheel self-balancing robot, which is more like a scaled down version of a self-balancing personal transporter Segway, using the software MATLAB. The control system should be designed in such a way to self-balance the two wheel robot and also to move it without losing its balance. The control system should also be designed to reduce noise and disturbance. To motivate and inspire the students, interactive videos, that showcase the real-world application of the task, are planned to be showed during the preparation period of one week. On the scheduled day of practical exercise sessions, each group is provided with a robot and groups are given some time to upload their MATLAB script and calibrate the code to run their robots. The efficiency of the designed control systems is tested by successfully running the robot for a designated distance without losing its balance even under any external disturbances. The best performed group is given a chance to explain and demonstrate their control system design in front of the whole class, and thereby the whole class is benefitted by self-releasing the mistakes in their own design. The feedback from these practical exercises can help in bridging theory and practice of concepts learned in the course.