Project:	Interdisciplinary course with challenge based learning	MSc. 1Y – Q4
Applicant(s):	Danqing Liu	

5.1.6.1 Background and project motivation

The course brings together material properties and device design. It hereby fills the gap between molecular sciences (Synthetic Organic Chemistry, Physics of Soft Matter) on one hand and device engineering and applications on the other hand. The course will illustrate this by means of existing products, such as displays, smart windows, and microfluidic devices, and future developments such as soft robotics, electronic paper and interactive coatings and paints.

As such the course bridges the knowledge from different disciplines with aspects from chemical engineering, mechanical engineering, electrical engineering, physics and industrial design. Where needed an extension will be provided to the knowledge acquired in previous years in the present curriculum.

The course topics are in par with the research direction at TU/e: strategy 2030 to bring multi-discipline sciences together. The teaching method also aligns with the 'challenge-based learning' at TU/e. The philosophy of the course is that students are learning from the expert by joining the lectures as well as learning by working on the projects and doing the experiments on their own. At the end, students will also make a step further from academia approaches towards industrialization to learn how the devices are massively produced.

Although primarily aimed for students of the department of Chemical Engineering and Chemistry, students from the other engineering sciences (electric engineering, mechanical engineering, and applied physics) as well as Industrial Design will be stimulated to enrol. We are opting for students with different backgrounds that are evenly distributed. During the course, students from different backgrounds will be grouped to complete assignments.

With rapid advances in science and technology, new functional/ responsive devices are emerging in our society with every increasing rate. For example, soft robotics which are constructed from compliant materials and can bend, deform and adapt their shape showing promising application in field of medicine, biomedical engineering and manufacturing. In virtual reality, communicative materials that provide feedback are required to make the virtual environment more realistic. Also, the dynamic environment where privacy can be introduced on demand is discussed. As we are now entering 5G communication, photonic data exchange technique are developing for ultra-fast data transfer. Smart devices are made from smart materials. However, traditional chemistry education focuses on molecular science such as synthetic organic chemistry. How to translate and magnify deformation and motion on molecular level to device function on macroscopic level is becoming important given the current development in technology and science. Therefore, the aim of the course is to fill the gap between molecular sciences and device engineering. In order to understand smart devices or develop smart functions, one needs to have combined knowledge on various fields. Chemistry is needed to synthesize and characterize functional molecules, applied physics is used to deduce the underlying principle, mechanical engineering involves in analysing and further enhancing the device performance, many devices are driven by electricity and therefore electric engineering is required, and of course all devices start with design. For these reasons, we propose a new cross-departmental course on 'device integrated responsive materials'

Alignment with strategy 2030:

1. **Cross-disciplinary research and education**

The course connect chemistry to other scientific fields, and link different sciences (chemistry, mechanical engineering, electric engineering and applied physics) together. It illustrates a path from molecular design, material formulation, device processing and characterization by giving the examples of the existing devices (displays), and the emerging smart devices (soft robotics, smart windows).

2. **Challenge-based learning**

Evaluation of the students is based on project assignment. Students with different background will be grouped to accomplish projects. In a typical project, students are expected to start with an original idea on device design, then they will make the devices in the laboratory with the help of teaching assistants, and eventually they will characterize the performance of the device. This in turn reflects the cross-disciplinary education as student group needs to acquire and master knowledge from various disciplines. Furthermore, students need to learn how to work and communicate with their peer-colleagues coming from different background.

5.1.6.2 Objectives and expected outcomes of the project

The teacher will collaborate with the project team to:

- Design and implement a diagnostic test to determine the level of the students.
- Design and implement pre-knowledge modules for all involved departments.
- Design and implement a standard assessment in a cross-disciplinary learning environment.
- Design, plan and implement coaching sessions to guide students and teams on the project.
- Design, plan and implement lab sessions with hands-on support for students and teams.
- Plan the coordination activities between departments and Teachers.

Additionally, we would expect the following desired effects:

1. We hope that this course can also inspire the lectures from other faculties on establishing cross-disciplinary education.
2. The course will strengthen the collaboration between different departments within TU/e and eventually in a broader scope.
3. In a longer term, the course should in turn promote the cross-disciplinary research at the university and deliver researchers that are prepared to challenge the cross-disciplinary research projects.

5.1.6.3 Required resources

1. This project requires 2 teaching assistants (TA, PhD) to help students making devices in the lab. Each TA invests 12 hours per week for 5 weeks (from May till June 2019) during the period of the course. Therefore, a total of 120 hours is required.
2. A post-doc for 3 months is required to assist the responsible lecture to further develop and consummate the course.

5.1.6.4 Risks and success factors

1. The Teachers should allocate sufficient time.
2. The teaching assistants should have sufficient knowledge on the topic and timely guidance on the content.

3. Standard evaluation criteria should be composed to standardize process and assure the grade being objective. Teachers, post-doc assistant will work together to formalize this.
4. Prior knowledge on basic thermodynamics, polymer physics, polymer chemistry, and responsive materials will be available on the website before the lectures starts. Post-doc will help lectures to sort out materials.
5. To guide the student groups throughout the project, each group is assigned with a mentor to provide sufficient and timely advice.
6. 30 hours of lab work is estimated for each student group. TA will plan the lab work time and provide hands-on help to students with their experiments.
7. 11 lectures are involved in the course. It is essential for lectures to have an overview on all the topics and promote a connection of a specific topic to the other topics. The post-doc will coordinate this.

5.1.6.5 Global planning

Phase	Activities	Planning	Owner / execution
Hiring	Place the advertisements, explore the academic network	January 2019	Teachers
Training	Join "Tutoring for Engineers"	January 2019	TAs
Preparation of the course	Design and implement background knowledge in Canvas	March 2019	Post-doc
	Distribution of study material / prepare lab space	March 2019	Post-doc
	Coordination of lectures	March 2019	Post-doc
	Instruction and coordination of TAs	March 2019	Post-doc
Implementation	Monitor the quality of the course	April-June 2019	Teachers, Post-doc
	Exam (oral presentation, report)	June 2019	Teachers, post-doc, TA
Knowledge transfer	Dissemination in CEC Education Day and/or CEC Education meeting	Variable	Teachers & TSO
Evaluation	Evaluation of the project	July 2019	Project coordinator
	Evaluation of the course	After delivering the course	Lectures with support of QAO