This handbook contains an overview and practical information for Software Technology students in the 3rd semester. Should further information regarding the contents of this handbook be required, please contact the semester coordinator, supervisors, lecturers, or the secretary's office.

## Semester Project Plan Outline

| Weeks | Contents and submission | Supervisors |
|---|---|---|
| W36 – W37: Project starts. | ● W36: Class meeting: Course Introduction.<br>● W36: Project group registration on Blackboard – Students must form groups and register them online by themselves no later than **September 03rd, 5pm.**<br>● W37: Project proposal preparation: 1st supervisor meeting.<br>● W37: ST-3rd semester introduction meeting, **September 10th, 2pm.** | Project initiation.<br><br>Supervision meeting with students.<br><br>ST3 semester introduction meeting. |
| W38 – W 42: Problem Analysis and inception. | ● W38-W39: Project proposal approved by supervisor.<br>● W40: Project proposal draft deadline.<br>● W41: Project proposal review and feedback together with supervisor and two other project groups.<br>● W42: Project proposal deadline. | Regular meeting with students.<br><br>Project proposal. |
| W42 – W43: No classes and project week. | ● W42: fall break (or bonus project focus week)<br>● W43: project focus week | No classes during the two weeks and focus on project. |
| W43 – W48: Execution and elaboration | ● Iterative development of project.<br>● W49: Project delivery review with supervisor and two other project groups. | Regular meeting with students.<br><br>Supervision/feedback on project progress. |
| W49 -- W51: Completion | ● Delivery of project<br>● W51: Project delivery deadline, December 14th Monday, 12:00 (noon). | Regular meeting with students.<br><br>Supervision/feedback on project delivery. |
| January 2021: Evaluation and reflection | ● Exam | Project delivery evaluation at the exam. |

## Course curriculum and module descriptions

- ST3-ICPS: Industrial CPS [5ECTS]
- SI3-CLA: Calculus and Linear Algebra [5ECTS]
- SI3-ODW: Operating Systems, Distribution and Web Technology [10 ECTS]
- ST3-PRO: Semester Project [10 ECTS]

For further details, refer to the course description via the links:

- ST3-ICPS https://odin.sdu.dk/sitecore/index.php?a=fagbesk&id=68440&lang=da
- SI3-CLA https://odin.sdu.dk/sitecore/index.php?a=fagbesk&id=64432&lang=da
- SI3-ODW https://odin.sdu.dk/sitecore/index.php?a=fagbesk&id=68413&lang=da
- ST3-PRO https://odin.sdu.dk/sitecore/index.php?a=fagbesk&id=65138&lang=da

## Exam

This semester consists of the following exam modules:

- ST3-ICPS, SI3-CLA, SI3-ODW, and ST3-PRO

Further details regarding mandatory activities/evaluation conditions and course plans for ST3-ICPS, SI3-CLA, and SI3-ODW will be provided at the commencement of each course.

The project (ST3-PRO) is evaluated according to the 7-point scale based on the overall assessment as outlined below:

1. Submission of the project report;
2. Oral examination of the semester project: assessment of written work, product, and individual oral exam.

## Workload

The workload of the project amounts to 10 ECTS points, corresponding to 1/3 of the total semester load. Each student is expected to contribute a work effort of approx. 250-300 hours to the project throughout the semester. If the effort is less, it may result in a lower project result. Conversely, too much emphasis on the project work can result in too little time for the remaining activities during the semester. Students must be available and present for project work on the weekday(s) allocated for such purposes.

## Project groups, supervisors, and lecturers

The semester project is carried out in groups and each group is appointed a supervisor. It is a requirement that students work with their project group. The semester coordinator and the lecturers are responsible for the academic contents of the project whereas the project supervisors are responsible for the project framework, supervision, and exam. The project supervisors are not experts in all disciplines of the projects but have the necessary insight to provide professional and interdisciplinary guidance on the projects.

## Semester Coordination

There are four types of semester meetings:

- Class meetings: all students and semester coordinator. Project supervisors and lecturers may attend when relevant.
- Meetings with group representatives: semester coordinator, project supervisors or lecturers, and group representatives. Each group is represented by one person.
- Meetings of the semester team: semester coordinator, lecturers, and project supervisors.
- Meetings of project team: semester coordinator and project supervisors.

## The semester project

The project is problem-oriented, i.e., driven by a problem that the project groups identify and formulate independently and within the constraints set out in the curriculum and project description. Refer to details of curriculum via https://odin.sdu.dk/sitecore/index.php?a=fagbesk&id=65138&lang=da

The project description is provided in a separate document and it can be found under the directory “Course Materials” via Blackboard.

In the project the students have to implement a cyber-physical software system where control of a production (automation) of physical goods are included. The automation system can be completely or partly be implemented in advance. Thereby, given the opportunity to work both with a simulated and real installation with real industrial equipment. It is expected that a distributed industrial CPS is implemented with a proper architecture and with integration to the different automation systems. As part of the project distribution, web technologies and agile development methods can be used. Where relevant mathematical tools can be used for precision.

The project work is based on a Cyber-Physical System (CPS) case study, Beer Production. The task is, in general, to create software that can communicate with a PLC controlled beer production machine. Each group will implement an IT infrastructure/web-based system enabled to receive production data from the machine and send commands to control the production.

Some of the initial programming work can be done using a pure software simulation of the real PLC machine. The simulator software will be available for download via Blackboard and can be started locally on your own computer (windows only). Later communication is required via network with the real PLC controlled production machine. Note that the beer machine is not able to produce real beer. Specific technical questions related to the machine regarding initial boot and connection to the OPC-UA server hosted on the PLC, etc., should be directed to Thomas Ingemann Mørk.

Students can access the physical beer production machine located in the project room (ø27-507-2). To use the machine group bookings must be made. Further details regarding room bookings will be provided on Blackboard in due course.

Requirements are described in the project description and can be elaborated on in meetings and using the machine. It is expected that different project groups will have different views and prepare different project proposals based on the case study since a common case study is used. The groups must systematically explore the case study and identify needs and solutions (which are unknown in the original case study

description). Thus, the common case study description leads to different projects.

## Relation between project and courses during the semester

The project is required to relate to the different courses during the semester.

## Project variation for ICPS

1. Students will be able to apply the concepts of industrial manufacturing processes, such as the Automation Pyramid, Manufacturing Execution System, Enterprise Resource Planning and SCADA interfaces into Cyber-Physical Systems.

2. Students will learn how to program PLC devices using the Ladder programming language. They will also understand the different protocols used to communicate between devices and systems in the new Industry 4.0 and Internet of Things (IoT) perspective, such as the OPC UA framework. Some introduction to cloud solutions will also be presented.

## Project variation for CLA

1. Students will be able to organize the data collected from the machine and manipulate it in various forms following, select relevant variables, and plot it in a meaningful way, for instance, for visual inspection.

2. Students will have the opportunity to apply to a practical problem theoretical concepts of calculus and linear algebra such as; functions and function optimization, least square errors, and matrices and matrix operations. Furthermore, they will be provided with the theoretical tools to understand some of the underlying mechanism of control and production systems.

## Project variation for ODW

1. Students can utilize their knowledge of web technology (the HTTP protocol, HTML, CSS, JavaScript, REST) from ODW to create a web-based interface for the system. Additional knowledge can come into play, e.g., about web security, or Node.js if a group should choose to create a JavaScript-based web backend.

2. Students could use their knowledge of containers (docker and kubernetes) to split the delivered system into microservices. Knowledge about servers and network is relevant for deploying their solution. The use of event-based communication in the transition log architecture following a publish-subscribe pattern is also part of the course and is used extensively in automation systems, e.g., SCADA.

## The project groups

The semester project is carried out in groups. Each group consists of 6 students and each group is assigned a supervisor. Students will form appropriate groups based on professional interests, motivation, and personal

strengths and weaknesses. The group formation must be completed and registered on Blackboard by **September 03rd, 5pm** (firm deadline). In the event students are unable to select and join a group by the deadline, the semester coordinator will make allocations to relevant groups. No project group will be approved before all project groups are formed and registered.

## Project supervision

The project groups will attend regular meetings with their assigned supervisor (recommended weekly meeting). To conduct meetings effectively and efficiently, each group will write an agenda and record minutes of the meetings. For example,

1. Group invites the project supervisor to the meeting with an agenda;
2. Group prepares a list of questions/discussion points prior to the meeting;
3. One representative per group writes the minutes after the meeting and sends them to the supervisor, etc.

## Project submission

The table below is an overview of required submissions during the project over the course of the semester:

| **Phases** | **Submission** | **Format** | **Approval/Assessment** |
|---|---|---|---|
| Project start | Project group. | Description of group members. | Approved by semester coordinator. |
| | Group contract.<br>Supervisor contract. | Document. | Approved by supervisor. |
| Analysis | Project proposal. | Document: Further information regarding the proposal template will be announced. | Review by other project groups.<br>Approved by supervisor. |
| Elaboration | Project report. | Document: Template/content can be discussed with the supervisor. | Review by supervisor and other project groups.<br>Approved by supervisor. |
| Completion | Project report.<br>Software. | Document.<br>Relevant software. | Assessed and approved by supervisor. |
| Evaluation and reflection | Project report.<br>Software. Reflection. | Document | Evaluation at exam. |

## Deliverables

All deliverables during the semester are handed in using Blackboard Assignment and must be on time unless you have an explicit agreement with your teacher, or supervisor, to hand in at a later time.

## Project proposal (foundation), report and submission

Project proposal and report are formulated based upon the guidelines given and experiences gained from the 1st and 2nd semester (for references, visit "Problemorinteret projektarbejde - et online kursus (Software Engineering & Softwareteknologi-Efterar 2019" Blackboard and check the directory "Opgaver"), supplemented by the project supervisors.

Two elements are included in the project submission:

1. Report
2. The software implemented

The report must not exceed 40 pages (A4) excluding the Appendix. One possible report structure is detailed in the following example:

i. Cover: the cover/title page must describe the project title, educational institution, faculty, department, education, semester, module code, project period, supervisor, project group and project participants (first name, last name, study number).

ii. Summary

iii. Preface

iv. Table of Contents

v. Editorial: summarize each member's contribution/responsibility for parts of the report/project

vi. List of figures

Main Title

1. Introduction: motivation, problem formulation and overview of project.

2. Background: review of relevant literature and other background information.

3. Problem analysis.

4. Theory and methods.

5. Requirements: overall requirements specification and selected detailed requirements, i.e., functional and non-functional requirements, description of the physical setup you are working with, as well as a high level description (e.g. mathematical) of the simulation you are using, etc.

6. Architecture: description of the system architecture.

7. Design: description of selected parts of the system design, with a focus on the important and interesting

parts of the system.

8. Implementation: description of selected parts of the system implementation with a focus on the technically complicated parts of the system, e.g. distribution, concurrency, etc.

9. Verification and validation: verify, simulate and test that the implemented system fulfills the requirements.

10. Evaluation: Evaluation of the developed product from a user / customer point of view.

11. Conclusion.

12. References.

Appendix: all technical details that are not essential to understanding the report (e.g., detailed class diagrams, detailed use cases, etc.) are placed logically grouped in one or more appendices.

## Blackboard

All information regarding teaching, meetings and exams is published and accessible to students via each module's Blackboard. This is mainly done through **announcements**. Mail is used only in more urgent cases.

On the individual Blackboard pages, **Course Information** refers to overall information and **Course materials** refers to teaching resources and materials. **Assignments** refers to assignments. **Compulsory assignments** (in the courses) are used for the exam assessment.