CO3007 Communication and Concurrency

Credits: *20* **Convenor:** *Dr. I. Ulidowski* **Semester:** *1st*

Prerequisites:	*Essential: CO1003, CO1001, CO1012* *Desirable: CO2011, CO1005*				
Lectures:	*38*	*hours*	**Class Test Hours:**	*2*	*hours*
Surgeries:	*10*	*hours*	**Independent Study:**	*150*	*hours*
Assessment:	*Coursework: 40% + Three hour exam in January: 60%*				

Subject Knowledge

Aims

This module provides students with an introduction to theories and applications of concurrency. In particular, it will familiarise students with the process algebras CCS (Calculus of Communicating Systems) and its operational semantics. The module will teach, via individual and collective work, how to specify, design and implement simple concurrent and distributed systems.

Learning Outcomes

Students should be able to: demonstrate understanding of the notions of concurrency, communication, and concurrent systems; and CCS and its operational and axiomatic semantics; They should be able to develop informal and formal specifications of simple concurrent systems, and be able to produce systems' designs from specifications; able to reason about the behaviour of simple concurrent systems using the techniques of equational reasoning and bisimulation, including bisimulation games.

Methods Class sessions together with course notes (available on the Web and in the printed form), Bisimulation Games workshop, recommended textbooks, class worksheets, printed solutions, and Web support.

Assessment Marked problem-based worksheets, class tests, and traditional problem-based written examination.

Skills

Aims To teach students problem solving and scientific writing skills.

Learning Outcomes Students will be able to: solve abstract and concrete problems (both routine seen, and simple unseen); write short summaries of technical material.

Methods Class sessions, course notes and text books, class worksheets, printed solutions.

Assessment Marked problem-based worksheets, class tests, and traditional problem-based written examination.

Explanation of Prerequisites

Basic knowledge of discrete mathematics and logic is essential.

Module Description

A *concurrent system* is a system consisting of several components such that each component acts *concurrently* with, and independently of, the other components, and the components can also *communicate* (or interact) with each other to synchronize their behaviour or to exchange information. In recent decades there has been much interest in and demand for concurrent systems such as, for example, communication networks, air traffic controllers and industrial plant control systems. As concurrent systems are often very complex and essential in our everyday life, it is vital that they are highly reliable. Therefore, there is a growing need for formal description languages and software tools that can assist us in the design and construction of reliable concurrent systems. The module will provide students with the opportunity to study the language CCS and how it can be used to describe, design and verify simple concurrent and communicating systems.

Syllabus

Introduction. An introduction to concurrent and distributed systems, the notions of concurrency, communication and mobility, and a motivation for a formal theory of communication and concurrency.

Modelling concurrency and communication. An introduction, by means of examples, to the basic ideas and principles involved in the modelling of concurrency and communication. Transition rules, inference trees and transition graphs.

Process algebra. Syntax and operational semantics of CCS.

Equational laws and algebraic reasoning. Equational laws for CCS and their justification. Techniques for equational reasoning.

Bisimulation. Strong and weak bisimulations, strong and weak congruences (observational congruence). Techniques for establishing bisimulation equivalences, including (strong and weak) bisimulation games, differences and relationships between various bisimulation relations. Compositional reasoning.

Case studies. Specifications and designs of simple concurrent systems in CCS.

Reading List

[A] R. Milner, *Concurrency and Communication; ISBN: 0131150073,* Prentice-Hall 1989.

[B] C.A.R. Hoare, *Communicating Sequential Processes; ISBN: 0131532898,* Prentice-Hall 1985.

[B] J.C. Baeten and W.P. Weijland, *Process Algebra; ISBN: 0521400430,* Cambridge University Press 1990.

[B] C. Fencott, *Formal Methods for Concurrency,* Thomson Computer Press 1996.

[B] A.W. Roscoe, *The Theory and Practice of Concurrency; ISBN: 0136744095,* Prentice-Hall 1997.

[B] S. Schneider, *Concurrent and Real-time Systems; ISBN: 0471623733,* Wiley 2000.

[B] W. Fokkink, *Introduction of Process Algebra; ISBN: 354066579X,* Springer 2000.

[B] C. Stirling, *Modal and Temporal Properties of Processes; ISBN: 0387987177,* Springer 2001.

Resources Course notes, text books in library, study guide, worksheets, handouts, past examination papers, module web pages, lecture rooms with OHPs, surgeries.

Module Evaluation Course questionnaires, course review.