# Course descriptor B31YS

| Course code | B31YS |
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| Course title | Robotics Systems Science |
| Credits | 15 |
| School | Mathematical and Computer Sciences |
| SCQF Level | 11 |
| Semester | 1 |
| Aims | This course will be a level 11 degree level introduction to several core areas in robotics: kinematics of robots; robot control; motion planning; state estimation and signal processing; localization and mapping; computer vision for robotics; robotics architectures, tools and approaches for system integration. Lectures on these topics will be complemented by a large practical that exercises knowledge of a cross section of these techniques in the construction of an integrated robot system in the lab, motivated by a task such as robot navigation. Also, in addition to lectures on algorithms and lab sessions, we expect that there will be several lecture hours dedicated to discussion of implementation issues - how to go from the equations to code.<br><br>The aim of the course is to present a unified view of the field, culminating in a practical involving the development of an integrated robotic system that actually embodies key elements of the major algorithmic techniques. |
| Syllabus | • Kinematics - forward and inverse<br>• Control<br>• Sensing - proprioception, etc.<br>• Motion planning - basics and sampling based methods<br>• Motion planning - planning under uncertainty, etc<br>• State estimation, localization and mapping<br>• Implementing SLAM; Multi-modal sensor fusion<br>• Image acquisition<br>• Edge detection and segmentation<br>• Shape description and matching<br>• Two-view geometry<br>• Interest points and regions<br>• Recognition of specific objects<br>• Visual serving and ego-motion estimation<br>• Middleware and software engineering for robot systems<br><br>**Required Skills:**<br><br>This course is open to all MSc in Robotics and Beng/Meng in Robotics students. The course will require some knowledge of the following fundamental notions: Multivariate Calculus, Linear Algebra and matrix manipulations, Basic notions of Statistics and concepts including expectation and conditional probability. General programming |

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| | competence is assumed. The course will use C++ / python in a Linux environment, GIT and OpenCV.<br><br>**Reading list:**<br><br>**H. Choset, K.M. Lynch, S. Hutchinson, G. Kantor, Principles of Robot Motion: Theory, Algorithms and Implementations.**<br><br>**S. Thrun, W. Burgard and D. Fox, Probabilistic Robotics.**<br><br>**D.A. Forsyth, J. Ponce, Computer Vision: A Modern Approach.**<br><br>**Efforts:** 150 (Lecture Hours 30, Supervised Practical/Workshop/Studio Hours 30, Summative Assessment Hours 2, Directed Learning and Independent Learning Hours 88. You should expect to spend approximately 40 hours on the coursework for this course. |

| Learning Outcomes | |
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| Subject Mastery | Model the motion of robotic systems in terms of kinematics<br><br>Analyse and evaluate a few major techniques for feedback control, motion planning and computer vision as applied to robotics<br><br>Translate a subset of standard algorithms for motion planning, localization and computer vision into practical implementations<br><br>Implement and evaluate a working, full robotic system involving elements of control, planning, localization and vision<br><br>Appreciate and apply software engineering approaches for the development of robotic software systems<br><br>Ability to critically review, evaluate and implement a range of advanced techniques in robotics<br><br>Ability to review exiting literature and present it to an audience<br><br>Ability to write a technical report |
| Personal Abilities | The teams will be setup as a professional organisation and will be required to understand specifications from the project sheet, develop a design document, an implementation plan and a test plan, as routinely done in commercial organisations. We will also introduce the notion of risk register.<br><br>The project will develop autonomy and teamwork as groups of students will work together to develop a unique solution to solve a common problem on a set of robotics platforms. They will have a choice of sensors and algorithms to choose from and will need to work as a team (teamwork) on different aspects (Accountability) of the system.<br><br>The project will be mostly computer based developing high level engineering skills including knowledge of standard ICT frameworks for |

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| | robotics such as ROS and GIT. It will also involve the development of algorithms based on scientific programming (Numeracy). |

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| Assessment method | 60% course work  40% examination |