MEC7238: Automation

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course Description

Many of the emerging products and machine systems on the market now come with a high level of automation, embedded with control systems that integrate information and communications technology, intelligent mechano-electronic sensors, micro-processor controllers, and powerful deduction algorithms and integrate a diverse range of parameter sensors. In Automation Engineering, the integrations of applications of applied mathematics, information technology, computer engineering, electrical and electronics engineering into mechanical systems design, and control to create these autonomous or semiautonomous intelligent mechanical systems are explored, and equip the student with thenecessary technical skills to support automated systems.

Course Objectives

In this course, the objective is to provide the skills necessary to support, design and generate an automated or semi-automated unit system that can be integrated into a wider process of other existing or future automated systems. This also aims to produce a problems solving engineer using a process-centric pedagogical approach that puts the student hands-on in the practical applications of the theories covered, and with an individual centred research approach to solving set problems.

Learning Outcomes

The students will cover course material on applied mathematical methods, computer architecture and systems programming, mechanical systems design and simulation, mechanoelectronic system controller design integration, through:

- Knowing applied linear algebra and advanced computer programming methods, and numerical methods for deducing information from large systems of variables.
- Design, analyse and generate efficient software algorithms that interface the computer with sensors and peripheral component systems.
- Design mechano-electronic systems to sense environment parameters of interest and their transduction, conversion and fusion into usable digital formats for control.
- Design, simulation and analysis of multibody dynamic mechanical systems.
- Instructions and Learning Pattern

Systems that implement these principles will be designed in advance, so that the lectures focus on introducing the theoretical principles underlying the systems design. The theory will be reinforced with a practical approach to implement non-existing modules of the theory, and to forge a problem solving ethic in the students. Materials from journal papers on the topics of discussion will be used to create awareness of the diverse approaches used to solve a problem. Simulations and algorithm implementations will also be used.

Course Details

Applied advanced mathematics and systems analysis (9 hours)
Introduction to applied linear algebra , Numerical methods and algorithms [2],Applied differential equations (shock wave analysis for complex flow systems)

Computer systems applications (9 hours)
Computer organisation, hardware/software interface, Advanced computer programming, (C,C++,C#), Software development, simulations and analysis, Computer hardware systems and realtime system control, Embedded systems for dedicated system control, Computer interfaces and device drivers

Advanced automation, robotic systems, analysis and control (9 hours)
Introductory robotics and industrial robots, Manipulator design and kinematics analysis, Design and analysis of multibody dynamics systems, Robot programming, motion and control algorithms, Robot task generation, task based autonomous system modelling, design and analysis, Economic justification and robot selection

Systems engineering and artificial intelligence of mechanical systems (9 hours)
Image acquisition and analysis, Image processing and visual servoing, Visual feedback systems for robotic systems control, Signal processing, Environment sensing, sensor design and data fusion for robotic control, Multiple system interaction and control, Case study of object tracking

Electronics principles for component design and micro-controller programming (9 hours)
Fundamentals of diodes, transistors, Digital logic timers and counters, Electronic systems design and simulation, Applied electronics for computer periphery systems design, Historical background of PLCs, PCs vs PLC, PLC parts, Ladder Logic diagrams

References

[1] Gilbert Strang, "Introduction to linear algebra", Wellesley Cambridge Press, (2009) ISBN 978-09802327-45.
[2] William H. Press, Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery, "Numerical recipes in C++ - The art of scientific computing", Cambridge University Press, (2007) ISBN 0-521-75033-4.
[3] David A. Patterson and John L. Hennessy, "Computer organisation and design. the hardware/software interface", Elsevier Morgan Kaufmann, (2005) Third Ed.
[4] Steve Oualline, "Practical C programming", O'Reilly, 1997.
[5] John J. Craig, "Introduction ot robotics mechanics and control", Pearson Prentice Hall, 2005.
[6] Tsuneo Yoshikawa, "Foundations of robotics analysis and control", The MIT Press, 1990.
[7] Groover M.P, "Fundamentals of modern manufacturing: Materials, processes, and systems", John Wiley and Sons, Inc, 2007.
[8] Wikipaedia, "Programmable logic controller", http://en.wikipedia.org/wiki/Programmable-logic-controller.
[9] PLC Programming Org, "Plc programming, tutorial, training, hints and tips", http://www.plcprogramming.org.