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| Course unit title: | Dynamic Control System Laboratory | | |
| Course unit code: | AEEE432 | | |
| Type of course unit: | Technical Elective | | |
| Level of course unit: | Bachelor (1st Cycle) | | |
| Year of study: | 4 | | |
| Semester when the unit is delivered: | 7,8 | | |
| Number of ECTS credits allocated : | 6 | | |
| Name of lecturer(s): | Dr. Lestas Marios | | |
| Learning outcomes of the course unit: | <ul style="list-style-type: none"> • Torsional Control System Identification (Model 205a): Identify plant parameters. Use fundamental properties of lightly damped 2nd order systems to indirectly measure inertia, spring and damping constants in classical mass spring configurations. • Rectilinear Control System Identification (Model 210a): Identify plant parameters such as, mass, spring and damping parameters in a classical two spring-mass configurations. • Industrial Emulator / Servo Trainer System Identification (Model 220): Estimate the inertia, gain and damping of the various system components by measuring their effect on the system response. • Magnetic Levitation System Identification (Model 730): Identify Plant parameters such as input/ output characteristics of the laser sensor, magnet/coil actuators. • Inverted Pendulum Accessory (A51) Identification (Model: 205a, 210a or 220): Perform Numerical Plant Models for inverted and non-inverted configuration. Self-erecting LQR Design. Pole Placement Design. Non-inverted LQR • Demonstrate key concepts associated with proportional plus derivative (PD) control and the effects of adding integral action (PID). • Apply the techniques of Successive Loop Closure / Pole Placement to design controllers for a 2 Degrees of Freedom Plant. • Implement a Linear Quadratic Regulator (LQR) using full state feedback. | | |
| Mode of delivery: | Face-to-face | | |
| Prerequisites: | AEEE345, AMAT223, AMAT204, APHY112 | Co-requisites: | None |
| Recommended optional program components: | None | | |
| Course contents: | <ul style="list-style-type: none"> • Torsional Control System Identification (Model 205a) – Identifies plant parameters. Uses fundamental properties of lightly damped 2nd order systems to indirectly measure inertia, spring and damping constants in classical mass spring configurations. • Rectilinear Control System Identification (Model 210a) – Identifies plant parameters such as, mass, spring and damping parameters in a classical two spring-mass configurations. • Industrial Emulator / Servo Trainer System Identification (Model 220) – The inertia, gain and damping of the various system components are found by measuring their effect on the system response. This is implemented by a Proportional-plus rate feedback loop about the drive feedback encoder. • Magnetic Levitation System Identification (Model 730) – Plant parameters such as input/ output characteristics of the laser sensor, magnet/coil actuators and magnet/magnet interactions as they vary with relative position are measured. Strong magnetic field non-linearities via SISO System with non linear elements | | |

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| | <p>are also investigated.</p> <ul style="list-style-type: none"> • Inverted Pendulum Accessory (A51) Identification (Model: 205a, 210a or 220) - Numerical Plant Models for inverted and non-inverted configuration. Self-erecting LQR Design. Pole Placement Design. Non-inverted LQR Design. Control Robustness of the inverted LQR based control System. • Rigid Body PD and PID Control (Models: 205a, 210a, 220 or 730) – Demonstrates key concepts associated with proportional plus derivative (PD) control and the effects of adding integral action (PID). • Collocated PD Control with 2 DOF Plant (Model: 205a, 210a, 220 or 730) – PD control of a 2 Degree Of Freedom (DOF) system, where the controlled output is rigidly coupled to the actuator input (referred as collocated scheme). The increase of the order of the system (from 1 DOF to 2) can be effectively considered as dynamic disturbance to the plant. • Successive Loop Closure / Pole Placement Design for 2 DOF Plant (Model: 205a, 210a, 220 or 730) – A position loop is initially closed about the collocated position with a relatively high bandwidth (close tracking) PD Control. Then a low pass filter is implemented to attenuate high PD gains. Pole placement Control methodology is finally applied via outer loop. • LQR Control (Model: 205a, 210a, 220 or 730) – A linear Quadratic regulator is implemented using full state feedback. • Practical Control Implementation (Model: 205a, 210a, 220 or 730) – Non-ideal behaviours that affect many control applications, such as drive saturation, sensor quantisation, and discrete time sampling, drive flexibility and various forms of disturbances that affect many control applications are demonstrated and guidelines to mitigate their effects are given. |
| Recommended and/or required reading: | |
| Textbooks: | <ul style="list-style-type: none"> • Dynamic Control Systems (ECP) Laboratory Manual. |
| References: | <ul style="list-style-type: none"> • Modern Control Engineering, by K. Ogata, Prentice Hall, 2017. • Feedback Control of Dynamic Systems, by G.F. Franklin, J.D. Powell and A. Emami-Naeini, Prentice Hall, 2009. • Modern Control Systems, by R.C. Dorf and R.H. Bishop, Prentice Hall, 2014. |
| Planned learning activities and teaching methods: | <ul style="list-style-type: none"> • Students are taught through laboratory experiments (4 hours per week) in the Control Systems Laboratory, where the learning outcomes, the theory, the methodology and practical hints are explained before each experiment by the lecturer or the teaching assistant. • Laboratory experiments are carried out in small groups and lab reports are required two weeks after the laboratory class resulting in a cumulative mark. • Students are assessed continuously and their knowledge is checked through the laboratory reports with their assessment weight, date and time being set at the beginning of the semester via the course outline. Students are also assessed via oral examination of their knowledge and skills developed from the experiments carried out. • The final assessment of the students is formative and summative and is assured to comply with the subject's expected learning outcomes and the quality of the course. |
| Assessment methods and criteria: | <ul style="list-style-type: none"> • Oral Assessment 20% • Lab Reports 80% |

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| Language of instruction: | English |
| Work placement(s): | No |