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| **ES-422** | **FPGA-Based System Design** | **3+1** |
| **Prerequisite:** Digital Logic Design, VLSI System Design |
| **Objective:** Teach the design of digital electronic circuits with field-programmable gate arrays. |
| **Course Outline:** Introduction, digital design and FPGA, FPGA-based system design, manufacturing process, transistor characteristics, CMOS logic gates, wires, registers and RAM, packages and pads, FPGA architectures, SRAM-based FPGAs, permanently-programmed FPGAs, circuit design of FPGA fabrics, architecture of FPGA fabrics, logic design process, combinational network delay, power and energy optimization, arithmetic logic elements, logic implementation using FPGAs, physical design (PnR) for FPGAs, synthesis process, sequential design using FPGAs, sequential machine design process, sequential design style, FSM design, ASM design. |
| **Lab Outline:** Introduction to Verilog HDL, gate-level modeling, data flow modeling, behavioural modeling, design, simulation, synthesis and fitting of combinational circuits, design and implementation of an FSM and memory. |
| **Recommended Books:** * Wayne Wolf, “FPGA-Based System Design,” with CD-ROM, 2004, Prentice Hall, ISBN: 0131424610.
* Samir Palnitkar, “Verilog HDL,” Second Edition, 2003, Prentice Hall, ISBN:0130449113.
* Michael D. Ciletti, “Advanced Digital Design with the Verilog HDL,” First Edition, 2003, Prentice Hall, ISBN: 0130891614.
* Michael John Sebastian Smith, “Application-Specific Integrated Circuits,” First Edition, 1997, Addison Wesley, ISBN: 0201500221.
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| **ES-421** | **Robotics** | **3+1** |
| **Prerequisite:** Control Systems |
| **Objective:** Teach the fundamentals and applications of robots including the robot hardware and design of control laws. |
| **Course Outline:** Introduction to robots, robot fundamentals and applications, classification of robots, robot hardware, robot sensors, robot/system integration; provides a comprehensive treatment of the mathematical modelling of robot mechanisms and the analysis methods used to design control laws for these mechanisms. |
| **Lab Outline:** Experiments to introduce the students to basic robotics and programming of programmable devices used in the robotics field. |
| **Recommended Books:** * J. L. Fuller, “Robotics: Introduction, Programming, and Projects”, Second Edition, 1998, Prentice Hall, ISBN: 0130955434.
* David Cook, “Robot Building for Beginners,” 2002, Apress, ISBN: 1893115445.
* John J. Craig, “Introduction to Robotics: Mechanics and Control,” Third Edition, 2003, Prentice Hall, ISBN: 0201543613.
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