DESIGN OF MECHATRONIC SYSTEMS

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PRE-REQUISITES : Background of programming of microprocessor, A course in classical automatic control. Basics of mechanics kinematics and dynamics of planar motion.

INTENDED AUDIENCE : PG students, Research Scholars, Final year UG students, faculty teaching mechatronics, Professionals from automation industry

INDUSTRIES APPLICABLE TO : Larsen & Toubro, Eaton, John Deer, other companies in the area of mechatronics products.

COURSE OUTLINE :
This course is geared towards developing skills of candidates towards conceiving new mechatronics products based on raw ideas and develop them. The course focuses on hands-on experience along with a project, and offers a lot of practical tips to make theory work in practice. Furthermore, the course catalyzes integrated thinking in mechanical and electronics domain, which is crucial to successful product design and development.

ABOUT INSTRUCTOR :

Prof.Prasanna Gandhi, Professor in mechanical engineering, is also Director of Suman Mashruwala Advanced Microengineering Laboratory, and Professor-in-charge of IITB-Monash Academy. Prasanna's current research focuses on the areas of polymer and ceramic 3D micro-printing systems, control of fluid instabilities for Spontaneous Multiscale Manufacturing (SMM), dynamics and control of ultra-flexible mechanism systems for applications in micro-printing, micro-fluidics, medical robotics, products, and devices. He was pioneer in setting up non-VLSI based 3D digital microfabrication and characterization facility in the Department of Mechanical Engineering at IIT Bombay for the first time in India in 2004. Some of the technologies developed in his laboratory are transferred and licensed to Indian Space Research Organisation, Ordnance Factory Board, and a few private companies. He also is co-founder of Flexmotion Technologies, a startup based on compliant mechanisms technology developed at his laboratory.

Among other honours, he is a recipient of Robert Lowry Patten Award at Rice University (2000), BOYSCAST fellowship (2006) of Govt of India, Best faculty award (2008), FIE foundation award at IMTEX (2019), P K Patwardhan Technology Development Award (2021), SERB Technology Translation Award (2022), and Abdul Kalam Technology Innovation National Fellowship (2022), Chandrayn-3 honour (2023), MP Baya National Award (2023). He is certified teacher of stress relieving, personality enhancing Art of Living courses since 2010 and has taught several courses making positive difference to lives of students, householders, and professionals alike.

COURSE PLAN :

Week 1: Introduction: Elements of mechatronics system: Sensor, actuator, plant, and controller.

Week 2: Applications of mechatronics system. Systems like CDROM, scanner opened to see whats there inside and why?.

Week 3: Integrated mechanical-electronics design philosophy. Examples of real life systems. Smart sensor concept and utility of compliant mechanisms in mechatronics

Week 4: Microprocessor building blocks, combinational and sequential logic elements, memory, timing and instruction execution fundamentals with example of primitive microprocessor.

Week 5: Microcontrollers for mechatronics: Philosophy of programming interfaces, setting sampling time, and Getting started with TIVA programming

week 6: Microcontroller programming philosophy emphasis on TIVA, programming different interfaces PWM, QEI etc. Mathematical modeling of mechatronic systems,

week 7: Modeling friction, DC motor, Lagrange formulation for system dynamics.

week 8: Dynamics of 2R manipulator, Simulation using Matlab, Selection of sensors and actuators.

week 9: Concept of feedback and closed loop control, mathematical representations of systems and control design in linear domain

week 10: Basics of Lyapunov theory for nonlinear control, notions of stability, Lyapunov theorems and their application

week 11: Trajectory tracking control development based on Lyapunov theory, Basics of sampling of a signal, and signal processing

week 12: Digital systems and filters for practical mechatronic system implementation. Research example/ case studies of development of novel mechatronics system: 3D micro-printer, Hele Shaw system for microfabrication.