Course Number: 28551

Course Name: Mechatronics

Course Type: Theory	Type & Max Unit: Constant 3
Prerequisite: Applied Electronics 1 , 2	Corequisite: Mechatronics Lab
Level: Graduate	First Presentation: 1998
Group: Applied Mechanics	Last Edition: 2017-1

Objectives:

The main goal of this course is to present the basic principles involving the design and implementation of mechatronic systems composed of mechanical, actuation, sensing, interface/drive electronics and microprocessor/microcontroller subsystems. Considering the fact the students with BS in Mechanical Engineering take this course, topics mostly concentrate on electrical, electronic and control aspects.

Topics:

- **Introduction:** History, importance and applications of Mechatronics in industry in both product design and manufacturing automation
- **Electromechanical actuators:** Operation principles, governing equations, characteristic curves for solenoids, DC permanent magnet motors and stepper motors (including variable reluctance, PM and hybrid steppers), Actuator / gearbox selection and sizing principles based on force/stroke curve in solenoids and torque-speed curves in DC and stepper motors
- **Electronic drive for stepper and brushed-DC motors:** wave-drive/full-step/half-step drive and mirco-stepping, unipolar and bipolar drives for stepper motor, class-B and class-AB power amplifiers, voltage/current control, switching power amplifiers, single/two/four quadrant H-bridge switching servo-amplifiers, L297/L298 operation principle, switching operation modes of L298 and other similar IC's under microprocessor control
- **Digital Control Systems:** Nyquist sampling theorem, Z and inverse-Z transform. Pulse transfer function, discretization using forward/backward difference, bilinear and frequency pre-warping, pole-zero mapping, ZOH equivalent methods, Lead/lag compensation in Z-domain, frequency response analysis of discrete time systems
- **Piezoelectric Actuators:** Introduction to smart materials, Piezo and inverse-piezo effects, mechanical/electrical and electromechanical properties of piezoelectric materials, charge-strain, charge-stress, voltage-strain and voltage-stress models, Effects of electrical and mechanical boundary conditions on piezoelectric properties, Orthotropic 17 parameter model, 3-3 operation mode, 3-1 operation mode, piezo-stacks and piezo-bimorphs their governing equations and characteristic curves

References:

1. Stepping Motors and Their Microprocessor Controls, Takashi Kenjo
2. Mechatronics - An Integrated Approach, C. W. de Silva, CRC Press
3. Power Electronics : Circuit , Devices and applications, M.H. Rashid
4. Discrete Time Control Systems,K. Ogata, Prentice Hall
5. Micromechatronics: Modeling, Analysis and Design, Giucuitiu, Lyshevski