Title: Electronic components

Lecturer: Prof. Dr. Slavko Amon, Doc. Dr. Matej Možek

Aim of the course:
To give understanding of basic effects, structures, technologies and applications of electronic components and sensors, and to provide methods and skills for realization of advanced electronic systems.

Required (pre)knowledge:
Basic courses in electrical engineering, mathematics and physics

Contents:
Standardization: Definition. Standardization Organizations. Review of Standards.

Reliability: Definition. Failure Rate. Mathematical models.

Aging: Definition. Degradation. Accelerated aging. Acceleration Factor. Determination of lifetime and activation energy of degradation.

Resistors: Introduction. Color Code. Tolerance classes. Renard scales. Maximal power dissipation and Nominal Power. Electrical-thermal problems analogy. Stability and longterm operation. Impulse operation. Temperature coefficient. Sheet resistivity. High frequency operation. Noise. Review of structures, properties and applications of resistor families.

Nonlinear resistors: NTC thermistors, PTC thermistors, Varistors – overview of basic effects, properties and applications.

Capacitors: Introduction. Basic effects in dielectrics. Dielectric polarization. Dielectric absorption. Real capacitor. Loss/heat dissipation. Equivalent circuit, loss factor and impedance. High frequency operation. Temperature coefficient. Breakdown. Review of structures, properties and applications of capacitor families: Paper, Plastic, Ceramic, Mica, Glass. Electrolytic - aluminum and tantalum, wet and dry(solid). Special structures: thin and thick film technologies, semiconductor technologies (PN-junction, MOS, thin film, ferroelectric).

Coils: Introduction. Basic effects. Magnetic domains. Magnetization. Initial and complex permeability. Analogy between electrical and magnetic circuits. Coils without cores. Improved expressions. Coils with ferrite core. Diagram of normalized losses. Core with a slot. C-factors. Effective permeability. Inductance factor. Resistance factor. Desaccomodation. Losses. Temperature coefficient. Coil design. Sinus and pulse transformer design.

Piezoelectric elements: Piezoelectric effects. Stress induced voltage. Piezoelectric actuators. Quartz crystals. SAW (Surface Acoustic Wave) devices.

Displays: Introduction. Types. Luminescence, phosphorescence, scintillation. Cathode ray tube. LED displays: types, equivalent circuits, power supply, smart display with decoder. LCD (Liquid Crystal Display): effects, structures, operation, power supply. Addressing(direct, passive and active matrix). Light sources (fluorescent bulb, LED). Electroluminescent displays. Fluorescent displays. Plasma displays. FED (Field Emission Displays). Touch Screens.

Switches and relays: Introduction. Types: electromagnetic, semiconductor, optoelectric (optocouplers).

Sensors: Introduction. Basic sensor parameters: Characteristics, Sensitivity, Accuracy, Resolution, Nonlinearity, Dynamic Response etc. Processing of sensor signals. Sensor systems: basic units (sensor, amplifier, filter, sample and hold circuit, A/D converter, microcomputer). Description of basic units. Basic sensor circuits based on operational amplifiers (inverting and noninverting amplifier, follower, integrator, differentiator, differential and instrumentation amplifier, adding amplifier). Converters. Sensor technology: microelectronic technologies and micromachining. Review of sensor families (resistance, capacitance, inductance, and voltage). Sensors of displacement, strain, pressure, acceleration, level and flow meters, temperature, ligh, color, energetic particles and radiation, moisture, gas and bio/chemical.

Selected references:

S.Amon, Elektronske komponente, Internetna stran (Home page), 2010

J.P.Bentley, Principles of Measurement Systems, Prentice Hall, ISBN 0 130 43028 5, 2005

P.Horowitz, W.Hill: The Art of Electronics, Cambridge University Press, 1997

J.W.Gardner: Microsensors, Wiley, 1995