Mechatronics Engineering MSc
Subject 'Signal analysis, sensors'
Questions for final examination

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1. Classification of signals according to various points of view (deterministic, stochastic, real-value, complex-value, final duration, infinite duration, periodic, aperiodic, continous, quantized, analog, digital, parameters in time domain and in frequency domain)
2. Parameters of periodic signals in time domain and in amplitude domain (period, angular repetition frequency, rise time, fall time, stabilization time, delay time, minimal/maximal value, simple mean value, RMS value, absolute mean value, form factor, peak factor)
3. Classic form and measurement form of Fourier-series of periodic signals (expressions for Fourier synthesis and analysis, diagrams of Fourier spectrum, spectral lines, problems and solutions of calculation/measurement/technical application of classic and measurement-type forms of Fourier spectrum)
4. Complex form of Fourier spectrum of periodic signals (rotating complex vectors, meaning of positive/negative frequency, expressions for complex Fourier synthesis and analysis, diagrams of Fourier spectrum, symmetries in diagrams, calculation of complex Fourier spectrum, applying Laplace transformation, technical applications)
5. Power of periodic signals, energy of aperiodic signals (definitions, based on functions of time and based on Fourier spectrum, Parseval's theorems)
6. Complex form of Fourier spectrum of aperiodic signals (relation between periodic signals and finite duration aperiodic signals, lined spectrum vs. continous spectrum, expressions for complex Fourier synthesis and analysis of aperiodic signals, diagrams of Fourier spectrum, symmetries in diagrams, calculation, measurement, technical applications of continous Fourier spectrum)
7. Problems of ideal signal transporting units, linear systems (transfer functions, gain and phase shift requirements, real signal transporting units, group delay time characteristics, definition of linearity in signal transportation)

8. Possible reasons and types of sampling signals (low level information content, minimally disturbing processes, testing by breaking, multiplexing, digital storage, processing, transmitting of information, periodic, stochastic, adaptive sampling, ’mathematical’-’physical’ sampling, basic question of sampling methods)
9. ’Mathematical’ sampling (relation of signal to be sampled-sampling signal-sampled signal in time and in frequency domain, Shannons theorem, Nyquist-frequency, ideal signal reconstruction filters characteristics)
10. Irregular sampling (mirroring-shifting the spectrum of signal to be sampled, anti-aliasing filter, capabilities of sampling measurement technics)
11. ’Physical’ sampling (condition of validity of sampling rules, sampling by sinusoid signal, signal reconstruction by real filter, methods of interpolation, distorsion effect of limited-time sampling, window functions)
12. Methods to measure and to calculate Fourier-spectrum of signals (band-filter and rectifier, tunable/parallel filters, discrete Fourier-transformation, Fast Fourier Transformation)
13. Digital filters (basic digital signals, functional components of digital filters: adder, constant-multiplier, delay element, finite/infinite impulse response filters: FIR/IIR, special effects in filter characteristics_ mirroring-shifting, periodicity)
14. Basics of stochastic signals (definition of stochastic signals, realizations, stationarity, ergodicity, interval of testing signals)
15. Properties of stochastic signals in amplitude domain (amplitude-distribution function, amplitude-density function, definitions, properties, measuring methods, distribution and density functions of typical signals)
16. Properties of stochastic signals in time domain (auto-correlation function, cross-correlation function, definitions, properties, measuring methods)
17. Properties of stochastic signals in frequency domain (auto-power-density function, cross-power-density function, definitions, properties, measuring methods, Wiener-Chinchin rules)
18. Basics of electric transducers (block-diagram elements: sensor, electronic processing unit, output stage, standardised current range, living zero, supplying power by 4-wire, 3-wire, 2-wire connection to receiver unit)

19. Resistive type sensors (potentiometer-type, strain-gauge, sensing mechanical stress in 1 or in 2 dimensions, sensor electronic circuits: ¼ bridge, ½ bridge, full bridge, neglecting cable resistance, compensation of temperature dependence)
20. Inductive, capacitive and optical type sensors (differential transformer, differential condensator, tachometer generator, magnetostrictive sensor, magnetic stripe position sensor, optical strain gauge, code-disc incremental/absolute sensor)
21. Electronic sensing mechanical quantities (speed, acceleration, rotation angle, rotation speed, force, pressure, inclination, torque)
22. Sensors for measuring temperature (dilatation in liquid, in solid material, in gases, bimetalic sensor, resistive temperature detector: RTD, thermistor, thermocouple: TC)