Full time training
English – Mechatronics engineers – MSC
Specialization in Informatics

State exam's questions
Sensors and Signal Analysis + Micro- and Nanotechnics

Subject code: BGK-MEI-2021-AMM-E-JÉ+MNT
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Sensors and Signal Analysis

JÉ 01 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)

JÉ 02 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)

JÉ 03 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)

JÉ 04 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)

JÉ 05 Power of periodic signals, energy of aperiodic signals (definitions, based on functions of time and based on Fourier spectrum, Parseval's theorems)

JÉ 06 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)

JÉ 07 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)

JÉ 08 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)

JÉ 09 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)

JÉ 10 Irregular sampling (mirroring-shifting the spectrum of signal to be sampled, anti-aliasing filter, capabilities of sampling measurement technics)

JÉ 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)

JÉ 12 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)

JÉ 13 Resistive type sensors (potentiometer-type, strain-gauge, sensing mechanical stress in 1 or in 2 dimensions, sensor electronic circuits: 1 bridge, 1 bridge, full bridge, neglecting cable resistance, compensation of temperature dependence)

JÉ 14 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)

JÉ 15 Electronic sensing mechanical quantities (speed, acceleration, rotation angle, rotation speed, force, pressure, inclination, torque)

JÉ 16 Sensors for measuring temperature (dilatation in liquid, in solid material, in gases, bimetalic sensor, resistive temperature detector: RTD, thermistor, thermocouple: TC)

Micro- and Nanotechnics

MNT 01 Show the characteristic material formats of solid state, and the Miller - Bravais system used to describe the crystalline materials! Describe the crystal structure of the elementary semiconductors (Si, Ge)! Shortly describe the metallic, ionic, covalent, and molecule crystals! Summarize the different density definitions used in the crystallography!

MNT 02 Describe the experimental evidences of the material - wave duality of the matter! Show the band structure of the crystalline material! Describe the intrinsic and the extrinsic semiconductors! Give the continuity equation and explain its different components!

MNT 03 Explain the operation principle of the bipolar transistor, show the potential diagram and the current-voltage characteristics of the p - n junction (diode)! How the bipolar planar transistor, the resistor, and the capacitor produced by a bipolar IC technology?

MNT 04 Explain the operation principle of the MOS FET and the CMOS inverter! Show the basic steps of the CMOS technology using the CMOS inverter as an example!

MNT 05 Describe the photoelectric devices, show the differences between photo-diode, LED, and laser diode!

MNT 06 Describe the raw material production and the methods of the crystal growth and of the impurity removal! (Czochralski's and Bridgman's Method, Float-zone Process)

MNT 07 Describe the different layer growth techniques applied in the semiconductor device technologies (Liquid Phase Epitaxy, Vapor Phase Epitaxy, Molecular Beam Epitaxy)!

MNT 08 Describe the different layer deposition techniques of the the semiconductor device technologies (evaporation, sputtering, CVD, and the silicon-dioxide growth by thermal oxidation)!

MNT 09 Describe the different doping processes of the semiconductor device technologies (thermal diffusion, ion-implantation)!

MNT 10 What are the pattern formation processes? Describe the photo-, the electron-lithography, and the different etching processes!

MNT 11 Describe the different planarization methods (P-glass, CMP-chemical mechanical planarization). What is its role in the IC and MEMS technology?

MNT 12 Introduce the Micro – Electro – Mechanical – Systems, describe their basic characters and work principles! Show one MEMS example!