2022 年北京航空航天大学中法工程师学院硕士研究生入学考试大纲
994 工业科学综合
Master entrance examination of Beihang, 2022
Syllabus of Engineering Science and Physics

Expected skills and content of the exam

The examinee is expected to be able to analyze and solve an automation control problem and a problem involving several fields of physics (electrokinetics, mathematics for physics, wave physics, electromagnetism, thermodynamics, optics, and mechanics). The exam consists of two parts: an automation control problem which counts for 50 points, and a physics problem which counts for 100 points.

Engineering Science part (automation control)

I - Modeling of automation systems
- 1°) Forward chain control
- 2°) Feedback control

II - Hypotheses related to the study of linear time-invariant (LTI) systems
- 1°) Continuity
- 2°) Linearity
- 3°) Time invariance

III - Performances of LTI systems
- 1°) Steady-state performances
- 2°) Transient-state performances

IV - Mathematical tools for the study of LTI systems
- 1°) Laplace transform of a continuous signal
- 2°) Modeling by a block diagram

V - Time response
- 1°) First order systems
- 2°) Second order systems
- 3°) Higher order systems

VI - Frequency response
- 1°) Definition and methods
- 2°) Frequency plots
- 3°) Frequency response of some basic systems
- 4°) Frequency response of other systems

VII - Algebraic methods for the determination of the performances of a LTI system
- 1°) Stability
- 2°) Accuracy and robustness
- 3°) Swiftness and damping

VIII - Determination of the performances of a LTI system from the frequency response of its open-loop transfer function

1°) General methodology: Nyquist criterion
2°) Stability
3°) Damping: Nichols chart
4°) Accuracy/robustness and swiftness

IX - Compensation of control systems

1°) Types of controllers (serial, parallel, by anticipation)
2°) Classical controllers

Physics part

I - Electrokinetics

1°) General laws of electrokinetics
2°) Usual theorems of electrokinetics
3°) Transient regimes
4°) Linear circuits used with forced sinusoidal excitations
5°) Transfer function and filtering
6°) Filtering of periodic signals

II - Mathematics for physics presented through steady-state electromagnetism

1°) Charge distribution
2°) Electrostatic field
3°) Current distribution
4°) Magnetostatic field
5°) An electrostatic potential
6°) A vector potential
7°) The electrostatic dipole - The magnetic dipole

III - Wave physics

1°) 1-D d'Alembert equation
2°) Synchronous harmonic waves superposition: interferences and resonance
3°) Electromagnetic waves in vacuum
4°) Reflection of an electromagnetic wave off a perfectly conducting medium
5°) Linear propagation phenomenon - dispersion
6°) Propagation of an electromagnetic wave in a real conducting medium - absorption
7°) Reflection and refraction of an electromagnetic wave on a surface

IV - Electromagnetism

1°) Electromagnetism postulates
2°) Energy carried by an electromagnetic wave
3°) Conductive media
4°) Electric dipole radiation
5°) Quasi stationary state approximation
6°) Electromagnetic induction

V - Thermodynamics

1°) Temperature - Description of model fluids
2°) Thermodynamical system at the thermodynamical equilibrium
3°) First law of thermodynamics
4°) Second law of thermodynamics
5°) Heat engines
6°) Phase transition
7°) Transport phenomena: particles diffusion - heat conduction

VI - Optics

1°) Elements of geometrical optics
2°) Wave model of light
3°) Interference phenomena
4°) Spatial and temporal coherences
5°) Michelson interferometer

VII - Mechanics

1°) Newton’s laws of motion
2°) Work, potential energy and kinetic energy
3°) Angular momentum
4°) Linear systems used with forced sinusoidal excitations