**2021 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, 2021**
**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