**2025** 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, 2025**

**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