MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

NATIONAL TECHNICAL UNIVERSITY
«KHARKIV POLYTECHNIC INSTITUTE»

Department	Power stations
Specialty	141 «Electric Power Engineering, Electrical Engineering and Electromechanics»
Educational program	Electric Power Engineering (141.01 – «Electric Power Stations»)
Form of education	Full-time
Academic discipline	Mathematical Tasks of Power Engineering
Semester	5

LIST OF QUESTIONS AND TASKS INCLUDED IN THE EXAMINATION TICKETS FOR THE DISCIPLINE

Number of tickets ____________

Approved at the meeting of the department
Protocol № from 20 .

Head of Department
___________ Oleksandr LAZURENKO

Examiner
___________ Liudmyla LYSENKO

- System parameters, initial operation parameters, and electric parameters to specify in problems of power system steady-state analysis.
- Presentation of a power system with an equivalent diagram.
- Application of graph theory in power system steady-state analysis.
- Presentation of an electric equivalent diagram as a graph. Path, tree, chords of graph. The general topological property of a connected directed graph.
- First and second incidence matrices and their composition for electric grids of any configuration.
- Vertex-edge incidence matrix and cycle matrix of a graph. Their composition for power system configurations of any complexity.
- Complete and incomplete vertex-edge matrix and its composition for power system configurations of any complexity.
- Cycle matrix of a graph and its composition for power system configurations of any complexity.
- Analytical presentation of power system configuration of any complexity.
- The basic contours and their properties.
- Selection of the basic contours for a power grid configuration of any complexity.
- Analytical dependence of the first and the second incidence matrices.
- Composition of the generalized matrix state equation for a power grid of any complexity.
- Algorithm of calculating DC power system steady-state operation parameters with the generalized matrix state equation.
- Composition of a matrix nodal equation for a DC electric grid of any complexity.
- Composition of a matrix nodal equation for an AC electric grid of any complexity.
- Configuration and properties of nodal admittance matrix $\mathbf{Y}_{\mathbf{bus}\Sigma}$ for a DC power system of any configuration.
- Algorithm of calculating DC power system steady-state operation parameters with matrix nodal equation.
- Composition of matrix loop equation for a DC electric grid of any complexity.
- Configuration and properties of contour impedance matrix $\boldsymbol{Z}_C$ for a DC power grid of any configuration.
- Algorithm of calculating DC power system steady-state operation parameters matrix loop equation.
- Calculation of DC power system steady-state operation parameters with application of Matlab Simulink.
- Formation of a current flow matrix **C** for homogeneous power grids of any configuration.
- Composition of a system of linear nodal equations for an AC electric grid of any complexity.
- Composition of a system of linear current imbalance equations for an AC electric grid of any complexity.
- Configuration and properties of nodal admittance matrix $\mathbf{Y}_{\mathbf{bus}\Sigma}$ for an AC power grid of any configuration.
- Formation of a power flow matrix **C** for homogeneous power grids of any configuration.
- Algorithm of calculating AC power system steady-state operation parameters of linear matrix nodal equation.
- Composition of a system of nonlinear nodal equations for an AC electric grid of any complexity.
- Composition of a system of nonlinear current imbalance equations for an AC electric grid of any complexity.
- Algorithm of calculating AC power system steady-state operation parameters with nonlinear nodal equations.
- Methods of solving a system of linear equations.

- Accurate methods of solving a system of linear equations.
- Approximate methods of solving a system of linear equations.
- Methods of solving a system of nonlinear equations.
- Gaussian elimination method and its application to solving a system of linear algebraic equations.
- Iteration technique of solving a system of linear equations.
- Seidel technique of solving a system of linear equations.
- Application of MicroSoft Excel Solver to solving a system of linear equations.
- Application of Matlab Simulink to solving a system of linear equations.
- Newton's method and its application to solving a system of nonlinear nodal equations.
- Composition of Jacobi matrix for a system of nonlinear nodal equations.
- Task: Restore the equivalent diagram of an electric grid via matrix **M**, choose a system of basic contours, compose a system of contour equations (with zero e.m.f.) and solve it with inverse matrix method. Calculate the branch currents and the nodal voltages for the given parameters of the equivalent diagram.

$$\mathbf{M} = \begin{vmatrix} 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 & 0 & -1 & 0 \\ 0 & 0 & -1 & -1 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 \end{vmatrix}$$

- Task: Restore the equivalent diagram of an electric grid via matrix **M**, compose a system of nonlinear nodal equations and solve it with Newton's method. Calculate the nodal voltages and the branch currents for the given parameters of the equivalent diagram.

$$\mathbf{M} = \begin{vmatrix} 1 & 1 & 0 \\ 0 & -1 & 1 \end{vmatrix}$$

- Task: Restore the equivalent diagram of an electric grid via matrix **M**, compose a system of nonlinear nodal equations and solve it with any method. Calculate the nodal voltages and the branch currents for the given parameters of the equivalent diagram.

$$\mathbf{M} = \begin{vmatrix} 0 & 0 & 1 & -1 & -1 \\ 0 & -1 & -1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 \end{vmatrix}$$

- Task: Restore the equivalent diagram of a DC electric grid via matrix **M**, build a Matlab Simulink model and find the branch currents and the nodal voltages for the given parameters of the DC electric grid.

$$\mathbf{M} = \begin{vmatrix} 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 & 0 & -1 & 0 \\ 0 & 0 & -1 & -1 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 \end{vmatrix}$$

- Task: Restore the equivalent diagram of an electric grid via matrix **M**, find a system of basic contours, compose a system of state equations (with zero e.m.f.) and solve it with Gauss method. Calculate the branch currents and the nodal voltages for the given parameters of the equivalent diagram.

$$\mathbf{M} = \begin{vmatrix} 0 & -1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & -1 & -1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 \end{vmatrix}$$

- Task: Restore the equivalent diagram of an electric grid via matrix **M**, compose a system of linear nodal equations and solve it with Gauss method. Calculate the nodal voltages and the branch currents for the given parameters of the equivalent diagram.

$$\mathbf{M} = \begin{vmatrix} 0 & 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & -1 & 0 \\ -1 & -1 & 0 & 0 & -1 \end{vmatrix}$$

- Task: Restore the equivalent diagram of a DC electric grid via matrix **M**, compose a system of nodal equations and solve it with application of Matlab Simulink for the given parameters of the DC electric grid.

$$\mathbf{M} = \begin{vmatrix} -1 & 0 & -1 & 1 & 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & -1 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & -1 & -1 \end{vmatrix}$$

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- Task: Restore the equivalent diagram of an electric grid via matrix **M**, compose a system of linear nodal equations and solve it with Gauss method. Calculate the nodal voltages and the branch currents for the given parameters of the equivalent diagram.

$$\mathbf{M} = \begin{vmatrix} 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & -1 & -1 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & -1 & -1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 \end{vmatrix}$$

- Task: Restore the equivalent diagram of an electric grid via matrix **M**, choose a system of basic contours, compose a system of state equations and solve it with any method. Calculate the branch currents and the nodal voltages for the given parameters of the equivalent diagram.

$$\mathbf{M} = \begin{vmatrix} -1 & 0 & -1 & 1 & 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & -1 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & -1 & -1 \end{vmatrix}$$

- Task: Restore the equivalent diagram of an AC electric grid via matrix **M**, compose a system of nodal equations and solve it with application of Matlab Simulink for the given parameters of the DC electric grid.

$$\mathbf{M} = \begin{vmatrix} -1 & 0 & -1 & 1 & 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & -1 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & -1 & -1 \end{vmatrix}$$

- Task: Restore the equivalent diagram of an AC electric grid via matrix **M**, compose a system of nonlinear nodal equations and solve it with inverse matrix method. Calculate the nodal voltages and the branch currents for the given parameters of the equivalent diagram.

$$\mathbf{M} = \begin{vmatrix} 1 & 0 & 1 & 0 & 0 & 1 \\ -1 & -1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 & -1 \end{vmatrix}$$

- Task: Restore the equivalent diagram of an AC electric grid via matrix **M**, compose a system of linear nodal equations and solve it with Gauss method. Calculate the nodal voltages and the branch currents for the given parameters of the equivalent diagram.

$$\mathbf{M} = \begin{vmatrix} 0 & 0 & 0 & -1 & 0 & 0 & -1 & -1 \\ 0 & -1 & 0 & 0 & -1 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 \\ -1 & 0 & -1 & 1 & 1 & 0 & 0 & 0 \end{vmatrix}$$

- Task: Restore the equivalent diagram of an AC electric grid via matrix **M**, compose a system of nonlinear nodal equations and solve it with Newton's method. Calculate the nodal voltages and the branch currents for the given parameters of the equivalent diagram.

$$\mathbf{M} = \begin{vmatrix} 0 & -1 & 1 \\ -1 & 0 & -1 \end{vmatrix}$$

- Task: Restore the equivalent diagram of a DC electric grid via matrix **M**, build a Matlab Simulink model and find the branch currents and the nodal voltages for the given parameters of the DC electric grid.

$$\mathbf{M} = \begin{vmatrix} -1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & -1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 0 \end{vmatrix}$$

- Task: Restore the equivalent diagram of a DC electric grid via matrix **M**, find a system of basic contours, compose a system of contour equations (with zero e.m.f.) and solve it with inverse matrix method. Calculate the branch currents and the nodal voltages for the given parameters of the equivalent diagram.

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