A SET OF QUESTIONS of ELECTRICAL MACHINES

1. Give the integral, differential and circuit forms of Maxwell's equations (Ampere's law, Gauss law and Faraday law)?
2. What dependence describes the magnetization characteristic for material and what is the circuit magnetization characteristic ?
3. In what circumference the circuit magnetization characteristic is similar to material magnetization characteristic?
4. Give the relationship between the rms value of the electromotive force in the winding of N turns and the maximum value of main flux Φ. It is assumed that the winding is supplied from voltage source of sinusoidal waveform and frequency f. Calculate the maximum value of flux density in a inductor core powered by a 230 V source and a 50 Hz frequency if it is known that the winding has 100 turns and the core cross section area is 10×10 cm^2.
5. Why in single-phase transformers, HV and LV windings are placed on the same core column?
6. Draw an equivalent circuit of transformer. Explain exactly what the resistances and reactances are in this circuit?
7. How can the parameters of the equivalent circuit of single-phase transformer be determined by means of a short circuit test and open circuit test?
8. How will the open circuit current change after increasing the frequency of supply voltage from 50Hz to 60Hz with unchanged value of supply voltage?
9. What is the short circuit voltage in the transformer? What is the short circuit?
10. Determine the short-circuit current when transformer operates under the rated voltage.
11. What is the voltage drop in the transformer? How to determine the voltage drop? How does the voltage drop depend on the load?
12. Draw a transformer phasor diagram for a short-circuit state. Consider the phasor diagram for the equivalent circuit, without the transverse branch, so assume that $I_2'=I_1$.
13. Three-phase transformer with rated parameters is given: S_N=600 kVA, U_{HV}/U_{LV} = 15/0,4 kV, Yd connection. Calculate the rated currents (line current) and currents in the windings (phase current).
14. Three-phase transformer with rated parameters is given: S_N=800 kVA, U_{HV}/U_{LV} = 15/0,4 kV, Dy connection. Calculate the rated currents (line current) and currents in the windings (phase current).
15. Determine the short-circuit impedance of the three-phase transformer: S_N=55 kVA, U_{HV}/U_{LV} =3000/400 V and u_z=4%.
16. Draw an equivalent circuit of three phase transformer for balanced (symmetrical) loads. Explain exactly what the resistances and reactances are in this circuit?
17. Explain what is the inrush current in the transformer?

18. Define what is the pole pitch and how to calculate the pole pitch based on the dimensions and number of pole pairs.
19. In what position of the axis of the coil in relation to the axis of the field, the motional emf have a maximum value and in what position the transformer emf have a maximum value?

Asynchronous Machines

20. Explain differences between squirrel cage and wound rotor machines (design and characteristics)
21. Power flow (balance) of the ASM (explain quantities)
22. Torque vs. speed characteristic of ASM - explain operation modes
23. Draw equivalent circuit of the ASM - explain parameters.
24. Regulation of the rotor speed by change of the resistance in the rotor circuit (characteristics - comment).
25. Regulation of the rotor speed by change of the supply voltage (characteristics - comment).
26. Regulation of the rotor speed by change of the supply frequency (characteristics - comment).
27. Regulation of the rotor speed by change of the supply frequency, keeping the voltage to frequency ratio constant (characteristics - comment).

Synchronous Machines

28. Explain what it is the open circuit test?
29. Explain what it is the short circuit test?
30. Give definition of the short-circuit ratio and the relative value of synchronous reactance.
31. Draw a phasor diagram of the cylindrical synchronous machine of: (a) underexcited (b) overexcited; and (c) loaded only with active power.
32. Draw: (a) volt-ampere and (b) regulatory characteristic of the cylindrical synchronous machine for the different values of load power factor.
33. Give the formulas describing the electromagnetic torque of the synchronous machine for: (a) given values of armature current and excitation current, and given angle ψ between the voltage phasor and phase emf; (b) given values of armature voltage and emf and internal load angle β.
34. Draw the V curves of Synchronous machine for given value of armature voltage and electromagnetic torque.
35. Give (or draw) how the reluctance torque and how the synchronous torque depend on the value of armature voltage and the angle β of the internal load?
36. Give the formulas describing the d-q model of the synchronous motor. Draw the equivalent circuit for the d-q model.

37. Give the formulas describing the simplified d-q model of the synchronous motor. Draw the equivalent circuit for the simplified d-q model.

DC Machines

38. Draw the distribution of the radial component of magnetic flux density B_r in the air-gap of DC machine for given flux density excited by main poles and unloaded DC machine.
39. Draw the distribution of the radial component of magnetic field density in the air gap of DC machine for given flux density excited by armature winding.
40. Draw the distribution of the radial component of magnetic field density in the air gap of DC machine for given flux density excited by main poles and armature winding.
41. Discuss a method for generating electromotive force (*emf*) in the armature winding of DC machine.
42. Give the relationships describing the electromagnetic torque of the DC machine.
43. Draw the speed - torque characteristic of the separately excited DC motor for two values of supply armature voltages $U = U_N$ and $U = 0.5\ U_N$, while maintaining the constant of the value of the excitation current.
44. Draw the speed - torque characteristic of the separately excited DC motor for two values of the excitation current $I_F = I_{FN}$ and $I_F = 0.5\ I_{FN}$, while maintaining the constant of values of supply armature voltages $U = U_N$.