List of questions for state examinations – EAT, academic year 2016/17

KAE/SBET Electrical Engineering

Theory of Electrical Engineering

Electrical Engineering Theory *(c*ourse *KTE/UE, SAEO, TE1):*

1. Electrical quantities time diagrams, mean value, effective value (root-mean-square - rms)
2. Analysis of the circuitry with harmonic signal at steady (stationary) state.
3. Methods of the electric circuitry analysis (transfiguration, superposition, Kirchhoff's circuit laws, Thevenin's and Norton's equations)
4. Electric Power (apparent power, real power, reactive power)
5. Three phase electric circuitry analysis at steady state, all types of power
6. Analysis of the simple circuitry with non-harmonic signal sources, all types of power
7. Transition phenomena (initial conditions, particular solution, responses of the 1. and 2. order circuits, state quantities)
8. Two-port circuits (characteristic matrix, wave impedance, transfer function)
9. Non-linear elements characteristics.
10. Line with distributed parameter model (schematics of the line element, wave impedance, forward and backward wave, standing wave, impedance matching)

Electromagnetic Field *(course KTE/TE2):*

1. Simple Stationary Electromagnetic Field layout solution by the integral type of Maxwell's equations (planar or cylindrical capacitor, sphere electrode, thin conductor, two wire line)
2. Superposition of symmetrical fields, mirroring method
3. Potentials of stationary electromagnetic field, boundary conditions problems for potentials
4. The simple circuits R, L, C calculations (coaxial cable, cylindrical inductor, conductor above the Earth)
5. The force calculations in electric and magnetic fields
6. Calculation of forces in the electric and magnetic fields (from the Lorentz force and from the energy)
7. Solution of simple magnetic circuitry (magnetic resistance, inductance, forces)
8. Voltage induction (Faraday's law of induction, Maxwell – Faraday equation)
9. Physics of skin effect (skin depth, effect of skin effect on conductor parameters and Joule's losses, methods to avoid skin effect, advantages of the skin effect)

Written examination of the Electrical Engineering theory contains.

Electrical circuitry problems.

5 simple problems for 1 point
5 simple problems for 2 points
3 - 4 hard problems for total 10 points **sum 25 points**

Electric and magnetic field theory.

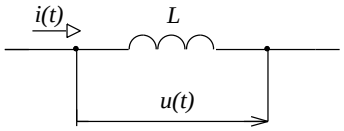
3 simple problems for 1 point
3 simple problems for 2 points
2 hard problems for 3 points **sum 15 points**

Sample exam: Electrical Circuits

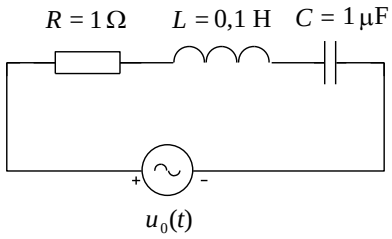
1 point

1. An electrical two-pole consists of a serial connection of two elements. The voltage and the current of the two-pole are given:
   $u(t) = 200 \sin(\omega t + 30^o)$V, $i(t) = 5 \sin(\omega t + 60^o)$A, $\omega = 500\ s^{-1}$. Calculate the values of these elements.

2. The periodical current $i(t) = 2 + 9\sin(\omega t + 30^0) + 2\sin(3\omega t)\,[\mathrm{A}]$ flows through an inductance. Calculate the effective (RMS) value of the voltage on the inductance, if L= 0,1 H; f = 50 Hz.



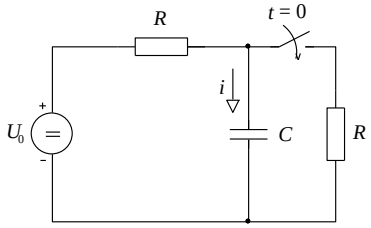
3. A circuit given by the picture is in the resonance. The voltage on the inductance is $u_L = 160\sin(\omega t + 30°)$ V. Calculate: resonance frequency ω_r, time functions of voltages $u_R(t)$ and $u_C(t)$ for the frequency ω_r,



4. Calculate the total attenuation of a two-port in dB, if the effective (RMS) values of the input voltage is 100V and of the output voltage is 80V.

5. Draw a V-A characteristics of a non-linear resistor with given characteristics $u = 10\ i^2$, mark the operating point $u_Q = 10$ V and define the values of static and dynamic resistance in that operating point.

6. Determine the voltage $u_C(\infty)$ and the current through a capacitor $i_C(0+)$ at the time of turning on the switch. The circuit was in the steady state at the time t = 0, $u_C(0) = 5\,\mathrm{V}$, R = 10Ω.



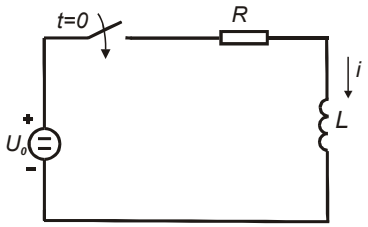
7. Symmetric 3-phase appliance connected into triangle is connected to the symmetric 3-phase voltage source, the effective (RMS) value of the line-to-line (joint) voltage is 500 V. The complex impedance of a single phase is **Z** = 50∠30°. Calculate the value of the currents in the phases of the appliance, values of joint currents in phases and calculate the active (real) power of the appliance.

2 points

8. Determine the input impedance of a two-port, if a resistor of R = 20 Ω,is connected to the output. The impedance matrix of the two-port is $Z = \begin{bmatrix} 15 & 5 \\ 5 & 20 \end{bmatrix}$.

9. A current of i(t) = 2 + 10 sin (ωt + 60°) + 4sin (3ωt + 30°) A and the voltage of u(t) = 10 + 100 sin (ωt + 15 o) + 40sin (3ωt) V are on the branch of electric circuit. Calculate powers P, Q, S.

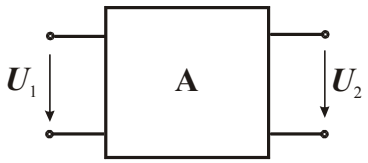
10. Solve a transient phenomena:
    a) calculate and draw graphs of time functions of voltage and current on the ideal coil,
    b) determine the time constant, explain it´s physical meaning and mark it´s value in the graph of voltage.



11. Define these terms:
    a) electric passive band pass filter,
    b) draw it´s attenuation frequency characteristics,
    c) draw a concrete connection of this filter.

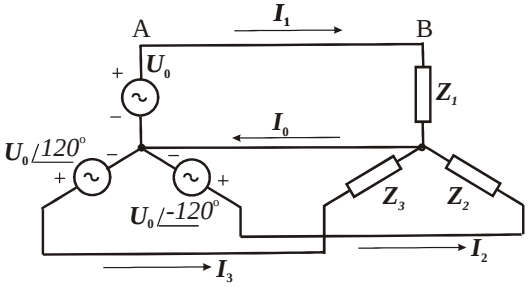
3 points

12. Two two-ports with cascade matrixes $\mathbf{A_1}$ and $\mathbf{A_2}$ are connected into cascade. Determine:
    a) the cascade matrix of the resulting connection **A,**
    b) the short circuit current transfer,
    c) calculate the amplitude of the input voltage U_1, if the amplitude of the output voltage is U_2 = 40 V when the two-port is loaded with $R_2 = 20\ \Omega$.



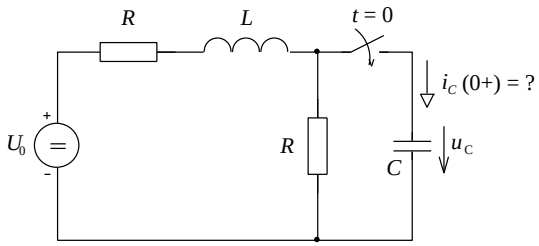
$$\boldsymbol{A}_1 = \begin{bmatrix} 2 & 30 \\ 0{,}1 & 2 \end{bmatrix} \quad \boldsymbol{A}_2 = \begin{bmatrix} 2 & 20 \\ 0{,}15 & 2 \end{bmatrix}$$

13. Symmetric three-phase voltage source (230/400V) connected into star powers a non-symmetric appliance with impedances $\mathbf{Z}_1 = 20\angle 30^o\ \Omega$, $\mathbf{Z}_2 = 10\angle 0^o\ \Omega$ and $\mathbf{Z}_3 = 10\angle -60^o\ \Omega$ connected into star (grounds of the voltage source are connected with the ideal conductor, $Z_N = 0$).
    a) calculate the current through the neutral conductor,
    b) draw the phasor diagram of voltages and currents on the phases of the appliance,
    c) determine the active power P and reactive power Q consumed by the appliance.



4 points

14. For the circuit given by the figure formulate equations for the solution of the transient phenomena for state quantities and write them in the matrix form.
    For the values U_0 = 100 V, $u_C(0) = 10$, L = 0,1 mH, C = 100μF, R = 20 Ω calculate:
    a) values $i_C\ (0+)$, $i_C\ (\infty)$, $u_C\ (\infty)$,
    b) the total energy accumulated in the circuit at the time t = 0,
    c) what is the character of the transient phenomena?

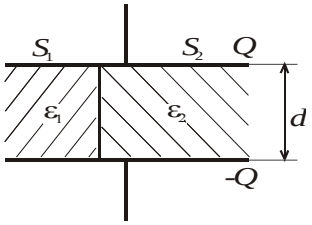


Sample exam: Electromagnetic field

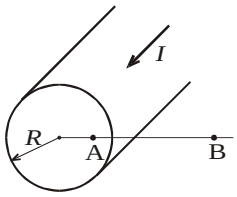
1 point

1. Draw lines of force and lines of equal potential in the surroundings of two point charges +Q and –Q placed in the distance of *d*. Write the equation, that investigates the distribution of the electric field. What is the character of this field (curl field or source field)?

2. Calculate the voltage between electrodes and the capacity of a plane double-layer capacitor, if the charge Q, geometrical dimensions and permittivities ε_1, ε_2 are given.



3. Determine the direction and the value of the magnetic field intensity ***H*** in the points A, B of a long cylindrical conductor with radius *R* and current *I*. Draw the graph of the function *H* (*r*).



4. Determine the force on the unit of length acting on the conductors of two-conductors-line , the current $i(t) = I_m \sin\omega t$ flows through the conductors. Draw the time function of the force F(t), draw the direction of the force and calculate the maximal value of the force F_{max}.

5. Explain the physical meaning of the skin-effect. What is the influence of the skin-effect on the resistance of conductors and on the Joule losses?

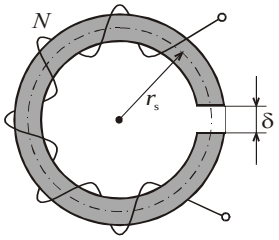
2 points

6. Coaxial cable with length ℓ = 10 m is connected to the voltage U = 1 kV and the leakage current in the insulation is I = 5 μA, radius of the cable core is a = 1 cm, inner radius of the coating b = 1,5 cm. Calculate:
   a) specific conductivity of the insulation γ,
   b) maximal value of the current density Jm of the leakage current
   c) Joule losses in the insulation

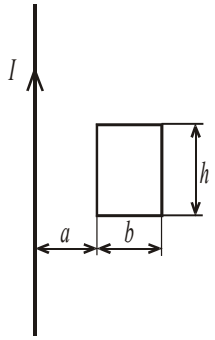
7. A coil is wired on the iron core with the cross-section S = 4 cm^2. The magnetic field induction in the coil core is B_m = 0,6 sin (ωt + 30°) T, the frequency of the harmonic change of the magnetic field induction is f = 100 Hz. Calculate the number of turns of the coil required to induce the voltage of effective (RMS) value 40V into the coil.

3 points

8. A coil with N = 200 turns is wired on the iron core (μr = 5000). The length of the air gap is δ = 5 mm, the cross section of the core is S = 2 cm^2, the mean radius of the core is r_s = 3 cm. Calculate:
   a) the current I required to generate a magnetic flux $\Phi = 2.10^{-4}$ Wb in the core,
   b) the inductance of the coil,
   c) the inductance of the coil, if the core is without the air gap.



9. Parallel to a long thin conductor with the current I lies in the same plane a rectangular coil with one turn. Determine :
   a) mutual induction M,
   b) the voltage induced into the coil, if the current through the conductor is(t) = I_m sinωt, draw the time function of the current i(t) and of the voltage induced into the coil, mark the time inte



Electrical measurements

Guarantor: **doc. Ing. Olga Tůmová, CSc.**, KET

1. Errors (sorted list of errors, errors spread through the calculation, errors of analog measurement devices, instrument accuracy classes, digital devices error evaluation).
2. Transducers for measurement (voltmeter and amperemeter measurement range changes, discussion about different methods for different systems, measurement voltage and current transformers, their features and working conditions).
3. Oscilloscope, analog and digital, block diagram and description of blocs, X-t, X-Y mode of measuring, utilization, probe diagram.
4. AC and DC measurement of electrical quantities (voltage, current, power – methods, measuring devices – principles, features).
5. Resistance and impedance measurements (measurement methods for R, L, C, M, Z measuring)

Electrical materials

Guarantor: **doc. Ing. Eva Kučerová, CSc.,** KET

1. Conductive materials, main properties, most common materials, utilization.
2. Magnetic materials, main parameters, partitioning.
3. Materials for electrical contacts, main features, utilization.
4. Inorganic insulators, features, most common insulators, area of utilization.
5. Organic insulation materials, main features, most common materials, utilization.

KAE /SBETK Electronics and Telecommunications

Electronics systems

Guarantor: **prof. Ing. Jiří Pinker, CSc.,** KAE

Lecturer: **Ing. Václav Koucký, CSc.,** KAE

Course: KAE/AES Analogue Electronic Systems

1. Silicon P – N junction diode, Schottky diode, Zener diode, LED diode, electrical characteristics (V-A, power dissipation).
2. Bipolar transistor, unipolar transistor MOSFET, function principles, V-A characteristics, limitations.
3. Feedback in electrical circuitry and its effect of circuitry parameters, electronic circuitry stability, stability estimation criterions.
4. Amplification stages coupling, Darlington pair, current mirror, power amplifiers classes and efficiency.
5. Operational amplifiers, simple operational amplifier connections, errors in OPAMP circuitry and their corrections, internal structure of OPAMP, dynamic parameters of OPAMP, frequency correction of OPAMP.
6. Comparators, function generators – nonlinearity implementation, relaxation generators, converters voltage – frequency and vice versa.
7. Oscillation theory, harmonic oscillators.
8. Analog multiplication principles, phase-locked loop.
9. Rectifiers, voltage multipliers, linear voltage regulator with feedback, over current protection, integrated voltage regulators.
10. Switching power supplies, DC-DC converters, forward converter, blocking converter.
11. D/A converters, principles, errors, circuitry schematics, A/D converters, flash type, successive approximation type, tracking type, integrating type and sigma – delta type.

Digital Electronic Systems

Guarantor a Lecturer: **prof. Ing. Jiří Pinker, CSc.,** KAE

Course: KAE/CES Digital Electronic Systems

1. Logic gates, general features, CMOS technology, nonstandard loads, output characteristics, not connected inputs, CMOS input protection.
2. Open collector and tristate devices, busses, termination.
3. LSI MSI logic devices, decoders, multiplexers, comparators, adders, priority circuits, flip – flops, timing, conditions of error free function.
4. Counters, registers, shift registers, Counter classification, asynchronous and synchronous counters, modulo and binary counters, counters applications, programmable frequency dividers, time measurement, frequency measurement, pulse width measurement, timers, pulse width modulators.
5. Combinatorial circuitry, description by truth table, formula, map, do not care states, synthesis of combinatorial circuits, minimization, hazards, its origin and removal, chained structures.
6. Sequential circuitry (synchronous), transition and output function, Mealy and Moore automaton, autonomous automaton, internal state coding design, clock and input signals timing, non-defined states, initial state setting.
7. Memories, RAM memory, static RAM, dynamic RAM, SDRAM, EDO, read/write cycles, refresh cycles at dynamic RAM, ROM, PROM, EPROM, EEPROM, FLASH, content programming.
8. Programmable logic devices, GAL, FPGA components.
9. Interference in digital systems, internal and external interference, coupling – capacitive, inductive, on parallel wires, recommendations for design of interference immune systems.

Communication systems

Guarantor: **doc. Ing. Jiří Masopust, CSc.,** KAE

Course: KAE/ZST Fundamentals of Telecommunications
KAE/OK Optical Communications
KAE/AVT Audio-Visual Technology

1. Signal spectrum, time diagram
2. Absolute and relative signal level, dB, attenuation and gain
3. Analog modulations AM, FM, PM; AM – time diagram, spectrum
4. Modulation speed, transition speed, channel capacity
5. Signal discretization, sampling, quantization, PCM, PWM
6. Discrete modulations with carrier frequency ASK, FSK, PSK, QAM
7. General scheme of the communication system, blocks description, example
8. Sharing of communication channels - TDM, FDM, CDM
9. Radio receiver, block diagram, description
10. Sound and picture recording (methods, technology)
11. TV systems, digital TV DVB
12. Optical communication systems, fiber optics, source and detectors of the optical signal

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