ISSUE № 5

ELECTRICAL ENGINEERING-2014

BULLETIN RNC CIGRE

ИГЭУ

Российский Национальный Комитет cigre Молодежная секция

НАДЕЖНАЯ СМЕНА Благотворительный фонд

ОАО «СО ЕЭС»

"IVANOVO STATE POWER ENGINEERING UNIVERSITY" (ISPEU)
JOINT-STOCK COMPANY "SYSTEM OPERATOR OF
THE UNITED POWER SYSTEM" (SO UPS)
"RUSSIAN NATIONAL COMMITTEE OF INTERNATIONAL COUNCIL ON
LARGE ELECTRIC SYSTEMS" (CIGRE RNC)
CHARITABLE FOUNDATION "RELIABLE RISING GENERATION"

BULLETIN

RUSSIAN NATIONAL COMMITTEE CIGRE

ISSUE № 5

INTERNATIONAL STUDENT COMPETITION "ELECTRICAL ENGINEERING-2014"

Russia, Ivanovo - 2014

"Russian National Committee of International Council on Large Electric Systems" (RNC CIGRE)
Joint-stock Company "System Operator of the United Power System" (SO UPS)
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RUSSIAN NATIONAL COMMITTEE CIGRE

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INTERNATIONAL STUDENT COMPETITION

«ELECTRICAL ENGINEERING-2014»

April 22-24, 2014, ISPEU

RUSSIA IVANOVO 2014

UDC 621.3.01
LBC 32.211
B 34
Russian national committee CIGRE bulletin // Issue № 5. Youth section RNC CIGRE proceedings: International student competition on theoretical and general electrical engineering «Electrical Engineering - 2014». – Ivanovo: Ivanovo State Power Engineering University, 2014 – 64 p.

In issue number 5 of the Bulletin RNC CIGRE the proceedings of the International competition on theoretical and general electrical engineering "Electrical Engineering - 2014" among the students of electrical and electrical power engineering programs of study organized by the youth section of RNC CIGRE and Ivanovo State Power University (ISPEU) are collected. The competition was held in Ivanovo, April 22-24, 2014.

The main objectives of the Competition - to increase educational process effectiveness of electrical engineering and electrical power engineering programs of study, to make students interested in their future work, to find out talented students, to form personnel reserve for power engineering facilities.

Presented proceedings include regulations, information documents and competitive tasks of the Competition, which can be used as a methodological basis for the preparation and carrying out similar events. The Appendix presents tasks of different complexity levels with the solutions that have been proposed at the competitions on theoretical and general electrical engineering, which can be useful for students' self-tuition.

The issue is intended for students and teachers of electrical power engineering and electrical engineering higher educational institutions, as well as for a wide range of people interested in theoretical electrical engineering.

ISBN

«ELECTRICAL ENGINEERING-2014»: GENERAL INFORMATION

Introduction

Russian National Committee of International Council on Large Electric Systems” (RNC CIGRE) and Ivanovo State Power Engineering University (ISPEU) in accordance with the plan of joint arrangements for the year of 2014 with the support of Joint-stock Company “System Operator of the United Power System” and Charitable foundation “Reliable Rising Generation” successfully held *The Annual International Student Competition on Theoretical and General Electrical Engineering* at Faculty of Electrical Power Engineering (Ivanovo State Power Engineering University, ISPEU) on 22-24 of April 2014.

The main objectives of the Competition - to develop individual creative thinking, to increase educational process effectiveness of electrical engineering and electrical power engineering programs of study, to make students interested in their future work, to find out talented students, to form personnel reserve for power engineering facilities.

The main contents and the results of work

Preparations for the Competition began in November 2013.

More than 40 Russian and foreign higher educational institutions, which prepare specialists in electrical engineering sphere, were invited to take part in this Competition. Many of them became interested in this arrangement and 20 higher educational institutions applied for their taking part in it.

The Competition Opening Ceremony

The welcoming speech of Vladimir Tyutikov, the Vice-rector for Research of ISPEU

The welcoming speech of Alexander Sorokin, the Dean of ISPEU Electrical Power Engineering Faculty

The welcoming speech of Arkadiy Makarov, the Coordinator of RNC CIGRE Youth Section, Head of the Competition organization, ISPEU

The welcoming speech of Darya Morozova, the Coordinator of the Competition

According to the Competition regulations, the teachers of Department of Electric Engineering and Electrotechnics Foundations of Electrical Engineering faculty (ISPEU) prepared 7 qualification tasks on 4 main sections of theoretical basics of electrical engineering (TBEE) course:

- DC circuits,
- AC circuits including non-sinusoidal current,
- Three-phase circuits,
- Transients in linear electric circuits.

The teachers from Saint Petersburg Electrotechnical University, National Research Tomsk Polytechnic University, Ural Federal University and other higher educational institutions also prepared tasks.

ISPEU has formed the team to participate in the Competition. It was organized according to the results of the ISPEU Open Competition on TBEE. Training lessons for better preparation of ISPEU students for the international competition were organized.

The announcements for students and guests with all the necessary information about the Competition were prepared and placed on the stands in all ISPEU buildings 7 days before the Competition started. The information about the Competition was also posted on ISPEU and CIGRE official sites.

Mobile stands with the symbols of ISPEU, sponsors and the Competition were also made. On 20-22 April, the meeting of the participating teams and their accommodation in *Ivanovo* hotel was organized. The coach tour around Ivanovo for the participants was held on April 22.

The competition itself took place on April 23, 2014 in rooms B-301, B-316.

During the Competition

Teams from 19 higher educational institutions took part in it:

- Kazakh National Technical University (Almaty, Kazakh Republic)
- Belarusian National Technical University (Minsk, Republic of Belarus)
- Vologda State University (Vologda, Russia)
- South-Russian State Polytechnic University (Novocherkassk, Russia)
- Kovrov State Technological Academy (Kovrov, Russia)
- Ivanovo State Power Engineering University (Ivanovo, Russia)
- Kazan State Energetic University (Kazan, Tatarstan Republic)

- Saint Petersburg Electrotechnical University “LETI” (Saint-Petersburg, Russia)
- Novosibirsk State Technical University (Novosibirsk, Russia)
- National Mineral Resources University «University of Mines» (Saint-Petersburg, Russia)
- Samara State Technical University (Samara, Russia)
- National Research Tomsk Polytechnic University (Tomsk, Russia)
- Rybinsk State Aviation Technical University (Rybinsk, Russia)
- Ivanovo State University of Chemistry and Technology (Ivanovo, Russia)
- Kostroma State Agricultural Academy (Kostroma, Russia)
- National Research Irkutsk State Technical University (Irkutsk, Russia)
- Penza State University (Penza, Russia)
- Ural Federal University (Yekaterinburg, Russia)
- National Research South-Ural State University (Chelyabinsk, Russia)

121 students took part in the individual championship.

Not only ISPEU teachers formed the jury, but also leaders of all teams. The jury checked up and assessed the works in chippering mode, that’s why the intrigue remained until the decryption of the works and debriefing.

The coach tour to Kostroma State District Power Plant was held for the participants right after the Competition.

Team championship results:

Place	Higher educational institution
I	Novosibirsk State Technical University
II	Ural Federal University
	Ivanovo State Power Engineering University
III	Saint Petersburg Electrotechnical University "LETI"
	Kazan State Energetic University
	Belarusian National Technical University
IV	National Research Tomsk Polytechnic University
V	South-Russian State Polytechnic University
VI	National Research South-Ural State University
VII	National Research Irkutsk State Technical University
VIII	Penza State University
IX	Samara State Technical University
X	Kazakh National Technical University
XI	National Mineral Resources University «University of Mines»
XII	Kostroma State Agricultural Academy
XIII	Rybinsk State Aviation Technical University
XIV	Kovrov State Technological Academy

The results of the individual championship:

Place	Name Surname	Higher educational institution
I	Gleb Nesterenko	Novosibirsk State Technical University
II	Roman Tjutin	Novosibirsk State Technical University
III	Ilya Tarasov	National Research Irkutsk State Technical University

The 4th year ISPEU student, Sergei Kononov was ahead of overall ranking. However, according to the rules of procedure he was not able to participate in individual and team championship. That's why the jury made the decision to award him with the diploma "For the 1st Prize on overall ranking" and JSC "Territorial Generating Company #2" presented him the certificate for 10000 rubles.

The rewarding of the competition participants took place April 24, 2014. The winners were awarded with the diplomas, presents and books on electrical engineering.

The winners' awarding

The congratulation speech of Arkadiy Makarov, the Head of the Competition organization, ISPEU

The congratulation speech of the representative of JSC "System Operator of United Power System"

The congratulation speech of V.Y. Ilushko, the deputy chief engineer of JSC "Territorial Generating Company #2"

The awarding of Sergey Kononov, the student of ISPEU, for the 1st prize in overall ranking

Sergey Tararykin the rector of ISPEU awarded the winners of the Competition

The awarding of Ilya Tarasov, the student of National Research Irkutsk State Technical University, for the 3rd prize

The awarding of Roman Tutin, the student of Novosibirsk State Technical University, for the 2nd prize

The awarding of Gleb Nesterenko, the student of Novosibirsk State Technical University, for the 1st prize

The awarding of students of Belarusian National Technical University for the 3rd prize in the team championship

The awarding of students of Saint Petersburg Electrotechnical University “LETI” for the 3rd prize in the team championship

The awarding of students of Ivanovo State Power Engineering University for the 2nd prize in the team championship

The awarding of students of Ural Federal University for the 2nd prize in the team championship

The awarding of students of Novosibirsk State Technical University for the 1st prize in the team championship

After the rewarding the round-table discussion *Electrotechnical Education: Problems and Prospects* were organized. The team leaders noted a high level of the Competition organization, the opportunity to communicate with each other, discussed the plans for the future partnership and offered to make the Competition annual.

The round-table discussion with the team leaders

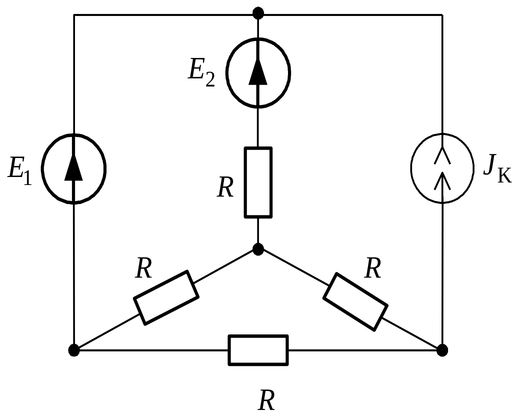
The results of the competition were posted on CIGRE Russian National Committee and ISPEU official sites.

Conclusion

There were no serious issues or failures during the organization and holding of the competition. All the participants noted a high level of preparation. The experience of using the competition tasks prepared by the teachers of participating higher educational institutions was very successful. There was an offer to make the competition annual. It seems to be appropriate to increase the number of participants from other countries and areas such as the Far East, France, Germany, and China.

QUALIFICATION TASKS WITH THE SOLUTIONS

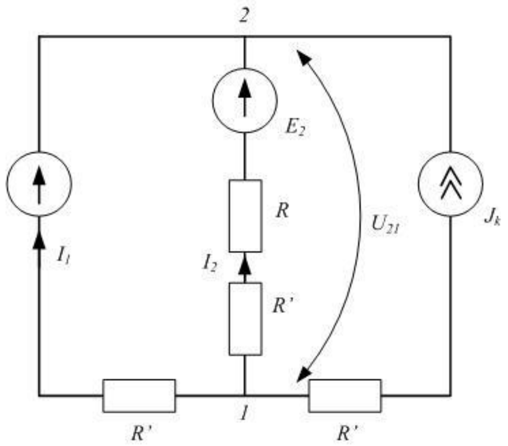
Task 1



In DC linear circuit $J_К = 1\,[A]$, $R = 30\,[Ohm]$, $E_2 = 0{,}5 \cdot E_1$, *the total power of voltage sources is* $\sum P_E = 9{,}5\,[Watt]$.

The task is to determine the magnitude E_1.

Solution:



$$R + R' = 30 + 10 = 40\ [Ohm] = 4R';$$

$$R \to R'; R' = \frac{R}{3} = \frac{30}{3} = 10\ [Ohm].$$

$$U_{21} = \frac{E_1 \frac{1}{R'} + E_2 \frac{1}{4R'} + J_K}{\frac{1}{R'} + \frac{1}{4R'}} =$$

$$= \frac{\frac{1}{4R'}(4E_1 + 0{,}5E_1 + 4J_K R')}{\frac{5}{4}R'} = 0{,}9E_1 + 8.$$

Ohm’s law:

$$\left.\begin{aligned} I_1 &= (E_1 - U_{21})\frac{1}{R'} = (E_1 - 0{,}9E_1 - 8)\frac{1}{10} = 0{,}01E_1 - 0{,}8, \\ I_2 &= (E_2 - U_{21})\frac{1}{4R'} = (0{,}5E_1 - 0{,}9E_1 - 8)\frac{1}{40} = -0{,}01E_1 - 0{,}2; \end{aligned}\right\} \to I_1 + I_2 = -I_{\hat{E}}.$$

$$0{,}01E_1 - 0{,}08 - 0{,}01E_1 - 0{,}2 = -1 = -J_K;$$

$$P_{E1} = E_1 I_1 = E_1(0{,}01E_1 - 0{,}8);\ P_{E2} = 0{,}5E_1 I_2 = 0{,}5E_1(-0{,}01 - 0{,}2);$$

$$\sum P_E = E_1(0{,}01E_1 - 0{,}8 - 0{,}005E_1 - 0{,}1) = 0{,}005E_1(E_1 - 180) =$$

$$= 0{,}005(E_1^2 - 180) = 9{,}5\ [Watt];$$

$$E_1^2 - 180E_1 - \frac{95}{0{,}005} = 0;$$

$$E_1^2 - 180E_1 - 1900 = 0.$$

$$X \to E_1;$$

$$X_{1;2} = 90 \pm \sqrt{8100 + 1900} = 90 \pm 100 \to E_1 = 90 \pm 100\ [V];$$

$$E_1 = 190\,[V],\ E_2 = 95\ [V];$$

$$I_1 = 0{,}01 \cdot 190 - 0{,}8 = 1{,}1\ [A];\ I_2 = -0{,}01 \cdot 190 - 0{,}2 = 2{,}1\ [A];$$

$$\sum P_E = 190 \cdot 1{,}1 - 95 \cdot 2{,}1 = 9{,}5\ [Watt];$$

$$E_1 = -10\ [V],\ E_2 = -5\ [V];$$

$$I_1 = 0{,}01 \cdot (-10) - 0{,}8 = -0.9\ A;\ I_2 = 0{,}01 \cdot 10 - 0{,}9 = -0{,}1\ [A];$$

$$\sum P_E = (-10) \cdot (-0{,}9) + (-5) \cdot (-0{,}1) = 9{,}5\,[Watt].$$

The answer:

$$E_1 = 190\ [V],\ E_2 = 95\ [V];$$

$$E_1 = -10\ [V],\ E_2 = -5\ [V].$$

Task 2

Coil resistance under the frequency of ω_0 is twice less than its inductive reactance. How the current frequency must be varied for the power factor increases twice?

Assumption: cable resistance is independent from frequency.

Solution

Under the conditions of the task: $2r = \omega_0 L.$

At the same time $\cos\varphi = \frac{r}{\sqrt{r^2 + \omega_0 L^2}} = \frac{r}{\sqrt{r^2 + 4r^2}} = \frac{1}{\sqrt{5}}.$

To increase the power factor twice, let’s vary current frequency in **k**-times.

As a result for **k** determining we have the correlation:

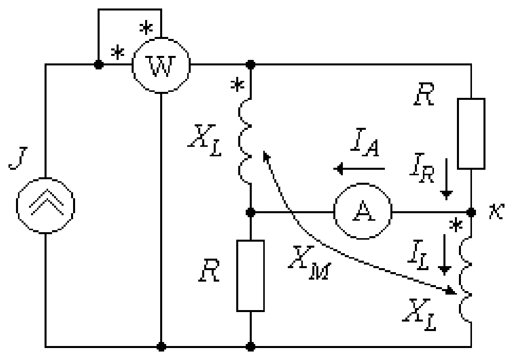
$$\frac{r}{\sqrt{r^2 + 4r^2}} = \frac{2}{\sqrt{5}} = \frac{r}{\sqrt{r^2 + k^2 \omega_0 L^2}} = \frac{1}{\sqrt{1 + 4k^2}};$$

$$(\frac{2}{\sqrt{5}})^2 = (\frac{1}{\sqrt{1+4k^2}})^2;$$

$$4+16k^2 = \frac{1}{16} k = 0,25.$$

The answer: *Frequency must be decreased 4 times.*

Task 3



In sinusoidal current linear circuit with current source J and resistances $R = X_M = X_L = 50$ [Ohm] the wattmeter shows the power of $P_W = 80$ [Watt].

The task is to determine the ammeter reading of the electromagnetic system and the current magnitude of current source J.

Solution

When compiling the loading diagram the wattmeter and the ammeter are taken away as structural components. The wattmeter reading P_W is determined as the power, which is spread at pure resistances R, and the ammeter reading being the current through the bridge simulating a measuring instrument. The elements X_L and R on the diagram trade places (fig. 1). Then let's do the inductive isolation (fig. 2). As the elements $2X_L$and R (fig. 2) form a balanced bridge ($2jX_L \cdot R = 2jX_L \cdot R$), then the voltage $U_{ab} = 0$ and the current $I_{ab} = 0$. According to the compensating substitution method the element – X_L with the current $I_{ab} = 0$ are substituted with the current source with the current $J_{ab} = 0$, and after that, according to the equivalent substitution method it is substituted with the breakage between the points a and b (fig. 3).

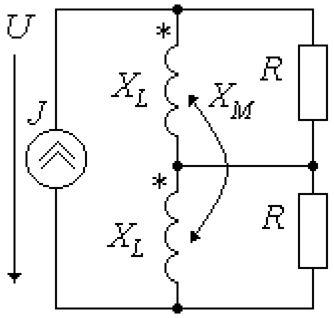


Fig. 1

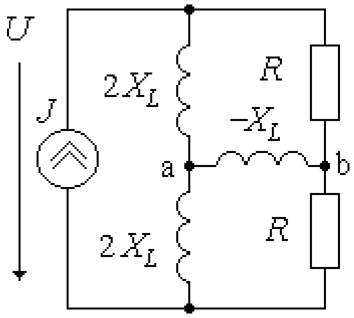


Fig. 2

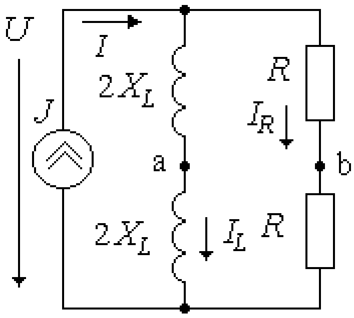


Fig. 3

In the diagram of fig. 3 using the known active power we determine the voltage U and the current I_R, and after that we find I_L and I:

$$U = \sqrt{2RP_W} = \sqrt{2 \cdot 50 \cdot 80} = 40\sqrt{5}\ [V];$$

$$I_R = \sqrt{P_W/(2R)} = \sqrt{80/(2 \cdot 50)} = 2\sqrt{0,2}\ [A];$$

$$I_L = U/(4X_L) = 40\sqrt{5}/(4 \cdot 50) = 0,2\sqrt{5}\ [A].$$

Because of $\dot{U} = U$ current complex is $\dot{I} = I_R - jI_L$, then

$$I = \sqrt{I_L^2 + I_R^2} = \sqrt{(0,2\sqrt{5})^2 + (2\sqrt{0,2})^2} = \sqrt{0,2 + 0,8} = 1\ [A].$$

Thus,

$J = I = 1\ [A]$.

The ammeter reading is determined according to ***Kirchhoff's first law*** for the component ***"κ"*** of the diagram fig. 3:

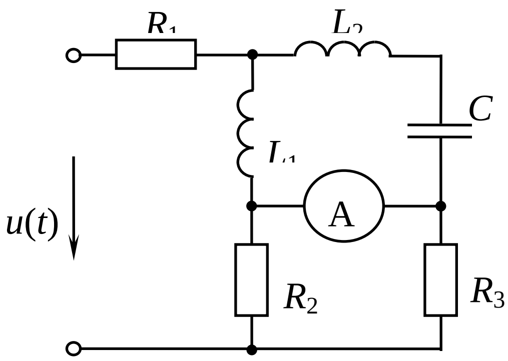
$$\dot{I}_A = \dot{I}_R - \dot{I}_L = I_R + jI_L.$$

Current module

$$I_A = \sqrt{I_R^2 + I_L^2} = 1\ [A].$$

The answer: $J = 1\ [A]$; $I_A = 1\ [A]$.

Task 4



There is a source of non-sinusoidal voltage in the circuit:

$$u(t) = 120 + 180\sqrt{2}\,sin(100t - 65^o) - $$
$$-160\sqrt{2}\,sin(200t + 25^o)\ [V].$$

The characteristics of passive elements in the circuit are following: R_1 = 10 *[Ohm];* $R_2 = R_3$ = 20 *[Ohm]; L* = 0,45 *[H];* L_2 = 0,15 *[H]; C* = 166,7 *[μF].*

The task is to determine the ammeter reading of the electromagnetic system.

Solution

The standard solution with the method of superposition

u = 120 *[V]* = const $\quad I_{A(B)} = \dfrac{120}{(R_1 + 0{,}5R_2)\,2} = 3\ [A];$

$u(t)$ = 180 √2 sin 100*t[V]*. The starting phase may be not taken into account.

$X_{L1(1)}$ = 45 *[Ohm]*, $X_{L2(1)}$ = 15 *[Ohm]*, $X_{C(1)}$ = 60 *[Ohm]*.

The overhead parallel circuit is a breakage for the outside current, but there is current in the circuit itself:

$$I_{A(1)} = 180/X_{L1(1)} = 4\,[A].$$

$u(t)$ = 160 √2 sin 200 *t[V]*; $X_{L1(2)}$ = 90 *[Ohm]*, $X_{L2(2)}$ = 30 *[Ohm]*,

$X_{C(2)}$ = 30 *[Ohm]*.

L_2 and *C* form the bridge: $I_{A(2)} = \dfrac{160}{(R_1 + 0{,}5R_2)2} = 4\ \ [A].$

$$I_A = \sqrt{I^2_{A(0)} + I^2_{A(1)} + I^2_{A(2)}} = 6{,}4\ [A].$$

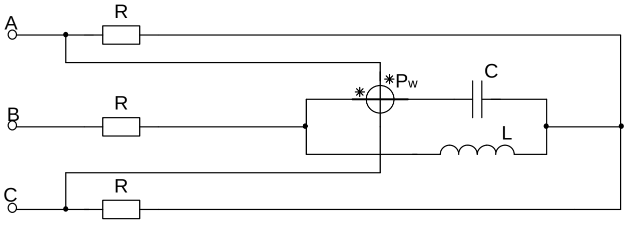
The answer: $I_A = 6.4\ [A].$

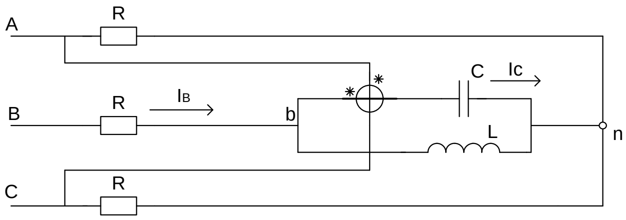
Task 5

The linear voltage in the three-phase circuit is $U_{Li} = 380$ *[V]. The resistances of resistors, a coil and a capacitor are*

$R = X_L = X_C = 100$ *[Ohm].*

Determine the wattmeter readings.

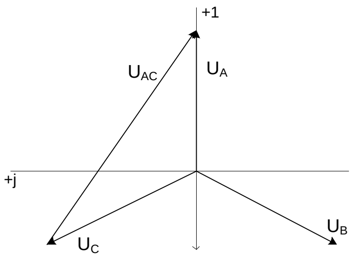


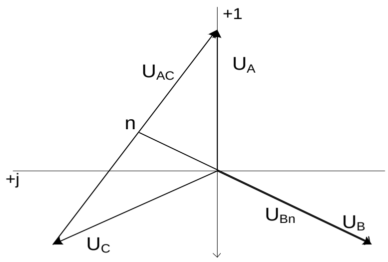


Solution

1) $P_W = Re\{U_{AC} * I_C\};$

$U_{AC} = U_{Li} e^{-j30^0};$





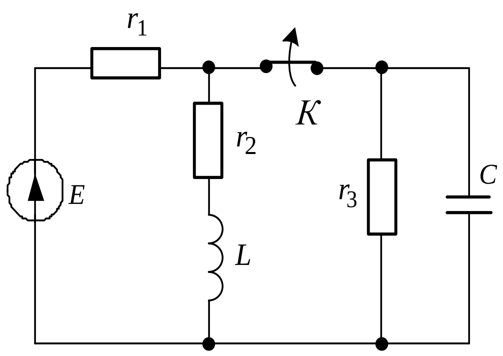
2) As $X_L = X_C$, then $I_B = 0$. Thus, $\varphi_b = \varphi_B$,

$$U_{bn} = \frac{3}{2} U_B = \frac{3}{2} \frac{U_{Li}}{\sqrt{3}} e^{-j120^0} = \frac{\sqrt{3}}{2} U_{Li} e^{-j120^0};$$

3) $$I_C = \frac{U_{bn}}{-jX_C} = \frac{\frac{\sqrt{3}}{2} U_{Li} e^{-j120^0}}{X_C e^{-j90^0}} = \frac{\sqrt{3}}{2} \frac{U_{Li}}{X_C} e^{-j30^0};$$

4) $$P_W = Re\left\{ U_{Li} e^{-j30^0} \frac{\sqrt{3}}{2} \frac{U_{Li}}{X_C} e^{j30^0} \right\} = \frac{\sqrt{3}}{2} \frac{U_{Li}{}^2}{X_C} = \frac{\sqrt{3}}{2} \frac{380^2}{100} = 1250.54 \text{ [W]}.$$

The answer: $P_W = 1250.54$ *[W].*



Task 6

After the disjunction the current through the inductance in the transient is $i_L(t) = 2 - 0{,}5e^{-300t}$ *[A] ;*

$r_1 = 10$ *[Ohm] ;* $L = 0{,}1$ *[H] ;*

$C = 50$ *[μF];* $E = const$.

The task is to determine the voltage on the capacity $u_C(t)$ *during the transient.*

Solution

$$p_1 = -300 = -\frac{r_{equiv}}{L} = -\frac{R_1 + R_2}{L} = -\frac{10 + R_2}{0{,}1} \Rightarrow R_2 = 20\ [Ohm];$$

$$i_{Lforced} = \frac{E}{R_1 + R_2} = \frac{2(R_1 + R_2)}{R_1 + R_2} = 2\ [A];$$

$$i_L(+0) = 2 - 0{,}5 = 1{,}5\ [A];$$

$$i_L(+0) = i_L(-0) = \frac{E}{R_1 + \frac{R_2 R_3}{R_2 + R_3}} \frac{R_3}{R_2 + R_3} = 1{,}5 \Rightarrow R_3 = 20\ [Ohm];$$

$$u_C(t) = u_{Lforced} + u_{Ctransient} = 0 + Ae^{p_2 t};$$

$$p_{1,2} = -\frac{1}{R_{equiv}C} = -\frac{1}{R_3 C} = -\frac{10^6}{20 \cdot 50} = -1000\ [\frac{1}{sec}].$$

The answer: $u_C(t) = 30e^{-1000t}$ *[V].*

Task 7

*There is a commutation of the switch **"K"** in DC circuit (fig. 1) with the characteristics $L = 0{,}9$ [H], $C = 10^{-3}$ [F], $R_1 = R_2 = R$ under $t = 0$. Voltage transient $u_{ab}(t)$ is shown on fig. 2.*

Determine the resistance parameters R_1, R_2, $R_3$and R_4.

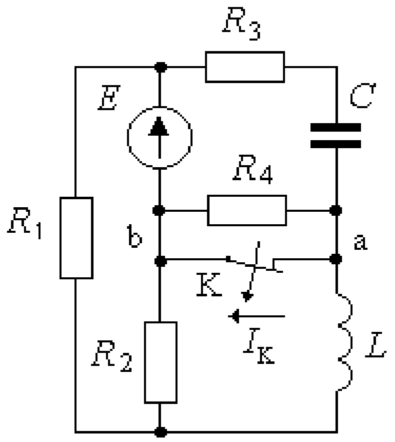


Fig. 1

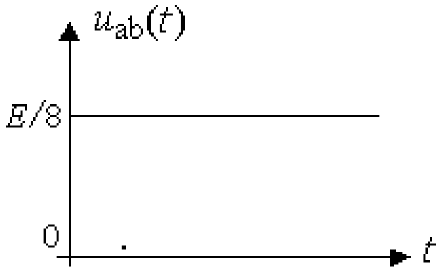


Fig. 2

Solution

The commutation starting conditions are not zero ones, that is why, in order to include $u_{ab}(t)$ into the calculation we shall use the method of reduction to the starting conditions, thus, let's determine the voltage $u_{ab}(t)$ as the sum

$u_{\text{ab}}(t) = u_{\text{ab}}^{(\text{o})}(t) + u_{\text{ab}}^{(\text{k})}(t)$, where

$u_{\text{ab}}^{(\text{o})}(t) = 0$ – is the voltage when the commutation of the switch is absent;

$u_{\text{ab}}^{(\text{k})}(t)$ – is the voltage when the commutation of the switch is present.

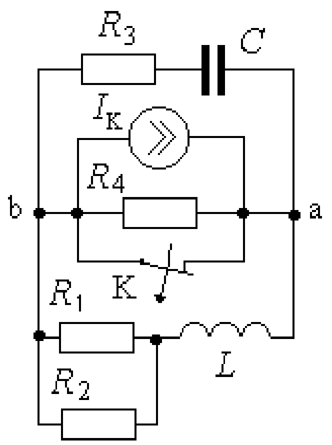


Fig. 3

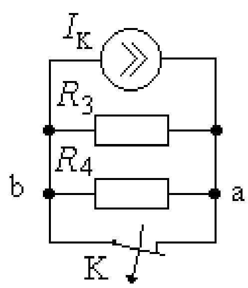


Fig. 4

The voltage $u_{\text{ab}}^{(\text{k})}(t)$ calculation is done in the diagram, given on fig. 3. The diagram is formed from the one (fig. 1) by voltage zeroing ($E = 0$) and switching in parallel the switch K and the current source $I_{\text{K}} = E/R_1$, which is directed as the opposed one to the current I_k in the diagram fig. 1.

The transient will look like as

one shown on fig. 2, if there is an indifferent resonance in the diagram, that is

$$R_3 = \frac{R_1 R_2}{R_1 + R_2} = R/2 = \sqrt{L/C} = 30 \ \textit{[Ohm]}.$$

Consequently, $R_1 = R_2 = R = 60$ *[Ohm]*.

The diagram under the indifferent resonance is shown on fig. 4. The voltage as the result of commutation is

$$u_{\text{ab}}(t) = u_{\text{ab}}^{(\text{k})}(t) = I_{\text{K}} \frac{R_3 R_4}{R_3 + R_4} = \frac{E}{8}.$$

Having done the substitution $I_{\text{K}} = E/R_1$, we get

$$\frac{E}{R_1} \frac{R_3 R_4}{R_3 + R_4} = \frac{E}{8}.$$

Subject to numerical values of $R_1$and R_3 there will be

$$\frac{E}{60} \cdot \frac{30 R_4}{30 + R_4} = \frac{E}{8}.$$

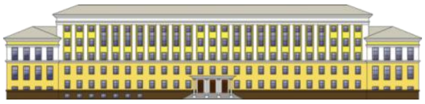
Hence,

$$4R_4 = R_4 + 30; \quad R_4 = 10 \ \textit{[Ohm]}.$$

The answer: $R_1 = R_2 = 60$ *[Ohm]*; $R_3 = 30$ *[Ohm]*; $R_4 = 10$ *[Ohm]*.

Appendix 1

INFORMATION LETTER



"Ivanovo State Power Engineering University" (ISPEU)
Joint-stock Company "System Operator of the United Power System" (SO UPS)
"Russian National Committee of International Council on Large Electric Systems" (CIGRE RNC)

ELECTRICAL ENGINEERING-2014
INTERNATIONAL STUDENT COMPETITION
ON THEORETICAL AND GENERAL ELECTRICAL ENGINEERING
IVANOVO, RUSSIA
April 22-24, 2014

INFORMATION LETTER

International Student Competition on Theoretical and General Electrical Engineering

April 22-24, 2014, Ivanovo, Russia

According to the plan of joint arrangements for the year of 2014 Ivanovo State Power Engineering University (ISPEU) and CIGRE Russian National Committee (RNC) with the support of System Operator of the United Power System (SO UPS), JSC "Territorial Generating Company #2" and JSC "Russian Grids" hold the International Student Competition on Theoretical and General Electrical Engineering among the students of electrotechnical and electrical power engineering specialties.

The aim

Improving the quality of electrotechnical and electrical power programs of study, increasing students' interest for their profession, finding out talented young people and forming personnel potential to organize research, project and administrative production activity.

The program of the competition

April 22 arrival and registration of the participants;

April 23 the Competition holding;

April 24 the closing ceremony of the Competition, the winners' awarding, the departure.

Language

Russian

The place of the Competition

Lecture-rooms in ISPEU (34, Rabfakovskaya Str., Ivanovo, Russia).

Staying: ISPEU and Ivanovo hotels.

The terms of the Competition

The participants of a team are full-time students studying theoretical basics of electrical engineering (general electrical engineering) **in the current academic year**. The Competition has the individual and the team championship. The number of the participants from every higher educational institution is not more than 7 students. Total number of points in team championship is a sum of five best student points. If the team consists of less than 4 students, they can take part only in the individual championship. Each participant should have a passport and student's card (or academic record book). A leader who is a teacher or a staff member of a higher educational institution represents the team. The leader is the member of the jury of the Competition.

The Competition tasks may be the ones prepared by the teachers of the theoretical basics of electrical engineering of other higher educational institutions, which take part in the competition. In order to take part in the Competition it is necessary to fill in the application form and send it on e-mail: cigre@ispu.ru. The deadline is **March 5, 2014**.The tasks to be included in the list of the Competition tasks should be sent on e-mail: olimpiada@toe.ispu.ru, not later than **March31, 2014**.

The participation in the Competition is confirmed with the application form on the higher educational institution note-paper certified by a person in charge and the seal of the institution (it may be sent by mail or taken to the organizational committee by the team leader). The participation in the Competition is free. The expenditure for meals, travel and lodging are at the expense of the funds of the sending institution. To reserve the hotel it is necessary to send the application form before **05.03.2014 г**. Team leaders and students' are to stay in ISPEU and Ivanovo hotels. The coach tour to Kostroma

State District Power Plant is included into the cultural program of the Competition.

Tasks subjects

1. DC circuits.
2. AC circuits including non-sinusoidal current.
3. Three-phase circuits.
4. Transients in linear electric circuits of the first and the second order.

Important dates

1.	The application form for taking part in the Competition	**deadline 05.03.2014**
2.	The application form for hotel reservation	**deadline 02.04.2014**
3.	The participants' arrival and registration	**22.04.2014г.**
4.	The Competition holding	**23.04.2014г.**
5.	Closing ceremony of the Competition, the winners' awarding, the departure	**24.04.2014г.**

THE ORGANIZATIONAL COMMITTEE

Vladimir Tyutikov,

The Chairman of Organizational Committee of the Competition, the vice-rector for Research of ISPEU.

Andrey Gofman,

The Vice-chairman, the leader of the organizational committee of Youth Section of CIGRE Russian National Committee

Arkadiy Makarov,

The vice-chairman, the head of the Competition organization,

Ph. +7 (4932) 269-945, +7-920-671-45-37, e-mail: makarov@ispu.ru

Appendix 2

THE COMPETITION RULES OF PROCEDURE

RULES OF PROCEDURE
INTERNATIONAL STUDENT COMPETITION
ON THEORETICAL AND GENERAL ELECTRICAL ENGINEERING

1. GENERAL RULES

1.1. International student competition (ISC) is held as a competition for students in creative application of knowledge and skills received in higher educational institutions while studying different subjects, as well as the professional readiness of future specialists.

1.2. ISC is held in order to improve the process of learning as well as improving the quality of specialists’ preparation, increasing students’ interest for their profession, finding out talented young people and forming personnel potential to organize research, administrative, production and business activity.

1.3. According to the plan of youth arrangements of the Youth section of CIGRE Russian National Committee (RNC) Ivanovo State Power Engineering University holds the International Student Competition on Theoretical and General Electrical Engineering (hereinafter referred to as Competition) among the students of electrotechnical and electrical power specialties.

2. THE COMPETITION ORGANIZATION

2.1. The organizer of the Competition is Non-commercial partnership “International Council on Large Electric Systems, Russian National Committee” (Moscow, CIGRE RNC) and Ivanovo State Power Engineering University (Ivanovo, ISPEU).

2.2. The organizational committee, which is formed by ISPEU vice-rector on the research work, realizes general management and the Competition organization. The chairman of the organizational committee is ISPEU vice-rector on the research work.

2.3. The organizational committee of the Competition:

- works out “*The Regulations on International Student Competition on Theoretical and General Electrical Engineering”*
- carries out the preparatory arrangements before the Competition;

- determines the dates of the Competition, provides the working places and technical equipment for the Competition;
- informs potential participants (electrotechnical higher educational institutions) about the Competition;
- forms the jury of the Competition, the credentials committee, the appeal committee;
- organizes the acceptance and processing of applications for the participation in the Competition;
- takes the decision on the admission to participate in the Competition;
- organizes and carries out the rewarding of winners;
- publicizes the information about the results of the Competition and its winners.

2.4. The jury of the Competition:

- is formed from the specialists on electrical engineering from ISPEU and other higher educational institutions, whose students take part in the Competition;
- works up and approves theoretical and practical tasks according to the State educational standard;
- works up mark system in points in accordance with the difficulty of the task;
- checks up and assesses the works of the participants in a ciphering mode;
- analyzes completed tasks, determines the winners.

2.5. The Credentials committee:

- consists of the representatives of ISPEU;
- checks up the authorities of the participants of the Competition;
- carries out the encrypting and decrypting of works.

The members of the credentials committee do not belong to the jury.

2.6. The appeal committee:

- consists of the specialists of ISPEU and the team representatives of other higher educational institutions (which take part in the Competition);
- examines conflict questions of the participants of the Competition.

2.7. In addition to the members from ISPEU the jury also consists of the team representatives or teachers from other higher educational institutions, which take part in the Competition.

2.8. The Competition tasks can include the tasks worked out by the electrical engineering specialists from other higher educational institutions, which are the participants of the Competition;

2.9 Appeals may be lodged not later than 10 p.m. the next day.

2.10. The meeting of the organizational committee, the jury, the credentials committee and the appeal committee are recorded and signed by the chairman of the organizational committee.

2.11. The winners are awarded with financial prizes and diplomas: the first prize is 5 000 rubles, the second prize – 3 000 rubles, the third prize – 1 000 rubles.

2.12. Photos and brief information about the winners, who placed high, can be placed on the official site of CIGRE RNC.

2.13. Photos and brief information about the winners can be given to the personnel departments of organizations of electrical engineering sphere.

2.14. The documents and materials connected with the Competition carrying out, are kept in the organizational committee during 1 (one) year after the date of taking decision about the summing-up and winners determining.

3. THE COMPETITION HOLDING PROCEDURE

3.1. The terms of the Competition holding

The participants of a team are full-time students studying electrical engineering in the current academic year. The Competition has individual and the team championship. The number of the participants from every higher educational institution is not more than 7 students. Total number of points in team championship is a sum of five best student points.

A leader who is a teacher or a staff member of a higher educational institution represents the team. The leader is the member of the jury of the Competition. Each participant should have a passport and student's card (or academic record book).

As an exception the higher educational institution that is the organizer of the Competition, is allowed to present two teams.

3.2. Methods and the Competition holding procedure

Competition participants take seats in such a way as to prevent communication between the team members of one institution.

Before entering the lecture-hall, students are registered in participant list of the Competition. After the registration, they are given personal cipher and an envelope that contains title-pages, rough and fair sheets. The list with the surnames and personal ciphers is sealed into the envelope and kept at the chairman of the Credentials committee. Statement of a problem and the table with the place for the participant's personal cipher are printed on the title-pages. Participants of the Competition fill in the title-page (insert their personal ciphers into the table), which are handed in with rough and fair sheets. When the time of competition start is announced, the students are allowed to open the envelopes and begin to solve the qualification tasks. The solution is written on title-pages and fair sheets on both sides.

When solving the problems, the students are allowed to use printed and written sources of information, nonprogrammable calculators, but it is forbidden to use mobile phones, notebooks and other electronic communications facilities. The jury can disqualify the participant or the team that violate this requirement.

When the time of the Competition is up, the participants put their title-pages and sheets into the envelope, and hand it in. Fair sheets are handed to the members of the jury to check them up. Rough sheets are put into another envelope and are also given to the members of the Competition jury.

3.3. Checking up and the assessment of the works

The members of the jury check up the works and put the number of points got for the work in the spreadsheet opposite the cipher of this work not later the next day after the Competition holding. They also sign in the spreadsheet opposite their records.

When assessing the works the members of the jury take into consideration:

1. The quality of students' material understanding;
2. The level of knowledge should be higher than it is necessary for the curriculum;
3. A creative approach in choosing the ways of solving the problems given.

The report of the Competition holding is filled in and signed first by the Coordinator of the Competition and then by all the members of the Competition jury.

The winners are determined after filling the column "The Number of Points" in the spreadsheet.

If several students pretend to be the laureates, having got the same number of points, the jury reassesses their works up and determines the first three winners after the comparative analysis of their fair and rough sheets. In this case, the decision of the jury is recorded specially as well as the opinion of individual members of the jury. The reassessing of the works of possible laureates is done before the deciphering.

The deciphering of all the works is done only after the spreadsheet is filled in completely and the winners are determined.

3.4. Determination of the winners

Leaders in personal championship are determined according to the sum of the points got for the solution of each task. The winners (the 1st, the 2nd and the 3rd prizes) are determined among the students of higher educational institutions according to the sum of the number of points.

The place of the higher educational institution in team championship is determined according to the sum of the points received by members of the team.

The final results of the Competition form report and ISPEU vice-rector for research approves it.

Winners of the Competition in each higher educational institution are presented in the organizational committee report and it is placed on CIGRE RNC and ISPEU official sites.

3.5. Awarding of the winners

The winners of the Competition in the individual and team championship are awarded with the diplomas of the higher educational institution, which is the organizer of the Competition. All the participants of the Competition get the certificates.

Appendix 3

THE PROGRAM OF THE COMPETITION

INTERNATIONAL STUDENT COMPETITION ON THEORETICAL AND GENERAL ELECTRICAL ENGINEERING April 22-24, 2014

<u>The program of the Competition for the participants</u>

April 22, Tuesday

0:00 – 24:00	Arrival and meeting of the participants of the Competition. Accommodation in the hotel.
11:30 – 13.30	Sightseeing tour about Ivanovo (**gathering in the hotel hall, the ground floor, 11.15**)

April 23, Wednesday

8:00 – 8:30	Transfer of the participants from the hotel to ISPEU
8:40 – 9:00	Photo-session of the participants of the Competition (**lobby near the Assembly Hall, building B**)
9:00 – 9.15	Opening ceremony of the Competition (**the Assembly Hall, building B**)
9:15 – 9:30	Registration and ciphering of the participants of the Competition (**B-301, B-316**)
9:30 – 13:30	The Competition carrying out (**rooms B-301, B-316**)
13:30 – 14:15	Lunch
14:30 – 19:00	Coach tour to Kostroma State District Power Plant (**gathering in the hall of building B, the ground floor**)
19:00 – 21:00	Gala-dinner
21:00 – 21:30	Transfer of the participants to the hotel

April 24, Thursday

12:30 – 13:00	Summing-up the results of the Competition. Rewarding the winners (**room B-240**)
13:00 – 14:00	Youth round-table discussion *Electrotechnical Education: Problems and Prospects*
14:00	Departure

Appendix 4

THE COMPETITION, SPONSORS AND ISPEU POSTERS

The poster of the Competition

The poster of CIGRE Russian National Committee

The posters of Charity fund “Reliable Young Generation” and OJSC “The System Operator of the United Power System”

ISPEU logotype

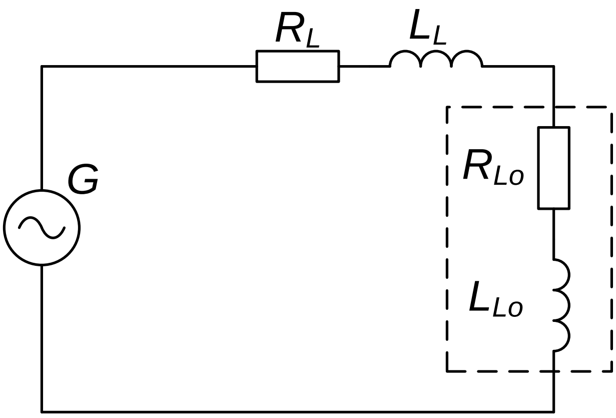
The poster of JSC "Territorial Generating Company #2"

The logotype of CIGRE Russian National Committee

Appendix 5

TASKS FOR SELF-TUITION

Task 1(10 points)



Generator supply active power of 40 *kW through power line. Generator voltage is* 3.3 *kV*

Transmission line parameters:

R_L=10 *Ohm*, X_L=60 *Ohm.*

Active power consumption by active inductive load is 32 *kW.*

Determine the load voltage and load parameters: R_{Lo} *u* X_{Lo}.

Solution:

Line impedance: $\underline{Z}_L = R_L + jX_L = 10 + j60$ *Ohm*.

The resistive line loss can be determined as follows $P_L = I^2 R_L$. In accordance with the power balance, current magnitude can be defined as:

$$I = \sqrt{\frac{P_G - P_{Lo}}{\mathrm{R_L}}} = 28{,}248\ A.$$

Load resistance: $R_{Lo} = \frac{P_{Lo}}{I^2} = \frac{32 \cdot 10^3}{28.248^2} = 40\ \text{O}hm$.

Vector power supplied by the generator and consumed by the entire system

$$S_G = U_G \cdot I = 3{,}3 \cdot 10^3 \cdot 28{,}248 = 93{,}34\ kVA.$$

The phase shift between current and voltage of the line:

$$\varphi_L = \arccos\left(\frac{R_L}{\sqrt{R_L^2 + X_L^2}}\right) = \arccos\left(\frac{10}{\sqrt{10^2 + 60^2}}\right) = 80{,}538°$$

The phase shift between current and voltage of the generator:

$$\varphi_G = \arccos\left(\frac{P_G}{S_G}\right) = \arccos\left(\frac{40 \cdot 10^3}{93{,}34 \cdot 10^3}\right) = 64{,}624°$$

Taking current phase equal to zero the vector of the line voltage drop can be calculated as follows: $\dot{U}_L = \dot{I} \cdot Z_L = 28{,}248 \cdot (10+j60\ ) = 282{,}48 + j1697\,V$

The generator complex voltage:

$$\dot{U}_G = U_G e^{j\varphi_G} = 3{,}3 \cdot 10^3 e^{j64{,}624} = (1{,}414 + j2{,}982) \cdot 10^3\ V\,.$$

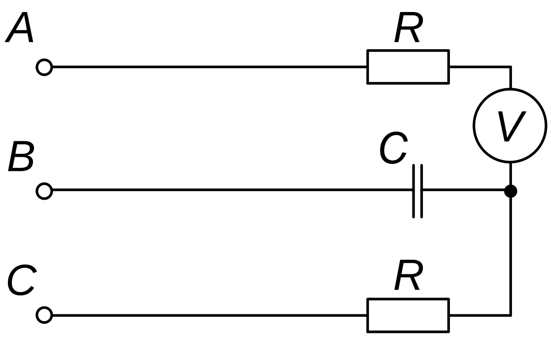
Load voltage:

$$\dot{U}_{Lo} = \dot{U}_G - \dot{U}_L = (1{,}414 + j2{,}982) \cdot 10^3 - (282{,}48 + j1697) = (1{,}131 + j1{,}285) \cdot 10^3\ V\,.$$

Load impedance $Z_{Lo} = \dfrac{\dot{U}_{Lo}}{\dot{I}} = \dfrac{(1{,}131 + j1{,}285) \cdot 10^3}{28.248} = (40 + j45{,}416)\ Ohm\,.$

Answer: $\dot{U}_{Lo} = (1{,}131 + j1{,}285) \cdot 10^3\ V$, $Z_{Lo} = (40 + j45{,}416)\ Ohm$

Task 2 (10 points)



Given:

R = X$_C$, U$_L$ = 220 *V.*

Determine voltage meter reading, considering it an ideal.

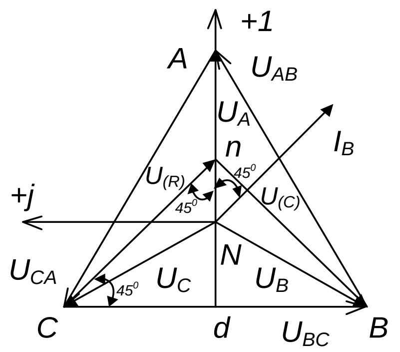
Solution:

There is a circuit break in phase A (as voltmeter is a perfect one), so the current $I_A = 0\ A$;

Resistive voltage drop in phase A is also equal to zero.

B and C phase currents magnitudes are equal, have opposite directions, and are essentially the same current, which can be determined by Ohm's law:

$$\dot{I}_B = -\dot{I}_c = \frac{\dot{U}_{BC}}{R - jX_C} = \frac{220e^{-j90}}{R\sqrt{2}e^{-j45}} = \frac{220}{R\sqrt{2}} e^{-j45}\ A,$$



Taking into account that R and X_C magnitudes are equal the current I_B leads the voltage by an angle of 45º.

In addition, resistive and capacitive voltage drop magnitudes U_R and U_C are equal too.

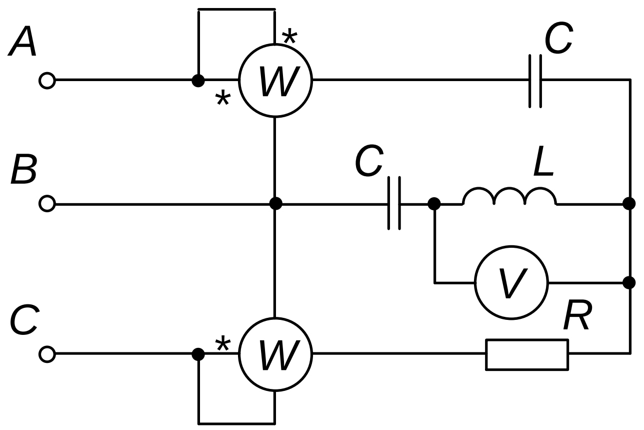
U_R voltage coincides with the direction of current I_B and this current leads U_C voltage by an angle of 90º, both voltages on the diagram form a right triangle CnB with a base CB (see Fig.). Dropping a perpendicular from the point n to the segment NE we will receive right isosceles triangle Cnd with a base Cn, and a right triangle CNd. The length of the vector Nn in such circumstances can be determined as follows:

$$U_{Nn} = U_{nd} - U_{Nd} = \frac{U_{BC}}{2} - U_C \sin\left(30^{\circ}\right) = \frac{220}{2} - \frac{220}{\sqrt{3}} \sin\left(30^{\circ}\right) = 110 - 127 \cdot \frac{1}{2} = 46{,}5\,V\ .$$

Voltage meter reading is equal to $U_A - U_{Nn}$= 127 – 46,5= 80,5 *V*.

Answer: U_A-U_{Nn}=*80.5 V*

Task 3 (15 points)



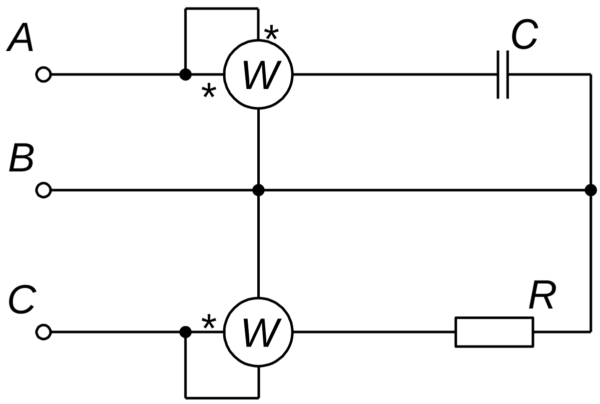
Determine the readings if

U_{AB}= U_{BC}= U_{CA}= 220 *V;*

$$\frac{1}{\omega C} = \omega L = R = 100\,Ohm.$$

Solution:

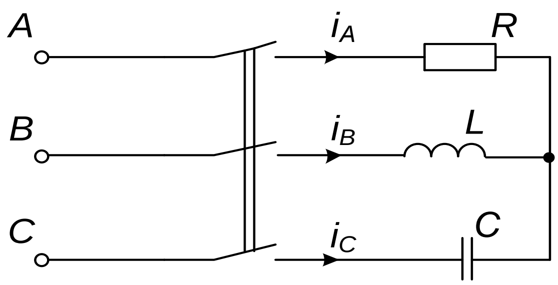
There is a voltage resonance in the phase B (the voltage drop across the inductance and capacitance cancel one another). In this case, the circuit can be represented by an equivalent circuit (see Fig.)



A phase active power meter is connected to the capacitor C, so its reading is zero.

Active power meter in phase C is connected to a purely active resistance R, and the resistance itself is connected to the line voltage U_{CB}, so active power meter reading is $U_{CB}^2/R=220^2/100=484$ *W*.

Task 4(15 points)



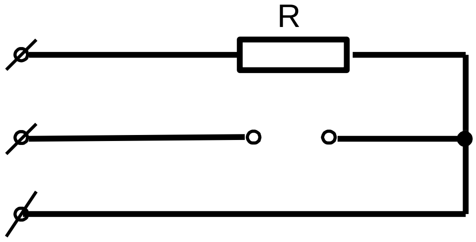
ABC is a symmetrical three-phase voltage system of positive sequence $U_{AB}= U_{BC}= U_{CA}$

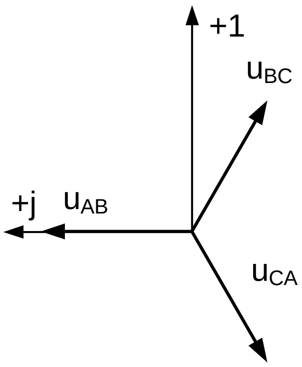
At the moment of contact closure $u_{AB}=u_m=500$ *V*, $u_c(0)=0$

Determine currents, as well as $\frac{du_C}{dt}$ *and* $\frac{di_L}{dt}$ *at the moment of contact closure, if* R =100 *Ohm;* L= 2 *H;* C =2 μF.

Solution:

Equivalent circuit and vector diagram of voltages for the first moment after switching are shown in Figures.





$$u_{AB} = U_m \sin\left(\omega t + \frac{\pi}{2}\right);$$

$$u_{BC} = U_m \sin\left(\omega t - 120^\circ + \frac{\pi}{2}\right);$$

$$u_{CA} = U_m \sin\left(\omega t + 120^\circ + \frac{\pi}{2}\right).$$

Thus, $i_A\left(0_+\right) = -i_C\left(0_+\right) = -\frac{u_{CA}\left(0_+\right)}{R} = -\frac{500\,sin150^\circ}{100} = -2.5\ A$

$$i_C\left(0_+\right) = 2.5\ A$$

$$i_C\left(0_+\right) = C\frac{du_C}{dt},$$

$$\frac{du_C}{dt} = \frac{i_C\left(0_+\right)}{C} = \frac{2{,}5}{2\cdot 10^{-6}} = 1{,}25\cdot 10^{6}\ V/sec.$$

We define $\frac{di_L}{dt}$ Voltage U_{BC} is behind U_{AB} at angle 120°, and the instantaneous voltage of the power source in accordance with the conditions of the task.

$$u_{AB} = U_m \sin\left(\omega t + \frac{\pi}{2}\right);$$

$$u_{BC} = U_m \sin\left(\omega t - 120^\circ + \frac{\pi}{2}\right);$$

$$u_{CA} = U_m \sin\left(\omega t + 120^\circ + \frac{\pi}{2}\right).$$

The switch is closed at time (t = 0) - the time of the passage of the instantaneous voltage through a maximum value. $\omega t = \frac{\pi}{2}$ is the time of closure of the switch (according to the conditions of the task).

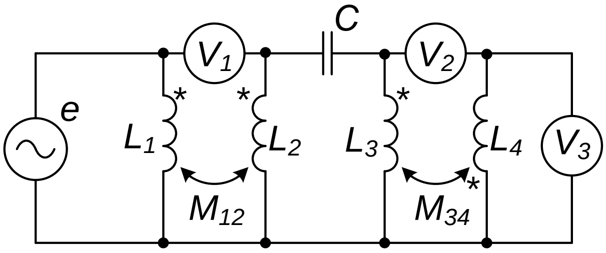
$$u_{BC}\left(0_+\right) = U_m\, sin\left(\frac{\pi}{2} - 120^\circ\right);$$

$$u_{BC}\left(0_+\right) = 500\, sin\left(\frac{\pi}{2} - 120^\circ\right) = 500\, sin\left(-30^\circ\right) = -250V;$$

$$u_L\left(0_+\right) = u_{BC}\left(0_+\right) = L\left.\frac{di_L}{dt}\right|_{t=0} = \frac{u_{BC}\left(0_+\right)}{2} = -125\ \frac{A}{sec}.$$

Answer: $i_A\left(0_+\right) = -2{,}5\ A;\ i_C\left(0_+\right) = 2{,}5\ A;\ \frac{du_C}{dt} = 1{,}25 \cdot 10^6\ V/sec;$ $\frac{di_1}{dt} = -125\ A/sec.$

Task 5(20 points)



Given:

$$e = 120\sqrt{2}\sin 4000t\ V,$$

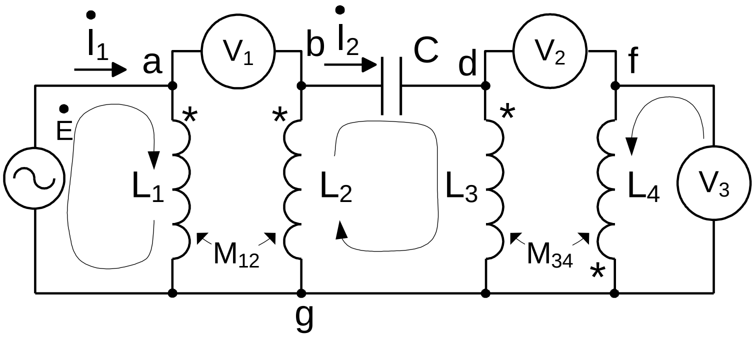
$L_1 = L_3 = 20\ mH$, $L_2 = L_4 = 25\ mH$,

$M_{12} = M_{34} = 10\ mH$, $C = 2{,}5\ \mu F$.

Determine voltage meter readings which register the effective voltage.

Inductors considered ideal, voltmeters self-conductance is neglected.

Solution:



$$\dot{E} = 120\,V\ ;$$

$$x_{L1} = x_{L3} = \omega L_1 =$$
$$= 4000 \cdot 20 \cdot 10^{-3} = 80\ Ohm;$$

$$x_{L2} = x_{L4} = \omega L_3 =$$
$$= 4000 \cdot 25 \cdot 10^{-3} = 100\ Ohm;$$

$$x_{M12} = x_{M34} = \omega M_{12} = 4000 \cdot 10 \cdot 10^{-3} = 40\ Ohm;$$

$$x_C = \frac{1}{\omega C} = \frac{1}{4000 \cdot 2{,}5 \cdot 10^{-6}} = 100\ Ohm.$$

Second Kirchhoff law equations:

$$\begin{cases} \dot{I}_1 jx_{L1} - \dot{I}_2 jx_{M12} = \dot{E}; \\ \dot{I}_2\left(jx_{L2} + jx_{L3} - jx_C\right) - \dot{I}_1 jx_{M12} = 0. \end{cases}$$

$$\begin{cases} \dot{I}_1 j80 - \dot{I}_2 j40 = 120; \\ \dot{I}_2\left(j100 + j80 - j100\right) - \dot{I}_1 j40 = 0. \end{cases}$$

$$\dot{I}_2 j80 - \dot{I}_1 j40 = 0 \Rightarrow \dot{I}_2 j80 = \dot{I}_1 j40 \Rightarrow \dot{I}_2 = \dot{I}_1 \frac{j40}{j80} = 0{,}5\dot{I}_1\ A.$$

$$\dot{I}_1 j80 - 0{,}5\dot{I}_1 j40 = 120 \Rightarrow \dot{I}_1 j80 - \dot{I}_1 j20 = 120 \Rightarrow \dot{I}_1 j60 = 120 \Rightarrow$$

$$\Rightarrow \dot{I}_1 = \frac{120}{j60} = -j2 = 2e^{-j90}\ A.$$

$$\dot{I}_2 = 0{,}5\dot{I}_1 = 0{,}5(-j2) = -j1 = e^{-j90}\ A.$$

$$\dot{I}_2 = 0{,}5\dot{I}_1 = 0{,}5(-j2) = -j1 = e^{-j90}\ A.$$

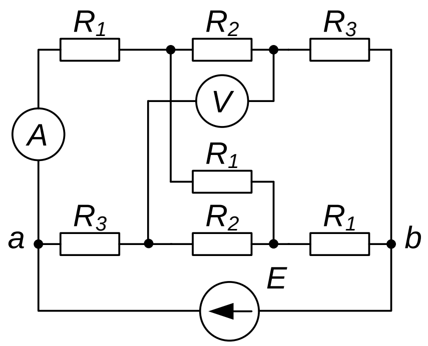
$$\dot{U}_{ab} = \dot{E} - \dot{U}_{bd} = 120 - (-20) = 140\,V.$$

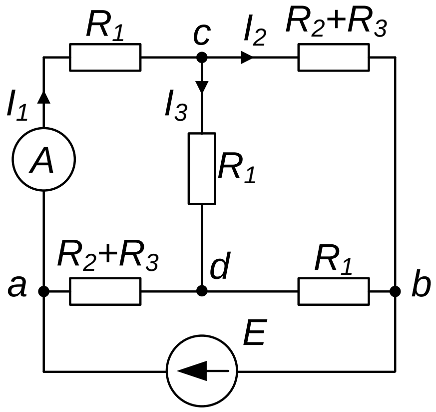
$$\dot{U}_{dg} = \dot{I}_2\, jx_{L3} = (-j1)\, j80 = 80\,V.$$

$$\dot{U}_{fg} = -\dot{I}_2\, jx_{M34} = -(-j1)\, j40 = -40\,V.$$

$$\dot{U}_{df} = \dot{U}_{dg} - \dot{U}_{fg} = 80 - (-40) = 120\,V.$$

Answer: *V_1 = 140 V; V_2 = 120 V; V_3=-40 B.*





Task 6 (10 points)

In DC system ammeter reading is I = 7 A. R_1=30 Ohm, R_2= 25 Ohm, R_3=15 Ohm. Determine voltage meter reading. Devices are perfect ones.

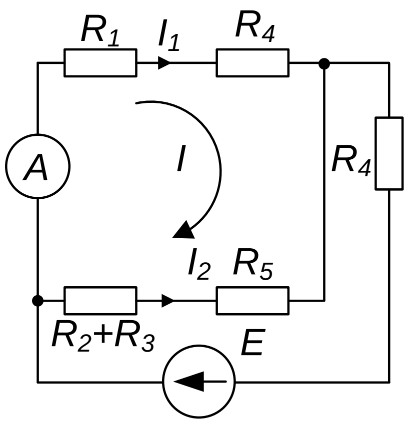
Solution:

For clarity, we transform the scheme: sum series resistors R_2 and R_3, and also denote nodes and the currents in the branches.

To determine the voltage meter reading we should find currents I_1 and I_2.

This scheme represents a bridge circuit. As $R_1 \cdot R_1 \neq (R_2 + R_3)^2$ current will flow in diagonal cd.

Let us make delta star transformation with cbd delta.



$$R_4 = \frac{(R_2+R_3)\cdot R_1}{2\cdot R_1+R_2+R_3} = \frac{(25+15)\cdot 30}{60+40} = 12\ Ohm$$

$$R_5 = \frac{R_1^{\ 2}}{2\cdot R_1+R_2+R_3} = \frac{30^2}{60+40} = 9\ Ohm$$

$I_1=J=7\ A$;

$$I_2 = \frac{I_1\cdot(R_1+R_4)}{R_2+R_3+R_5} = \frac{7\cdot(30+12)}{25+15+9} = 6\ A$$

(according to the second Kirchhoff's law for the I circuit).

$$U_V = I_1\cdot R_1 + I_2\cdot R_2 - I_2\cdot R_3 = I_1\cdot R_1 = 7\cdot 30 = 270\,V$$

(according to the second Kirchhoff's law for the circuit, containing R_1, R_2, $R_3$and voltmeter).

Answer: *270 V.*

Task 7 (10 points)

Resistance of the coil at a frequency of ω_0 is less than its reactance by 2 *times.*

How should the frequency be changed to increase the coil power factor by 2 *times? Wires resistance is independent of the frequency.*

Solution:

Under the conditions of the task $2\cdot r = \omega_0\cdot L$, and power factor is

$$\cos\varphi = \frac{r}{\sqrt{r^2+4\cdot r^2}} = \frac{1}{\sqrt{5}}$$

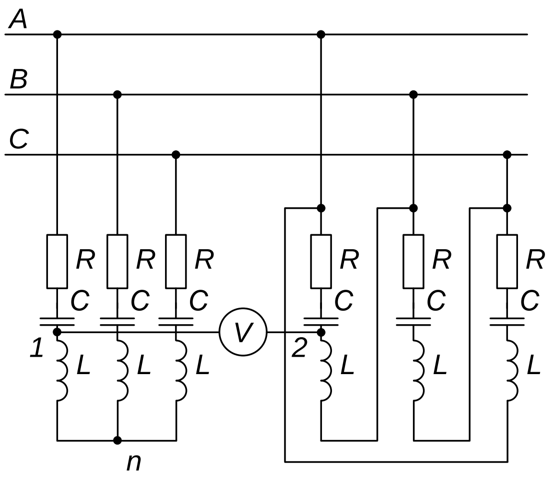
To increase power factor by 2 times let us increase frequency by v times. Then, v can be defined as follows

$$\frac{2}{\sqrt{5}} = \frac{r}{\sqrt{r^2+v^2\cdot(\omega_0\cdot L)^2}} = \frac{1}{\sqrt{1+4\cdot v^2}} \Rightarrow v = 0.25$$

Hence, the frequency should be reduced by a factor of 4.

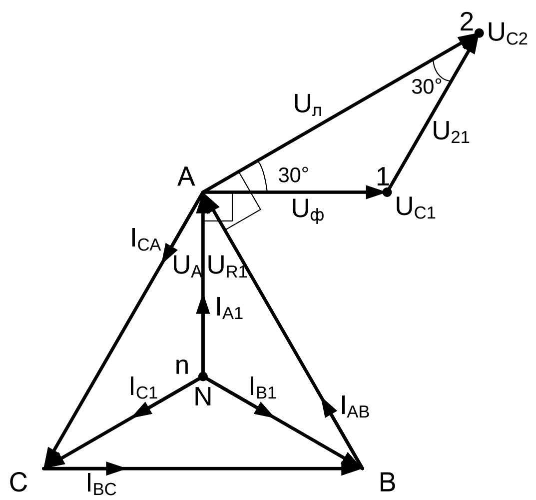
Task 8 (25 points)

Two 3-phase loads are connected to symmetrical three-phase circuit (see Fig.) with $R=X_L=X_C$. Define perfect voltage meter reading connected between points 1 *and* 2*, if the line voltage is U_L=*380 *V.*



Solution:

To determine the potential difference between points 1 and 2, you must draw voltage vector diagram of the three-phase symmetric source. Since $X_L=X_C$, then all the phases of the loads will have voltage resonance, so the loads phase current will coincide with the load phase voltages.



The equations for the second Kirchhoff's law for 1 and 2 loads phases, respectively:

1: $E'_A = U'_{R1} + U'_{L1} + U'_{C1}$

2: $U'_{AB} = U'_{R2} + U'_{L2} + U'_{C2}$

However, $U'_{L1} = -U'_{C1}$ and $U'_{L2} = -U'_{C2}$ (due to voltage resonance):

$E'_A = U'_{R1}; U'_{AB} = U'_{R2}$.

Where: $U_{R1} = I_A \cdot R = U_{C1} = I_A \cdot X_C = U_{L1} = I_A \cdot X_L = U_A$

$U_{R2} = I_{AB} \cdot R = U_{C2} = I_{AB} \cdot X_C = U_{L2} = I_{AB} \cdot X_L = U_{AB}$.

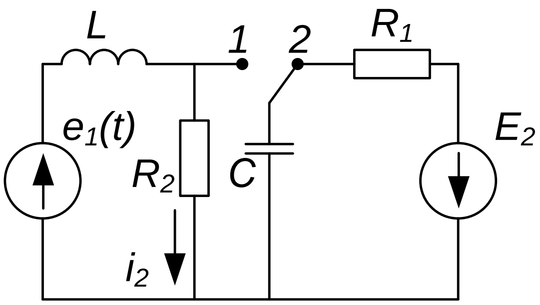
Now it is easy to draw voltage vectors for elements in the phases of the loads and determine the position of the points 1 and 2 on the vector diagram. For clarity, we denote the vector with the length equal to the source phase voltage as U_{ph}, and to linear voltage as – U_{Li}.

Knowing the value of vectors $U_{c1}$and $U_{c2}$and angle between them we can easily determine the length of the vector U_{21}.

$$U_{C1} = U_{ph}; U_{C2} = U_{Li} \Rightarrow U_{12} = \frac{U_{Li}}{\sqrt{3}} = 220\,V$$

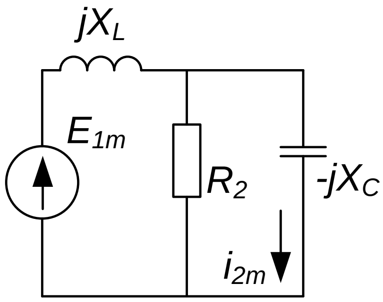
Answer: *220 V.*

Task 9 (25 points)



In the circuit shown in the figure, the switch instantly switches from the first to the second position. Determine the law of current variation i_2 after the commutation, if R_1=R_2=10 Ohm; L= 20 mH; C=50 μF; E_2=30 V; $e_1(t)$=10·sin(10³·t+135°) V.

Solution:



We solve this task by the classical approach.

$$i_2(t) = i_{2transient} + i_{2\,forced}$$

$i_{2forced}$=?

We define vector current in the resistor in the steady state after commutation.

$$X_L = \omega \cdot L = 10^3 \cdot 20 \cdot 10^{-3} = 20\,Ohm;$$

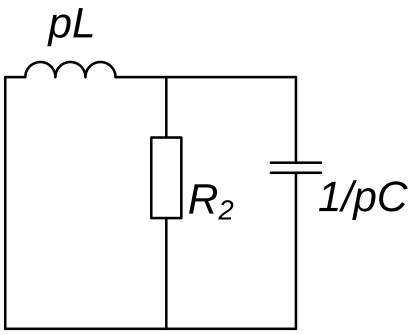
$$X_C = \frac{1}{\omega \cdot C} = \frac{1}{10^3 \cdot 50 \cdot 10^{-6}} = 20\,Ohm;$$

$$i_{2m\,forced} = \frac{E'_{1m} \cdot (-jX_C)}{\left(jX_L + \frac{-jX_C \cdot R_2}{R_2 - jX_C}\right) \cdot (R_2 - jX_C)} = \frac{E'_{1m} \cdot (-jX_C)}{X_L \cdot X_C + j \cdot (R_2 \cdot X_L - R_2 \cdot X_C)} =$$

$$= \frac{10\sqrt{2} \cdot e^{j135^\circ} \cdot 20 \cdot e^{-90^\circ}}{20 \cdot 20 + j \cdot (10 \cdot 20 - 10 \cdot 20)} = \frac{\sqrt{2}}{2} \cdot e^{j45^\circ}\ A;$$

$$i_{2\,forced}(t) = \frac{\sqrt{2}}{2} \cdot sin\left(10^3 \cdot t + 45^\circ\right) A;$$

We form the characteristic equation by the input impedance approach and determine its roots.



$$Z_{imp}(p) = pL + \frac{\frac{1}{pC} \cdot R_2}{R_2 + \frac{1}{pC}} = 0$$

$$pL + \frac{R_2}{R_2 \cdot pC + 1} = 0$$

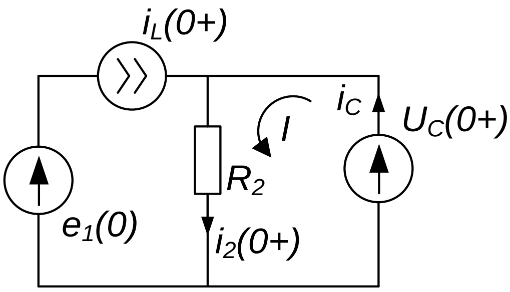
$$p^2 \cdot R \cdot L \cdot C + pL + R_2 = 0$$

$$p^2 \cdot 10 \cdot 20 \cdot 10^{-3} + p \cdot 20 \cdot 10^{-3} + 10 = 0$$

$$p^2 + p \cdot 2000 + 10^6 = 0$$

$$p_1 = p_2 = -1000 \Rightarrow i_{2transient}(t) = (A_1 + A_2 \cdot t) \cdot e^{-1000t}$$

$$I_2(t) = \frac{\sqrt{2}}{2} \cdot sin\left(10^3 \cdot t + 45°\right) + (A_1 + A_2 \cdot t) \cdot e^{-1000t} \ A;$$



We define the constants A_1 and A_2. For this purpose it is necessary to determine $i_2(0_+)$ and $\left.\frac{di_2}{dt}\right|_{t=0_+}$ from after commutation regime at the initial time t=0_+.

$$i_L(0_+) = \frac{e_1(0_+)}{R_2} = \frac{10}{10} = 1\,A$$

$$u_C(0_+) = u_C(0_-) = -E_2 = -30\,V$$

(In accordance with the laws of commutation).

$$i_2(0_+) = \frac{u_C(0_+)}{R_2} = \frac{-E_2}{R_2} = \frac{-30}{10} = -3\,A$$

$$i_2(0_+) = -3 = \frac{\sqrt{2}}{2} \cdot sin(45°) + A_1 \Rightarrow A_1 = -3 - \frac{\sqrt{2}}{2} \cdot \frac{\sqrt{2}}{2} = -3.5$$

To determine the constant A_2 it is necessary to find $\left.\frac{di_2}{dt}\right|_{t=0_+}$. The equations for the second Kirchhoff's law for circuit 1.

$$U_C = R_2 \cdot i_2$$

Differentiate it with respect to time.

$$\frac{du_C}{dt} = \frac{di_2}{dt} \cdot R_2 \Rightarrow \frac{di_2}{dt} = \frac{du_C}{dt} \cdot \frac{1}{R_2}, where\ \frac{du_C}{dt} = \frac{i_C}{C}$$

$$\left.\frac{du_c}{dt}\right|_{t=0_+} = \frac{u_C(0_+)}{R_2 \cdot C} - \frac{i_L(0_+)}{C} = \frac{-E_2}{R_2 \cdot C} - \frac{i_L(0_+)}{C} = \frac{-3-1}{50 \cdot 10^{-6}} = 80000$$

$$\frac{di_2}{dt} = -\frac{80000}{10} = -8000$$

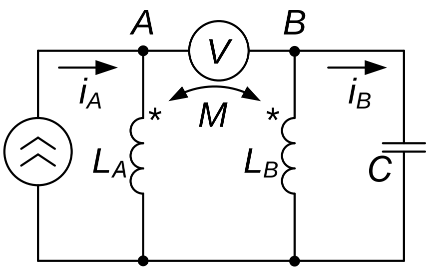
$$\frac{di_2}{dt} = \frac{\sqrt{2}}{2} \cdot 10^3 \cdot cos\,45° - 1000A_1 + A_2 = -8000$$

$$A_2 = -8000 - 3500 - 500 = -12000$$

$$i_2(t) = \frac{\sqrt{2}}{2} \cdot sin\left(10^3 \cdot t + 45°\right) - \left(3.5 + 12000 \cdot t\right) \cdot e^{-1000t}$$

Answer: $i_2(t) = \frac{\sqrt{2}}{2} \cdot sin\left(10^3 \cdot t + 45°\right) - \left(3.5 + 12000 \cdot t\right) \cdot e^{-1000t}$

Task 10 (15 points)



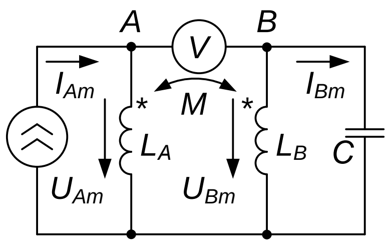
In the circuit shown in the figure, the current varies according to the law:

$$i_A = 2 + 45 \cdot sin(\omega \cdot t) + 2 \cdot sin(2 \cdot \omega \cdot t + 30°)$$

A; circuit parameters: ωL_A= 5 *Ohm;* ωL_B=10 *Ohm;* ωM=2.5 *Ohm;* $\frac{1}{\omega C} = 60\,Ohm$.

Determine the perfect electromagnetic voltage meter reading connected between terminals A and B, and write the law of variation u_{AB} *in time.*

Solution:



We calculate the vector voltage of the points A and B.

For this purpose we consider separately each i_A current harmonic.

We form a system of second Kirchhoff's law equations for the two side circuits:

$$\dot{U}_{Am1} = \dot{I}_{Am1} \cdot jX_{LA} - \dot{I}_{Bm1} \cdot jX_M$$

$$\dot{I}_{Bm1} \cdot jX_{LB} - \dot{I}_{Am1} \cdot jX_M - \dot{I}_{Bm1} \cdot jX_C = 0 \Rightarrow \dot{I}_{Bm1} = \frac{\dot{I}_{Am1} \cdot jX_M}{j(X_{LB} - X_C)} =$$

$$= \frac{j2.5 \cdot 4}{j(10-60)} = -0.2\ A$$

$$\dot{U}_{Bm1} = -\dot{I}_{Bm1} \cdot jX_{LB} + \dot{I}_{Am1} \cdot jX_M = 0.2 \cdot j10 + 4 \cdot j2.5 = j12 = 12 \cdot e^{j90°}\ V$$

$$u_{B1}(t) = 12 \cdot sin(\omega t + 90°)\,V$$

$$\dot{U}_{Am1} = 4 \cdot j5 - 0.2 \cdot j2.5 = j20.5 = 20.5 \cdot e^{j90°}\ V$$

$$u_{A1}(t) = 20.5 \cdot sin(\omega t + 90°)\,V$$

Similarly, considering doubling the frequency ω:

$$\dot{U}_{Am2} = \dot{I}_{A21} \cdot j2 \cdot X_{LA} - \dot{I}_{Bm2} \cdot j2 \cdot X_M$$

$$\dot{I}_{Bm2} \cdot j2 \cdot X_{LB} - \dot{I}_{Am2} \cdot j2 \cdot X_M - \dot{I}_{Bm2} \cdot j\frac{X_C}{2} = 0 \Rightarrow \dot{I}_{Bm2} = \frac{\dot{I}_{Am2} \cdot j2 \cdot X_M}{j\left(2 \cdot X_{LB} - \frac{X_C}{2}\right)} =$$

$$= \frac{j2 \cdot 2.5 \cdot 2 \cdot e^{j30°}}{j\left(2 \cdot 10 - \frac{60}{2}\right)} = e^{j120°}\ A$$

$$\dot{U}_{Bm2} = -\dot{I}_{Bm2} \cdot j2 \cdot X_{LB} + \dot{I}_{Am2} \cdot j2 \cdot X_M = -e^{120°} \cdot j2 \cdot 10 + 2 \cdot e^{j30°} \cdot j2 \cdot 2.5 =$$
$$= j12 = 30 \cdot e^{j120°}\ V$$

$$u_{B2}(t) = 30 \cdot sin\left(2\omega t + 120°\right) V$$

$$\dot{U}_{Am2} = 2 \cdot e^{j30°} \cdot j2 \cdot 5 - e^{j210°} \cdot j2 \cdot 2.5 = j20.5 = 25 \cdot e^{j120°}\ V$$

$$u_{A2}(t) = 25 \cdot sin\left(2\omega t + 120°\right) V$$

Now we find $u_{AB}(t)$:

$$\dot{U}_{AB} = \dot{U}_{Am} - \dot{U}_{Bm} \Rightarrow u_{AB}(t) = \left(u_{A1}(t) - u_{B1}(t)\right) + \left(u_{A2}(t) - u_{B2}(t)\right) =$$
$$= 20.5 \cdot sin\left(\omega t + 90°\right) - 12 \cdot sin\left(\omega t + 90°\right) + 25 \cdot sin\left(2\omega t + 120°\right) -$$
$$-30 \cdot sin\left(2\omega t + 120°\right) = 8.5 \cdot sin\left(\omega t + 90°\right) - 5 \cdot sin\left(2\omega t + 120°\right) V$$

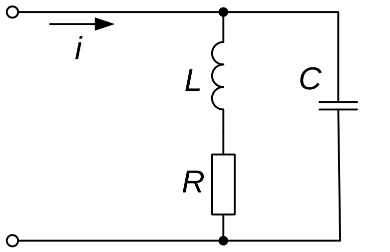
$$u_{AB}(t) = 8.5 \cdot sin\left(\omega t + 90°\right) + 5 \cdot sin\left(2\omega t + 60°\right) V$$

$$U_V = \sqrt{\left(\frac{U_{ABm1}}{\sqrt{2}}\right)^2 + \left(\frac{U_{ABm2}}{\sqrt{2}}\right)^2} = \sqrt{\left(\frac{8.5}{\sqrt{2}}\right)^2 + \left(\frac{5}{\sqrt{2}}\right)^2} = 6.97\,V$$

Answer: $u_{AB}(t) = 8.5 \cdot sin\left(\omega t + 90°\right) + 5 \cdot sin\left(2\omega t + 60°\right) V$, $U_V = 6.97\,V$

Task 11 (15 points).

Inductance L and the angular frequency of the current are known for the chain of periodic sinusoidal current. Determine an expression for the capacitance C of the capacitor using circuit parameters at which the input current i will not depend on the resistance R.



Solution:

Let the RMS value of the voltage *U* at the power input circuit is equal to 1 *V*, then the current *I* can be defined as follows:

$$I = \frac{1}{Z} = \sqrt{\frac{(1-\omega^2 LC)^2 + \omega^2 C^2 R^2}{R^2 + \omega^2 L^2}}$$

If we want to make current independent from *R* value, it is necessary to satisfy the condition:

$$\frac{(1-\omega^2 LC)^2 + \omega^2 C^2 R^2}{R^2 + \omega^2 L^2} = const = A \ or$$

$$1 - 2\omega^2 LC + \omega^4 L^2 C^2 + \omega^2 C^2 R^2 = A\omega^2 L^2 + AR^2$$

Consequently, the ratios should be executed:

$$\begin{cases} \omega^2 C^2 r^2 = AR^2 \\ \omega^4 C^2 L^2 = A\omega^2 L^2 \\ 1 - 2\omega^2 LC = 0 \end{cases} \quad \text{from which} \quad \begin{cases} \omega^2 C^2 = A \\ 1 = 2\omega^2 LC \end{cases}$$

In other words $A = \frac{1}{2}\frac{C}{L}$, $C = \frac{1}{2\omega^2 L}$

Thus, when $C = \frac{1}{2\omega^2 L}$ in the circuit with *U* = 1 *V* the current *I* is equal to $\sqrt{\frac{C}{2L}}$ and does not depend on *R*.

Task 12(20 points)

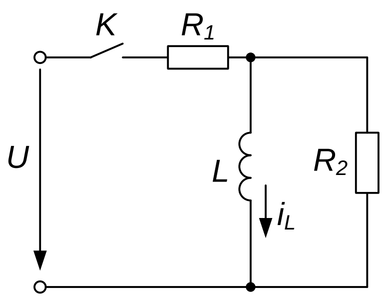


Fig. 1

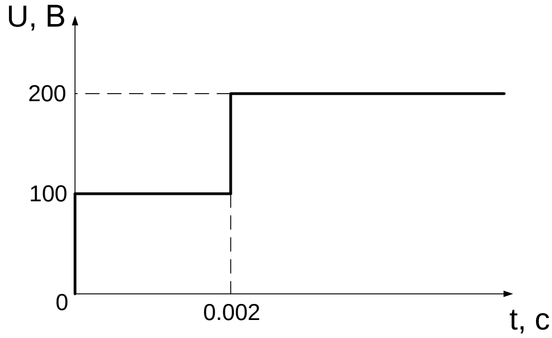


Fig. 2

For the circuit shown in Figure 1, with the following parameters: $R_1 = 100\ Ohm;\ R_2 = 300\ Ohm;\ L = 0.15\ H$. *Without using graphic drawings, determine at what time t the current* i_L reaches *1.5 A value, if the input voltage varies as shown in Figure* 2*?*

Solution:

1. While $t \le 0.002$ sec i_L current will not reach 1.5*A* because

$$i_{\max} = i_{forced} = \frac{U}{R_1} = \frac{100}{100} = 1\ A$$

Thus, the solution can be found while $t > 0.002$ sec

2. While $t \le 0.002$ sec

$$i_L = (i_{forced} + Ae^{-\frac{t}{\tau}}) + (i_{forced} + Ae^{-\frac{t-0.002}{\tau}}) = 2i_{forced} + A(e^{-\frac{t}{\tau}} + e^{-\frac{t-0.002}{\tau}}) =$$

$$= 2i_{forced} + A(1 + e^{\frac{0.002}{\tau}})e^{-\frac{t}{\tau}}$$

Due to laws of commutation $A = -i_{np} = -1;$

$$\tau = \frac{L}{\frac{R_1 R_2}{R_1 + R_2}} = 0.002\ \text{sec}.$$

Thus $i_L = 2 - 1(1 + e^{\frac{0.002}{0.002}})e^{-\frac{t}{0.002}} = 2 - 3.718e^{-500t}$

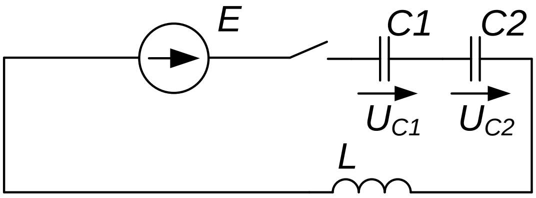
3. The value of time:

$$1.5 = 2 - 3.718e^{-500t} \rightarrow e^{-500t} = \frac{0.5}{3.718} = 0.1345$$

$$-500t = \ln(0.1345) \rightarrow t = -\frac{\ln(0.1345)}{500} = 0.004$$

Answer: *0.004 sec.*

Task 13 (20 points)



The following circuit parameters are known:

$$E = 100 \ V; \ C_1 = 100 \ \mu F; \ C_2 = 200 \ \mu F$$

Determine voltages u_{C1} and u_{C2} when the current in the circuit reaches its maximum value.

Solution:

$U_L = L\frac{di_L}{dt}$ means that when $i_L = \max$ then $U_L = 0$

$$E = U_L + U_{C1} + U_{C2}, \ U_L = 0 \Rightarrow E = U_{C1} + U_{C2}$$

$$U_{C1} = q_1 \cdot C_1; \ U_{C2} = q_2 \cdot C_2,$$

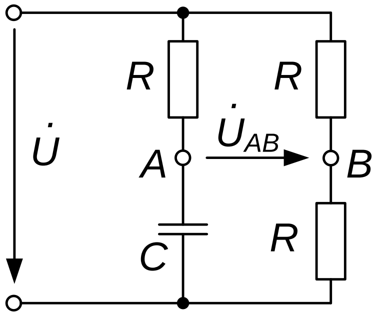
but $q_1 = q_2 = q \Rightarrow \frac{U_{C1}}{U_{C2}} = \frac{C_1}{C_2} = \frac{1}{2} \Rightarrow U_{C1} = \frac{1}{2}U_{C2}$

$$E = \frac{1}{2}U_{C2} + U_{C2} \Rightarrow U_{C2} = \frac{2}{3}E = 66.67 \ V; \ U_{C1} = \frac{1}{3}E = 33.33 \ V.$$

Answer*:* $U_{C1} = 33.33 \ V; \ U_{C2} = 66.67 \ V.$

Task 14 (15 points)

Determine the phase angle $\gamma = \psi_U - \psi_{UAB}$ *between the voltages* $\dot{U} = U \cdot e^{j\psi_U}$ *and* $\dot{U}_{AB} = U_{AB} \cdot e^{j\psi_{UAB}}$ *if the circuit parameters are related as follows* $\frac{1}{\omega C} = R$.



Solution:

The equations for the second Kirchhoff's law:

$$\dot{U}_{AB} - \dot{I}_2 R + \dot{I}_1 R = 0$$

$$\dot{I}_1 = \frac{\dot{U}}{R - jX_C}; \ \dot{I}_2 = \frac{\dot{U}}{2R}$$

$$\dot{U}_{AB} = \dot{U}\left(\frac{1}{2} - \frac{R}{R - jX_C}\right)$$

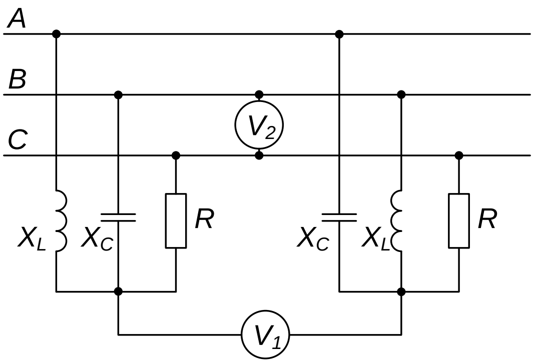
$$\frac{\dot{U}}{\dot{U}_{AB}} = \frac{U}{U_{AB}} e^{j(\psi_U - \psi_{UAB})} = \frac{1}{\frac{1}{2} - \frac{R}{R - jX_C}}$$

$$\psi_U - \psi_{UAB} = \gamma = \arg\left(\frac{1}{\frac{1}{2} - \frac{R}{R - jX_C}}\right)$$

$$\gamma = arg\left(\frac{1}{\frac{1}{2} - \frac{1}{2}e^{j45}}\right) = arg\left(\frac{1}{-j\frac{1}{2}}\right) = 90^\circ$$

Answer: *90°.*

Task 15 (20 points)



Ideal passive components and ideal electromagnetic voltmeters are connected to symmetrical three-phase circuit. $R = X_L = X_C$. *Voltmeter V1, connected between loads neutral points reading is* U_1=220 *V. Determine the reading of the second voltmeter V2.*

Solution:

Voltmeter 1 shows magnitude of voltage difference between neutrals potentials U_{n1N} and U_{n2N}. They can be defined as follows:

$$\dot{U}_{n1N} = \frac{\dot{E}_A \cdot Ye^{-j90} + \dot{E}_A \cdot Ye^{-j120}e^{j90} + \dot{E}_A \cdot Ye^{j120}}{Ye^{j90} + Ye^{-j90} + Y} = \dot{E}_A(e^{-j90} + e^{-j30} + e^{j120}) = (\sqrt{3}-1)\dot{E}_A e^{-j60}$$

$$\dot{U}_{n2N} = \frac{\dot{E}_A \cdot Ye^{j90} + \dot{E}_A \cdot Ye^{-j120}e^{-j90} + \dot{E}_A \cdot Ye^{j120}}{Ye^{j90} + Ye^{-j90} + Y} = \dot{E}_A(e^{j90} + e^{-j210} + e^{j120}) = (1+\sqrt{3})\dot{E}_A e^{j120}$$

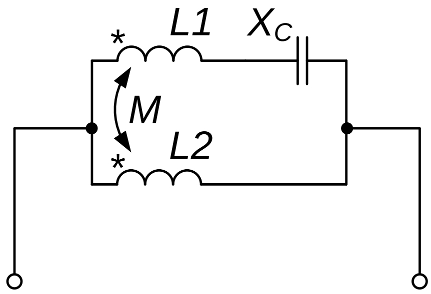
$$U_n = \left|\dot{U}_{n1N} - \dot{U}_{n2N}\right| = E_A(1+\sqrt{3}+\sqrt{3}+1) = 2\sqrt{3}E_A$$

$$U_{V2} = U_л = E_A\sqrt{3} \Rightarrow E_A = \frac{U_{V2}}{\sqrt{3}} \Rightarrow U_{V1} = 2\sqrt{3}\frac{U_{V2}}{\sqrt{3}} \Rightarrow U_{V1} = 2U_{V2}$$

$$\Rightarrow U_{V2} = \frac{1}{2}U_n = 110\ V$$

***Answer**: 110 V.*

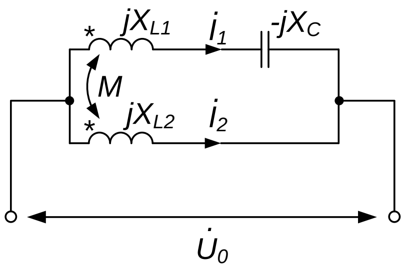
Task 16 (15 points)



There is a resonance in the circuit. Determine the magnetic coupling ratio K_m if we know the following circuit parameters: $f = 50\ Hz;\ L_1 = 0.4\ H;\ L_2 = 0.9\ H;$ $C = 7.1\ \mu F.$

Solution:

1) Method 1



The equations for the second Kirchhoff's law:

$$U_0 = \dot{I}_1 \cdot j(X_{L1} - X_C) + \dot{I}_2 \cdot jX_m$$
$$U_0 = \dot{I}_2 \cdot jX_{L2} + \dot{I}_1 \cdot jX_m$$

In the current resonance mode $\dot{I}_1 = -\dot{I}_2$, thus

$$\dot{I}_1 \cdot j(X_{L1} - X_C) - \dot{I}_1 \cdot jX_m = -\dot{I}_1 \cdot jX_{L2} + \dot{I}_1 \cdot jX_m$$

$$X_{L1} + X_{L2} - X_C - 2 \cdot X_m = 0 \Rightarrow X_m = \frac{X_{L1} + X_{L2} - X_C}{2}$$

$$\Rightarrow \omega M = \frac{\omega L_1 + \omega L_2 - \frac{1}{\omega \cdot C}}{2} \Rightarrow M = \frac{L_1 + L_2 - \frac{1}{\omega^2 \cdot C}}{2}$$

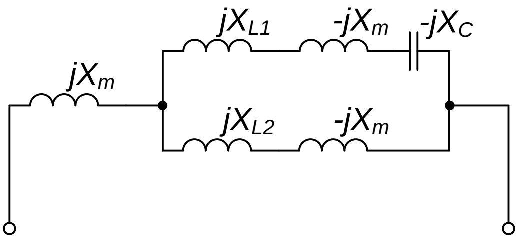
but

$$M = K_m \cdot \sqrt{L_1 L_2} \Rightarrow K_m = \frac{L_1 + L_2 - \frac{1}{\omega^2 C}}{2\sqrt{L_1 L_2}}$$

$$K_m = \frac{0.4 + 0.9 - \frac{1}{314^2 \cdot 7.1 \cdot 10^{-6}}}{2 \cdot \sqrt{0.4 \cdot 0.9}} = 0.5$$

2) Method 2

We make the inductive coupling decoupling:



$$Z_{imp} = jX_M + \frac{j(X_{L1} - X_M - X_C)\cdot j(X_{L2} - X_M)}{j(X_{L1} + X_{L2}) - j(2X_M + X_C)}$$

In the current resonance mode $Z_{imp} = \infty \Rightarrow$ denominator is equal to 0.

$$X_{L1} + X_{L2} - 2X_M - X_C = 0 \Rightarrow X_M = \frac{X_{L1} + X_{L2} - X_C}{2}$$

$$\Rightarrow K_M = \frac{L_1 + L_2 - \frac{1}{\omega^2 C}}{\sqrt{L_1 L_2}\cdot 2}$$

Answer: $K_m = 0.5$

Appendix 6

THE PICTURES OF THE TEAMS

The picture of the participants of the Competition (I)

The picture of the participants of the Competition


Южно-Российский государственный технический универсистет

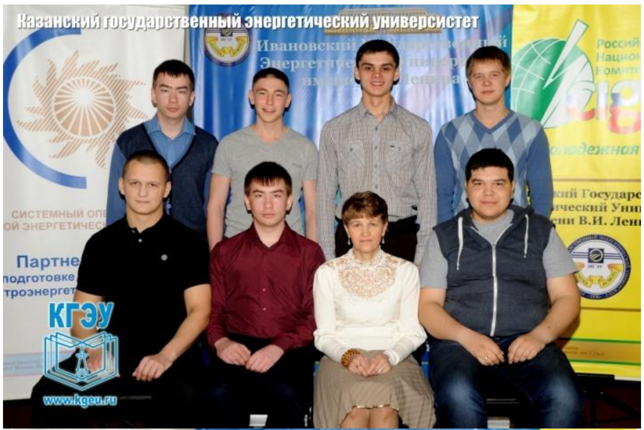

Белорусский национальный технический универсистет


Национальный минерально-сырьевой университет «Горный»


Казахский национальный технический университет


Ивановский государственный энергетический универсистет


Иркутский государственный технический универсистет


Казанский государственный энергетический университет
КГЭУ
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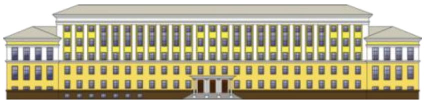
Санкт-Петербургский государственный электротехнический университет
1886


Костромская сельскохозяйственная академия


Новосибирский государственный технический университет
НГТУ

ANNOUNCEMENT



Ivanovo State Power Engineering University (ISPEU)
Open joint stock company "System Operator of United Power System" (SO UPS)
"Russian National Committee of International Council on Large Electric Systems" (CIGRE RNC)
JSC "Schneider Electric"

ELECTRICAL POWER ENGINEERING-2014

INTERNATIONAL STUDENT COMPETITION
ON ELECTRICAL POWER ENGINEERING, IVANOVO, RUSSIA,
November 18-22, 2014

INFORMATION LETTER

INTERNATIONAL STUDENT COMPETITION ON ELECTRICAL POWER ENGINEERING,

November 18-22, 2014, Ivanovo, Russia

Russian National Committee of International Council on Large Electric Systems (CIGRE RNC) and Ivanovo State Power Engineering University (ISPEU) in accordance with the plan of joint arrangements for the year of 2014 with the support of Joint-stock Company "System Operator of the United Power System", JSC "Territorial Generating Company #2", JSC "Schneider Electric" and Charitable foundation "Reliable Rising Generation" hold the International Student Competition on Electrical Power Engineering among the students of electrical and electrical power engineering programs of study.

The aim

Improving the quality of students' preparation of Electrical and Electrical Power Engineering programs of study, increasing students' interest for their profession, finding out talented young people and forming personnel potential to organize research, project and administrative production activity.

Dates

The Competition is held November18-22, 2014.

Preliminary program of the competition

November 18	arrival and registration of the participants;
November 19	the Competition holding;
November 20	checking up of the works;
November 21-22	awarding and excursion

Language

Russian, English, French

The place of the Competition

Lecture-rooms in ISPEU (34, Rabfakovskaya Str., Ivanovo, Russia).

Staying: ISPEU and Ivanovo hotels.

The terms of the Competition

The participants of a team are full-time graduate, 1st and 2nd year Master's Degree Students whose programs of study are **Electrical Power Engineering and Electrical Engineering**. The Competition has the individual and the team championship. The number of the participants from every higher educational institution is not more than **7** students. Number of teams is not limited. Total number of points in team championship is a sum of **five** best student points. The team is represented by a leader who is a teacher or a staff member of a higher educational institution. The leader is the member of the jury of the Competition.

The Competition tasks may be the ones prepared by the teachers of the electrical engineering of higher educational institutions, which take part in the Competition. . The tasks to be included in the list of the Competition tasks, with the decisions should be sent to e-mail cigre@ispu.ru no later than **November 1, 2014**.

In order to take part in the Competition it is necessary to fill in the application form and send it on e-mail: cigre@ispu.ru no later than October 15, 2014. Each participant must have a passport, student's card (or academic record book), calculator, pen

The participation in the Competition is confirmed with the application form on the higher educational institution note-paper certified by a person in charge and the seal of the institution (it may be sent by mail or taken to the organizational committee by the team leader) and its copy must be send to e-mail: cigre@ispu.ru. **The participation in the Competition is free**. The expenditure for meals, travel and lodging are at the expense of the funds of the sending institution. To reserve the hotel it is necessary to send the application form **before October 15, 2014**. Team leaders and students' are to stay in ISPEU and Ivanovo hotels. Cost of one day living is 300 - 700 rubles.

Excursion to energy efficient electricity facility is included to the Competition. The winners and participants are awarded with the diplomas, presents and are included in the personnel reserve of electric facilities.

Tasks subjects

There will be **12 tasks** of different difficulty levels in the following disciplines:

- Theoretical Basics of Electrical Engineering
- High-Voltage Engineering
- Relay Protection and Automation
- Electric Power Stations' and Substations' Electrical Equipment
- Electric Systems and Nets
- Electric Power Supply

Important dates

1.	The application form for taking part in the Competition	**deadline 15.10.2014**
2.	The application form for hotel reservation	**deadline 15.10.2014**
3.	The Competition holding	**18-22 November 2014**

The Organizational Committee

Vladimir Tyutikov,

The Chairman of Organizational Committee of the Competition, the vice-rector for Research of ISPEU.

Andrey Gofman,

The Vice-chairman, the leader of the organizational committee of Youth Section of CIGRE Russian National Committee

Arkadiy Makarov,

The head of the Students' Scientific Research and Talented Students department of Ivanovo State Power Engineering University, Coordinator of RNC CIGRE Youth Section

Ph. +7 (4932) 269-945, +7-920-671-45-37, e-mail: nirs@ispu.ru

Timophey Shadrikov, coordinator of the Competition,

Ph. +7-910-992-68-69, e-mail: cigre@ispu.ru

34, Rabfakovskaya Street, Ivanovo, Russia. 153003

Operational information about the competition is posted on the website of the university: www.ispu.ru and RNC CIGRE website www.cigre.ru (informational notices, the Competition rules of procedure, the themes and examples of tasks, routes to academic buildings and campus ISPU and hotels, etc.). The Organizational Committee reserves the right to make minor changes in the program of the Competition.

APPLICATION FORM

for participation in the Competition on Electrical Power Engineering

Table 1. Information about the participants

1. Surname, name of the participant (fully)	
2. Faculty	
3. Year of study, group	
4. Contact phone	
5. E-mail	
6. Requirement for hotel (yes/no)	

Note! This form is completed for each participant of the Competition.

Table 2. Information about the leaders of the team

1. Surname, name of the leader (fully)	
2. Official capacity	
3. Academic title, academic degree	
4. Contact phone	
5. E-mail	
6. Requirement for hotel (yes/no)	

Table 3. Information about the higher educational institution

1. Country	
2. Name	
3. Full address	
4. Surname, name of the higher educational institution leader (fully)	

Signature of the responsible person. Stamp.
Date of completion.

APPLICATION FORM

for hotel reservation

1. Name of higher educational institution	
2. Country	
3. Number of people	
4. Dates of stay	

Signature of the responsible person. Stamp.
Date of completion.

CONTENTS

BULLETIN
RUSSIAN NATIONAL COMMITTEE CIGRE

Issue №5

Youth section RNC CIGRE proceedings:
International student competition on theoretical and general electrical engineering «Electrical Engineering - 2014».
April 22-24, 2014, Ivanovo

Editor and responsible for the release - Arkadiy Makarov

Technical editor and desktop publishing - Dmitry Kormilicyn

Passed for printing 11.08.2014. Format 60x84 $^{1}/_{16}$.
Lithography. Conventional printed sheet . Publisher's signature 4.5.
Circulation of 100 copies. Order number .

Ivanovo State Power Engineering University.
Printed by Academic literature publication department of Ivanovo State Power Engineering University
34, Rabfakovskaya Street, Ivanovo, Russia. 153003.

ВЕСТНИК
РОССИЙСКОГО НАЦИОНАЛЬНОГО КОМИТЕТА СИГРЭ

Выпуск № 5

Материалы Молодежной секции РНК СИГРЭ: Международная студенческая олимпиада по теоретической и общей электротехнике «Электротехника - 2014», 22-24 апреля 2014 года, Иваново

Составитель и ответственный за выпуск – Макаров А.В.

Технический редактор и компьютерная верстка – Кормилицын Д.Н.

Подписано в печать 11.08.2014. Формат 60x84 $^{1}/_{16}$.

Печать плоская. Усл. печ. л. 4. Уч.-изд. л. 4.

Тираж 100 экз. Заказ №   .

ФГБОУ ВПО «Ивановский государственный энергетический университет имени В.И. Ленина».

Отпечатано в УИУНЛ ИГЭУ

153003, г. Иваново, ул. Рабфаковская, 34.