ISSN 2518-1726 (Online),
ISSN 1991-346X (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
Әль-фараби атындағы Қазақ ұлттық университетінің

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Казахский национальный университет
имени Аль-фараби

N E W S

OF THE NATIONAL ACADEMY OFSCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
Al-farabi kazakh
national university

SERIES
PHYSICO-MATHEMATICAL

5 (327)

SEPTEMBER-OCTOBER 2019

PUBLISHED SINCE JANUARY 1963

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

Б а с р е д а к т о р ы
ф.-м.ғ.д., проф., ҚР ҰҒА академигі **Ғ.М. Мұтанов**

Р е д а к ц и я а л қ а с ы:

Жұмаділдаев А.С. проф., академик (Қазақстан)
Кальменов Т.Ш. проф., академик (Қазақстан)
Жантаев Ж.Ш. проф., корр.-мүшесі (Қазақстан)
Өмірбаев У.У. проф. корр.-мүшесі (Қазақстан)
Жүсіпов М.А. проф. (Қазақстан)
Жұмабаев Д.С. проф. (Қазақстан)
Асанова А.Т. проф. (Қазақстан)
Бошкаев К.А. PhD докторы (Қазақстан)
Сұраған Д. корр.-мүшесі (Қазақстан)
Quevedo Hernando проф. (Мексика),
Джунушалиев В.Д. проф. (Қырғыстан)
Вишневский И.Н. проф., академик (Украина)
Ковалев А.М. проф., академик (Украина)
Михалевич А.А. проф., академик (Белорус)
Пашаев А. проф., академик (Әзірбайжан)
Такибаев Н.Ж. проф., академик (Қазақстан), бас ред. орынбасары
Тигиняну И. проф., академик (Молдова)

«ҚР ҰҒА Хабарлары. Физика-математикалық сериясы».

ISSN 2518-1726 (Online), ISSN 1991-346X (Print)

Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.)
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 01.06.2006 ж. берілген **№5543-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік

Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18, http://physics-mathematics.kz/index.php/en/archive

---

© Қазақстан Республикасының Ұлттық ғылым академиясы, 2019

Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

Главный редактор
д.ф.-м.н., проф. академик НАН РК **Г.М. Мутанов**

Редакционная коллегия:

Джумадильдаев А.С. проф., академик (Казахстан)
Кальменов Т.Ш. проф., академик (Казахстан)
Жантаев Ж.Ш. проф., чл.-корр. (Казахстан)
Умирбаев У.У. проф.. чл.-корр. (Казахстан)
Жусупов М.А. проф. (Казахстан)
Джумабаев Д.С. проф. (Казахстан)
Асанова А.Т. проф. (Казахстан)
Бошкаев К.А. доктор PhD (Казахстан)
Сураган Д. чл.-корр. (Казахстан)
Quevedo Hernando проф. (Мексика),
Джунушалиев В.Д. проф. (Кыргызстан)
Вишневский И.Н. проф., академик (Украина)
Ковалев А.М. проф., академик (Украина)
Михалевич А.А. проф., академик (Беларусь)
Пашаев А. проф., академик (Азербайджан)
Такибаев Н.Ж. проф., академик (Казахстан), зам. гл. ред.
Тигиняну И. проф., академик (Молдова)

«Известия НАН РК. Серия физико-математическая».

ISSN 2518-1726 (Online), ISSN 1991-346X (Print)

Собственник: РОО «Национальная академия наук Республики Казахстан» (г. Алматы)
Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан **№5543-Ж**, выданное 01.06.2006 г.

Периодичность: 6 раз в год.
Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел.: 272-13-19, 272-13-18,
http://physics-mathematics.kz/index.php/en/archive

© Национальная академия наук Республики Казахстан, 2019

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

E d i t o r i n c h i e f
doctor of physics and mathematics, professor, academician of NAS RK **G.M. Mutanov**

E d i t o r i a l b o a r d:

Dzhumadildayev A.S. prof., academician (Kazakhstan)
Kalmenov T.Sh. prof., academician (Kazakhstan)
Zhantayev Zh.Sh. prof., corr. member. (Kazakhstan)
Umirbayev U.U. prof. corr. member. (Kazakhstan)
Zhusupov M.A. prof. (Kazakhstan)
Dzhumabayev D.S. prof. (Kazakhstan)
Asanova A.T. prof. (Kazakhstan)
Boshkayev K.A. PhD (Kazakhstan)
Suragan D. corr. member. (Kazakhstan)
Quevedo Hernando prof. (Mexico),
Dzhunushaliyev V.D. prof. (Kyrgyzstan)
Vishnevskyi I.N. prof., academician (Ukraine)
Kovalev A.M. prof., academician (Ukraine)
Mikhalevich A.A. prof., academician (Belarus)
Pashayev A. prof., academician (Azerbaijan)
Takibayev N.Zh. prof., academician (Kazakhstan), deputy editor in chief.
Tiginyanu I. prof., academician (Moldova)

News of the National Academy of Sciences of the Republic of Kazakhstan. Physical-mathematical series.

ISSN 2518-1726 (Online), ISSN 1991-346X (Print)

Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)
The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 5543-Ж, issued 01.06.2006

Periodicity: 6 times a year
Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
http://physics-mathematics.kz/index.php/en/archive

© National Academy of Sciences of the Republic of Kazakhstan, 2019

Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
PHYSICO-MATHEMATICAL SERIES
ISSN 1991-346X **https://doi.org/10.32014/2019.2518-1726.63**
Volume 5, Number 327 (2019), 98 – 104

UDC 531, 53(075). 622.732.62-9. 53.072
IRSTI 29.03.77

K.A.Kabylbekov[1], Kh.K.Abdrakhmanova[2],
B.Sh.Kedelbaev[1], Ye.B. Issayev[1]

[1]M.Auezov South-Kazakhstan State University, Shymkent, Kazakhstan;
[2]South-Kazakhstan State Pedagogical University, Shymkent, Kazakhstan
kenkab@mail.ru, khadi_kab@mail.ru, b.sh.kedelbaev@mail.ru, erzhanisaev@mail.ru

MODELING OF THE NORMAL MAGNETIZATION CURVE OF FERROMAGNETIC

Abstract. The normal magnetization curve is used in technical calculations of magnetic circuits when it is required to investigate (to model) nonlinear inductive elements. Modeling of the normal magnetization curve by the use of an analytical function allows describing with a high precision a real magnetization curve along all characteristic sections and defining the magnetization curve by the continuous function. This procedure allows avoiding breaks and discontinuities of the extreme dependences obtained as a result of differentiation. There are a lot of ways of approximating the table function by the analytical function which with a particular degree of accuracy models an initial function at the given points. Modeling of the normal magnetization curve of the ferromagnetic is done by using the *arctangent* function for approximation of the curve and the Matlab software. The *arctangent* function is chosen because this function and its derivative are easily calculated and also because this function describes the normal magnetization curve with an adequate accuracy. There are also the experimental data of magnetic field induction dependence on magnetizing field intensity and the approximating magnetization curve. The obtained diagrams show that the table function is approximated by the analytical function of *arctangent* which with a sufficient accuracy models the table function at the given points.

Key words: ferromagnetic, magnetization curve, experimental data, approximation, arctangent function.

Introduction. Modeling of the normal magnetization curve of the ferromagnetic is done by using the Matlab software [1-7]. The Matlab software is based not only on the best practices of development and computer realization of numerical methods build up for the last three decades but also on all experience of formation of mathematics throughout all history of mankind. About one million legally registered users already apply this software. The top universities and scientific centers of the world willingly use it in their scientific projects. It is important that the Matlab software can be integrated with such popular software as Mathcad, Maple and Mathematica. Thus, the Matlab system can become the excellent assistant in scientific research.

Unfortunately, the numerical calculations which are carried out by students often are done by means of the calculator that is almost manually. Modern computers are frequently used only for presentation of the work. Actually students should be able not only to solve these or other engineering problems, but also do them by using modern methods, that is, using personal computers.

The use of the computer simulation allows: to individualize and differentiate tutoring process; to exercise control with diagnostics of mistakes and with a feed-back; to carry out self-testing and self-correction of educational activity; to avoid during indoor classes the laborious routine calculations due to performing them by computers; to visualize an educational information; to simulate and imitate the studied processes or phenomena; to carry out the virtual version of the real laboratory works and experiments by simulating them on the computer; to develop imaginary and theoretical thinking; to enhance learning motivation; to form the culture of cognitive activity, etc.

In M.Auezov South Kazakhstan State University computers are used on Physics classes for the following activities: statistical processing of results of a laboratory experiment and plotting the diagrams of the studied relationship; demonstration and study of processes which for various reasons can't be observed in reality.

Application of Matlab software on Physics classes allows simulating and researching various physical processes, saves time for practical classes, promotes deeper understanding the phenomena, increases interest in studying physics; develops creativity of students.

In our early works [8-28] we have shown the potentials of the Matlab software for modeling and visualization of physical processes in mechanics, molecular physics, electromagnetism and quantum physics.

The normal magnetization curve is used in technical calculations of magnetic circuits when it is required to investigate (to model) nonlinear inductive elements. The normal magnetization curve is presented by the diagram of the magnetic field induction versus magnetic field intensity or reverse functional dependence H(B). The normal magnetization curve has three segments: the initial segment corresponding to lower part of the curve, the second segment corresponding to the swift increase of the induction and the third segment corresponding to the saturation of the steel core of the inductor.

As an example in the table we have given the data for the magnetization curve of the **steel 2312.**

Source: © simenergy.ru

№	1	2	3	4	5	6	7	8	
H, A/m	**0**	**68**	**76**	**86**	**96**	**140**	**190**	**240**	
B, T	**0**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**	
№	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
H, A/m	**300**	**400**	**550**	**1000**	**1600**	**3400**	**7700**	**13400**	**19400**
B, T	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**

There are many ways of approximation of table function by analytical function which with a particular degree of accuracy models the initial function at the given points. These mathematical ways of description of the table function are based on application of various mathematical functions. Modeling of the normal magnetization curve by using analytic function allows with a high precision describing a real magnetization curve along all characteristic segments, defining the magnetization curve by the continuous function. This procedure allows avoiding breaks and discontinuities of the extreme dependences obtained as a result of differentiation. In general, power functions are widely used since they allow carrying out calculations of magnetic circuits with alternating magnetic fields. The accuracy of approximation of a real curve by power polynomial is proportional to the determination number of its coefficients. Hyperbolic sine and tangent at their expansion in a series turn into power polynomial. The results of approximation by a hyperbolic sine and tangent are close to approximation by a power polynomial, and in many cases they almost exactly coincide with data of natural experiments.

The *arctangent* function is widely used nowadays for approximation of the magnetization curve because this function and its derivative are easily calculated and also because this function with an adequate accuracy describes the normal magnetization curve.

Formulation of the problem. Let us consider the approximation of the normal magnetization curve by the function containing *arctangent* and three adjustable coefficients

$$B(H) = p1 \cdot arctg(p2 \cdot H) + p3 \cdot H$$

The unknown coefficients (*p1, p2, p3*) may be determined by using least square technique. According to this technique the approximating function is determined as the minimum of the sum of squares of the calculated approximating function deviation from experimental points. This criterion of the least square technique is written as the following expression:

$$\sum_{i=1}^{N} \delta^2 = \sum_{i=1}^{N} \left(p1 \cdot arctg(p2 \cdot H_i) + p3 \cdot H_i - B_i \right)^2 \to \min$$

The necessary condition for existence of the function minimum is the equality to zero of its partial derivatives with respect to unknown variables *p1, p2* and *p3*. As a result we obtain the following system of equations:

$$\frac{\partial}{\partial p_1}\sum_{i=1}^{N}\delta^2 = 0; \sum_{i=1}^{N} 2\cdot\left(p1\cdot arctg\left(p2\cdot H_i\right) + p3\cdot H_i - B_i\right)\cdot arctg\left(p2\cdot H_i\right) = 0$$

$$\frac{\partial}{\partial p_2}\sum_{i=1}^{N}\delta^2 = 0; \sum_{i=1}^{N} 2\cdot\left(p1\cdot arctg\left(p2\cdot H_i\right) + p3\cdot H_i - B_i\right)\cdot \frac{p1\cdot H_i}{1+p_2^2\cdot H_i^2} = 0$$

$$\frac{\partial}{\partial p_3}\sum_{i=1}^{N}\delta^2 = 0; \sum_{i=1}^{N} 2\cdot\left(p1\cdot arctg\left(p2\cdot H_i\right) + p3\cdot H_i - B_i\right)\cdot H_i = 0$$

The solution of this system of nonlinear equations allows determining the coefficients of the approximating function.

There is the listing of the program for approximation at small magnitudes of the magnetizing field:

```
>> H=[0 68 76 86 96 140 190 240]; % in A/m
>>  B=[0 0.4 0.5 0.6 0.7 0.8 0.9 1]; % in T
>> plot(H,B,'o')
>>grid on
>> p1=0.984;
>>p2=7.273*10.^-3;
>>p3=1.935*10.^-5;
>>hold on
>>B=p1*atan(p2*H)+p3*H;
>>plot(H,B,'-');
```

The result is presented in the fig.1

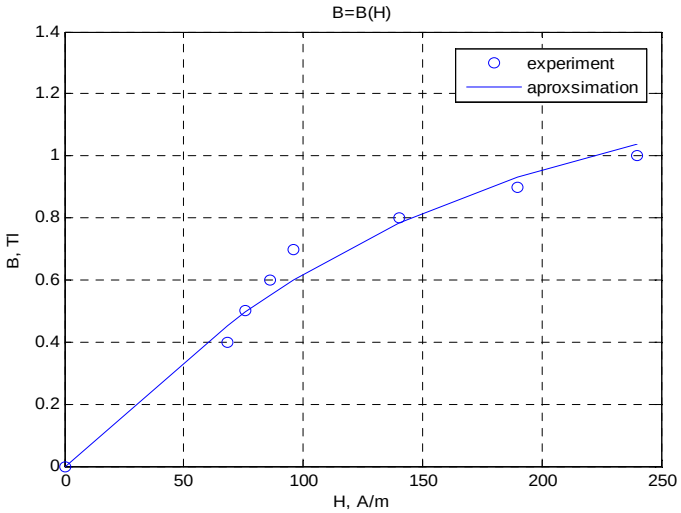

Figure 1 - Approximation of the magnetization curve by *arctangent* function at small magnitudes of the magnetizing field

The listing of the program for approximation at large magnitudes of the magnetizing field:

```
>> H=[300 400 550 1000 1600 3400 7700 13400 19400];% in A/m
>> B=[1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9]; % in T
>> plot(H,B,'o')
```

```
>> grid on
>> p1=0.984;
>> p2=7.273*10.^-3;
>> p3=1.935*10.^-5;
>> hold on
>> B=p1*atan(p2*H)+p3*H;
>> plot(H,B,'-');
```

The result is presented in the fig.2

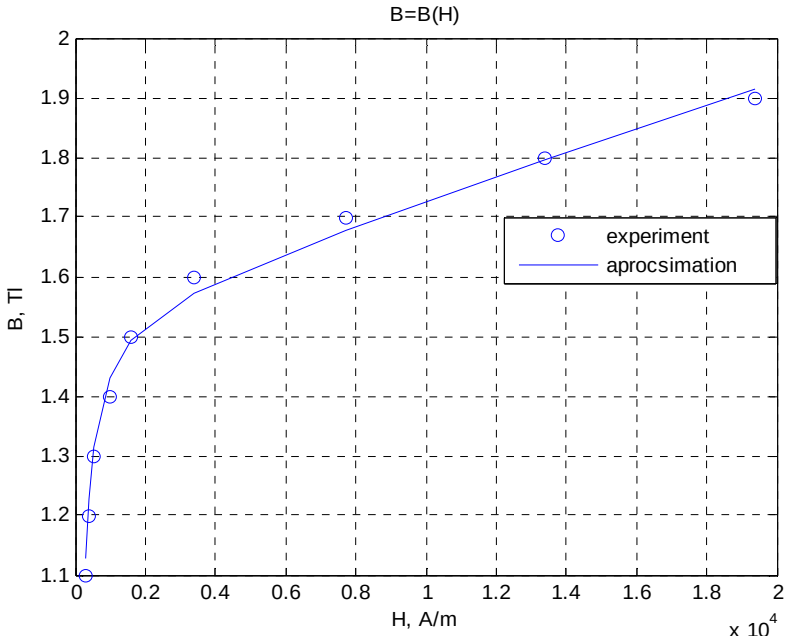

Figure 2 - Approximation of the magnetization curve by *arctangent* function at large magnitudes of the magnetizing field

This approximation is odd and may be applied for calculation of magnetic circuits with stationary as well as with alternating fields.

The listing of the program for approximation at magnitudes of the magnetizing field from zero up to 7700 A/m:

```
>> H=[0 68 76 86 96 140 190 240 300 400 550 1000 1600 3400 7700];
>>  B=[0 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7];
>> plot(H,B,'o');
>> plot(H,B,'o');
>> grid on
>> p1=0.984;
>>p2=7.273*10.^-3;
>>p3=1.935*10.^-5;
>>hold on
>>B=p1*atan(p2*H)+p3*H;
>>plot(H,B,'-');
```

The result is presented in the fig.3

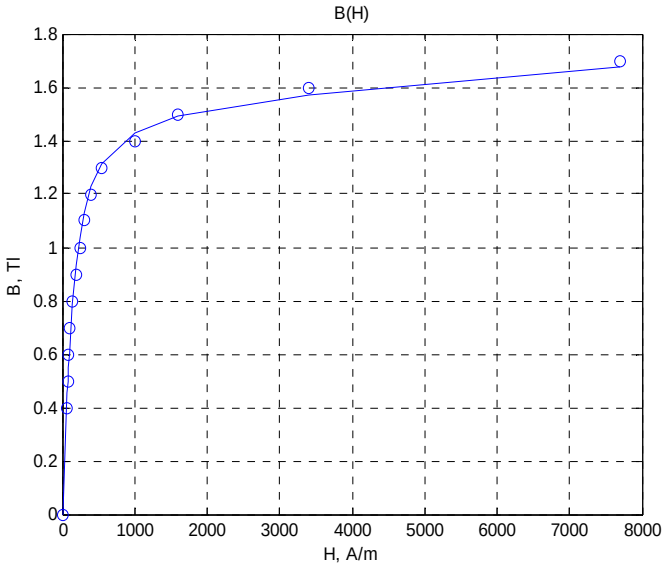

Figure 3 - Approximation of the magnetization curve by *arctangent* function
at magnitudes of the magnetizing field from zero up to 7700 A/m

Conclusion: Modeling of the normal magnetization curve of the ferromagnetic is done by using the *arctangent* function for approximation of the curve and the Matlab software. The *arctangent* function is chosen because this function and its derivative are easily calculated and also because this function describes the normal magnetization curve with an adequate accuracy. There are also the experimental data of magnetic field induction dependence on magnetizing field intensity and the approximating magnetization curve. The obtained diagrams show that the table function is approximated by the analytical function of *arctangent* which with a sufficient accuracy models the table function at the given points.

К.А.Қабылбеков[1], Х.К.Абдрахманова[2], Б.Ш. Кеделбаев[1], Е.Б. Исаев[1]

[1]М.Әуезов атындағы Оңтүстік Қазақстан мемлекеттік университеті, Шымкент, Қазақстан
[2]Оңтүстік Қазақстан мемлекеттік педагогикалық университеті,
Шымкент, Қазақстан
kenkab@mail.ru, khadi_kab@mail.ru, b.sh.kedelbaev@mail.ru, erzhanisaev@mail.ru

ФЕРРОМАГНЕТИКТІҢ НЕГІЗГІ МАГНИТТЕЛУ ҚИСЫҒЫН МОДЕЛДЕУ

Аннотация. Магниттік тізбектерді техникалық есептеулерде сызықтық емес индуктивті элементтерді зерттегенде (моделдеуде) негізгі магнттелу қисығы қолданылады. Магниттелудің негізгі қисығын аналитикалық функция көмегімен модельдеу барлық сипаттамалық бөлімдерде нақты магниттелу қисығын жоғары дәлдікпен сипаттауға, дифференциалдау нәтижесінде пайда болатын экстремалды тәуелділіктердегі үзілістерді болдырмайтын үздіксіз функциямен магниттелу қисығын орнатуға мүмкіндік береді. Белгілі бір дәлдікпен берілген нүктелердегі бастапқы функцияны модельдейтін аналитикалық функциямен кестелік функцияны жақындастырудың көптеген әдістері бар. Ферромагнетиктің негізгі магниттелу қисығын модельдеу үшін біз Matlab жүйесін және магниттелу қисық сызығын аппроксимациялау үшін, функцияның өзі мен оның туындысын есептеу қарапайымдылығына, сондай-ақ тәжірибелік магниттелу қисығын жеткілікті дәлдікпен сипаттайтына байланысты, арктангенс функциясын таңдадық. Нақты ферромагнетик үшін магниттік индукцияның магниттеуші өрістен тәуелдігінің эксперименттік мәліметтері мен олардың аппроксимацияланған қисық келтірілген. Келтірілген суреттен (кесте бойынша) нүктелермен берілген функцияны жеткілікті дәлдікпен арктангенс фукциясымен аппроксимацияланған, яғни бастапқы функцияны модельдейтін арктангенс фукциясы арқылы алынған магниттелу қисығы көрсетілген.

Түйін сөздер. Ферроманетик, магниттелу қисығы, тәжірибелік берілгендер, аппроксимация, арктангенс функциясы.

К.А. Кабылбеков[1], Х.К. Абдрахманова[2], Б.Ш.Кеделбаев[1], Е.Б.Исаев[1]

[1]Южно-Казахстанский государственный университет им. М.Ауэзова, Шымкент, Казахстан;
[2]Южно-Казахстанский государственный педагогический университет, Шымкент, Казахстан

МОДЕЛИРОВАНИЕ ОСНОВНОЙ КРИВОЙ НАМАГНИЧЕНИЯ ФЕРРОМАГНЕТИКОВ

Аннотация. Основная кривая намагничивания используется при технических расчетах магнитных цепей, когда требуется исследовать (моделировать) нелинейные индуктивные элементы. Моделирование основной кривой намагничивания с помощью аналитической функции позволяет с высокой точностью описать реальную кривую намагничивания на всех характерных участках, задать кривую намагничивания непрерывной функцией, что позволяет избежать изломов и разрывов экстремальных зависимостей, получаемых в результате дифференцирования. Существуют множество способов аппроксимации таблично заданной функции аналитической функцией, которая с определенной степенью точности моделирует исходную функцию в заданных точках. Для моделирования основной кривой намагничивания ферромагнетика нами выбрана система Matlab и арктангенсная функция аппроксимации кривой намагничивания из-за простоты вычислений самой функции и ее производной, а также достаточной точности отображения оригинальной кривой намагничивания. Представлены экспериментальные данные зависимости индукции магнитного поля от напряженности намагничивающего поля с аппроксимационой кривой намагничивания. Из представленной картины видно, что таблично заданная функция аппроксимируется аналитической функцией арктангенса, которая с достаточной степенью точности моделирует исходную функцию в заданных точках.

Ключевые слова. Ферромагнетики, кривая намагничивания, экспериментальные данные, аппроксимация, функция арктангенса.

Information about authors

Kabylbekov K.A. – cand.ph-math.sc., associate professor of the chair of Physics, M.Auezov South-Kazakhstan State University, kenkab@mail.ru;

Abdrakhmanova Kh.K. - cand.chem.sc., associate professor of the chair of Physics, South-Kazakhstan State Pedagogical University, khadi_kab@mail.ru;

Kedelbaev B.Sh. - doc. eng. sciences, professor of the chair of “Microbiology”, M. Auezov South-Kazakhstan State University, b.sh.kedelbaev@mail.ru;

Issaev E.B. - cand.techn.sciences, associate professor of the department “Biology” of M. Auezov SKSU, erzhanisaev@mail.ru

REFERENCES

[1] Porsev S. V. Computer simulation of physical processes in the package MATLAB. M.: Hot Line-Telecom, 2003. 592 p.

[2] Kotkin G.A., Cherkassky V.S. Computer modeling of physical processes using MATLAB: Tutorial. / Novosibirsk University.

[3] Lurie M. S., Lurie O. M. Application of the MATLAB program in the study of course of electrical engineering. For students of all specialties and forms of educatio. Krasnoyarsk: SibSTU, 2006208 p.

[4] Potemkin V. system of engineering and scientific calculations MATLAB 5.x (in 2 volumes). Moscow: Dialog-MIFI, 1999.

[5] Averyanov G. P., Budkin, Dmitrieva V. V. Design automation. Computer workshop. Part 1. Solving problems of Electrophysics in MATLAB: tutorial. Moscow: MEPhI, 2009. 111 p.

[6] Dyakonov V. p. MATLAB. Complete tutorial. M: DMK Press, 2012. 768 p.

[7] Ryndin E. A., Lysenko I. E. Solving problems of mathematical physics in Matlab. Taganrog: TRTU. 2005. 62 p.

[8] Kabylbekov K.A., Abdrakhmanova Kh.K., Abekova J., Abdraimov R.T., Ualikhanova B.S. Calculation and visualization of a system-an electron in a deep square potential well, with use of the software package of MATLAB. Proceeding of the III International Scientific and Practical Conference «Topical researches of the World Science» (Iune 28, 2017,Dubai, UAE). №7(23). Vol.I, July 2017, P 7-13.

[9] Kabylbekov K., Saidullaeva N., Spabekova R., Omashova G, Tagaev N., Bitemirova A., Berdieva M. Model of a blank form for computer laboratory work on research of the speed selector. Journal of Theoretical and Applied Information Technology15th July 2017. Vol. 95. No 13, P. 2999-3009, c 2005 – ongoing JATIT & LLS. Indexada en Scopus.

[10] Kabylbekov K.A., Omashova G.,Spabekova R., Saidullaeva N., Saidakhmetuv P., Junusbekova S. Management and organization of computer laboratory work in physics education. Espacios. Vol. 38 (Nº 45) Año 2017. Pág. 35. Indexada en Scopus.

[11] Kabylbekov K., Omashova G, Spabekova R, Saidullaeva N, Saidakhmetuv P. Junusbtkova S., Management and organization of computer laboratory work in physics education. Espacios. Vol. 38 (Nº 45) Año 2017. Pág. 35. Indexada en Scopus, Google Schollar.

[12] Kabylbekov K.A., Ashirbaev Kh.A., Arysbaeva A.S., Jumagaliyeva A.M. Model of the form of the organization of computer laboratory work in the study of physical phenomena. Modern high technologies, №4, Moscow, 2015, P 40-43.

[13] Kabylbekov K.A., Madiyarov N.K., Saidakhmetov P.A. Independent design of research tasks of computer laboratory works on thermodynamics. Proceedings of the IX International Scientific and Methodological Conference. Teaching natural sciences (biology, physics, chemistry) mathematics and computer science. Tomsk-2016, P. 93-99.

[14] Kabylbekov K.A, Omashova G. Sh, Spabekova R.S, Saidakhmetov P.A, Serikbaeva G.S, Aktureeva G. Organization of computer laboratory works on study the turn-on and turn-off current of the power supply by using MATLAB software package. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Physics and Mathematics, Almaty, Volume 3, Number 313 2017, P. 139-146**.**

[15] Kabylbekov K.A, Omashova G. Sh, Spabekova R.S, Saidakhmetov P.A, Serikbaeva G.S , Aktureeva G. Organization of computer labs for the study of velocity and height distribution of molecules from the Earth's surface by using MATLAB software package. Bulletin of NAS RK, Almaty, Volume 3, Number 367, 2017, P 111-119.

[16] Kabylbekov K.A, Ashirbayev H.A, Abdrakhmanova Kh.K, Dzhumagalieva A.I., Kydyrbekova J.B. Organization of laboratory work on study of electric and magnetic fields by using MATLAB software package. Proceedings of the National Academy of Sciences of the Republic of Kazakhstan, Series of Physics and Mathematics, Almaty, Volume 3, Number 313, 2017, P 206-213.

[17] Kabylbekov K. A., Spabekova R. S., Omashova G.Sh., Abzhapparov A.A., Polatbek A, Serkebayeva S. G. The use of the software package MATLAB for solving problems on bifurcated electrical circuits. Bulletin of NAS RK, Almaty 2017, Volume 4, Number 368, P 101-108.

[18] Kabylbekov K. A., Ashirbaev H. A., Abdrakhmanova Kh.K., Dzhumagalieva A. I., Kadyrbekova J. B. Organization of the performance of the laboratory work "Modeling the electric field of a system consisting of a dielectric square and a long charged conductor" by using MATLAB software package. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Physics and Mathematics, Almaty 2017, Volume 4, Number 314, P 252-259.

[19] Kabylbekov K. A., Abdrakhmanova Kh.K., Ermakhanov M.N., Urmashev B.A., Jатканbayev E.T. Calculation and visualization of a body motion in a gravitational field. NEWS of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences.Volume 4, Number 430 (2018), P 87-98.

[20] Kabylbekov K. A., Abdrakhmanova Kh.K., Omashova G.Sh., Lakhanova K.M., Abekova Zh.A. Organization of computer laboratory work “Calculation and visualization of small forced oscillations” N E W S of the National Academy of Sciences of the Republic of Kazakhstan, Series of geology and technical sciences. Volume 3, Number 430 (2018), P 145-155.

[21] Kabylbekov K. A., Abdrakhmanova Kh.K., Omashova G.Sh., Kedelbaev B., Abekova Zh.A. Calculation and visualization of electric field of a space –charged sphere. N E W S of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. Volume 5, Number 431 (2018), P 201 – 209. doi.org/10.32014/2018.2518-170X.26

[22] K. A. Kabylbekov, Kh. K. Abdrakhmanova, P. A. Saidakhmetov, T. S. Sultanbek, B. Sh. Kedelbaev. Calcuiation and visualization of isotopes separation process using MATLAB program. N E W S of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. Volume 5, Number 431 (2018), P 218– 225. doi.org/10.32014/2018.2518-170X.28

[23] Kabylbekov K. A., Abdrakhmanova Kh.K., Saidakhmetov P.A., Musaev J.M., Issayev Ye.B., Ashirbaev Kh.A. Calculation and visualization of a body motion under the gravity force and the and the opposing drag. N E W S of the National Academy of Sciences of the Republic of Kazakhstan Series of geology and technical sciences. Volume 6, Number 432 (2018), P 85– 95. doi.org/10.32014/2018.2518-170X.38

[24] Kabylbekov K. A., Abdrakhmanova Kh.K., Saidakhmetov P.A., Kedelbaev B.Sh., Abdraimov R. T., Ualikhanova B.S. Calculation and visualization of the field coaxial cable carrying steady current. N E W S of the National Academy of Sciences of the Republic of Kazakhstan Series of geology and technical sciences. Volume 6, Number 432 (2018), P 55 – 65. doi.org/10.32014/2018.2518-170X.35

[25] Kabylbekov K. A., A.D.Dasibekov, Abdrakhmanova Kh.K., Saidakhmetov P.A., Issayev E.B., Urmashev B.A. Calculation and visualization of oscillating systems. N E W S of the National Academy of Sciences of the Republic of Kazakhstan Series of geology and technical sciences. Volume 6, Number 432 (2018), P 110 – 120. doi.org/10.32014/2018.2518-170X.41

[26] Kenzhekhan Kabylbekov, Khadisha Abdrakhmanova, Gaukhar Omashova, Pulat Saidakhmetov, Turlan Sultanbek, Nurzhamal Dausheyeva. A Laboratory on visualization of Electrostatic and Magnetic Fields. Acta Polytechnica Hungarica Vol. 15, No. 7, 2018, P49-70. DOI: 10.12700/APH.15.7.2018.7.3

[27] Kabylbekov K. A., Dasibekov A.D., Abdrakhmanova Kh.K., Saidakhmetov P.A. Calculation and visualization of quantum-mechanical tunnel effect. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Physics and Mathematics, Volume 2, Number 324 (2019), P 60-68 . doi.org/10.32014/2019.2518-1726**.**13

[28] Kabylbekov K. A., Dasibekov A.D., Abdrakhmanova Kh.K., Saidakhmetov P.A. Calculation and visualization of small oscillations of a double plane pendulum. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Physics and Mathematics, Volume 2, Number 324 (2019), P 69-79. doi.org/10.32014/2018.2518-1726**.**14

Publication Ethics and Publication Malpractice
in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier.com/postingpolicy), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service http://www.elsevier.com/editors/plagdetect.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:

www:nauka-nanrk.kz

http://physics-mathematics.kz/index.php/en/archive

ISSN 2518-1726 (Online), ISSN 1991-346X (Print)

Редакторы *М. С. Ахметова, Т.А. Апендиев, Д.С. Аленов*
Верстка на компьютере *А.М. Кульгинбаевой*

Подписано в печать 10.10.2019.
Формат 60x881/8. Бумага офсетная. Печать – ризограф.
9,6 п.л. Тираж 300. Заказ 5.

Национальная академия наук РК
050010, Алматы, ул. Шевченко, 28, т. 272-13-18, 272-13-19