

## Research Article

# Reversible transliteration of the historical Ukrainian alphabets in the context of heritage preservation and linguistic technologies development

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The article analyzes the alphabets used for the Ukrainian language in the course of its evolution and proposes a system of their simple-correspondent (isomorphic) transliteration into the Latin script that possesses the property of reversibility and is the base for the Ukrainian transliteration standard DSTU 9112:2021. It is stated that due to the complete letter register, compatibility with the language processing procedures, and the more appropriate phonological motivation, the proposed system is more viable than the Romanization tables of the ISO 9:1995 and that of the Library of Congress. In addition, a phonemic transcription mechanism for modern Ukrainian is proposed, that is necessary for machine translation, cross-lingual information retrieval, language transfer, speech generation, and other Natural Language Processing tasks. The obtained results are helpful for the effective inclusion of Ukraine and other Slavic countries in international cooperation in the field of preservation of historical written monuments, information and linguistic technologies, corpus linguistics and computational lexicography, machine translation, and library science.

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## 1. Introduction

The globalization processes and rapid development of information and linguistic technologies have resulted in the rise of an information space in which textual linguistic data are provided mainly through Latin script. Given this, the countries whose languages are based on non-Latin alphabets,

have developed the Romanization systems which are used in their international communication: *Hitachi* (Jap.), *Pyongyang* (Kor.), *Xinhua* (Chin.), *Hurghada* (Arab.), *Haifa* (Yid.), etc.

The use of Latin script has gone today far beyond the traditional linguistic problem of how to render individual proper names and exoticisms. The Natural Language Processing (NLP) scenarios often require the availability of equivalent Latinized alphabets for languages based on non-Latin scripts. Transliteration issues have been explored mainly in the context of the use of automatic transliteration tools for ancient and modern Sanskrit (Cai & Wang 2018), Javanese (Razak et al. 2018; Widiarti & Pulungan 2020), Punjabi (Abbas & Asif 2020), Arabic and other non-Latin texts (Bogacz, Klingmann & Mara 2017) where machine transliteration is considered as a component of **information retrieval** (Naji & Allan 2016). The projection of text from orthographic space to phonemic space was proven by Tsvetkov & Dyer (2016) and Chaudhary et al. (2018) to enable effective **knowledge transfer** across languages. Phonemic Latinization (transcribing phonemes in International Phonetic Alphabet – IPA) of low-resource languages involved in **machine translation** and **speech recognition**, helps to improve the translation and recognition quality for proper names and other lexical units that sound similar in different tongues.

The need to reflect the Latin texts of historic Ukrainian texts is especially urgent because of the necessity to preserve the cultural heritage of Ukraine and other European countries possessing historical monuments of the 9th – 14th centuries containing texts in the Ancient Ukrainian language that is recognized by historical linguists studying Ukrainian as one of the major dialects of Old Slavic (Mozer 2018, 9). Despite the great role of the ancient Kievan state in the development of the languages of Eastern and other Slavs (see Sobolevskij 1907; Istrina 1915; Shevelov 1979; Mozer 2018), it is relatively little known about the Ancient and Old Ukrainian languages spoken on its territory. A notable reason for this is the absence of a corresponding comprehensive Romanization system, where the existing standards for the Slavic alphabet (ISO 9:1995) and the Church Slavic alphabet (ALA-LC 2011) have strong restrictions on their use: the first does not have in its register the most of historic Cyrillic letters (Ѣ, Ѧ, Ѧ, Ѧ, Ѧ, etc.); the second fails to provide transliteration using the basic Latin letters (with the ASCII codes 33–127) that is important in language processing technologies and does not contain the Cyrillic letters з, ї, ґ.

The appearance of the Unicode system allowing for communication in the Cyrillic script has alleviated but not completely resolved these problems. For example, the development of the Ukrainian cultural sector involves, in particular, the preservation of historical written monuments of Ukraine, as well as

ensuring their “visibility” and accessibility for professionals and users in Ukraine and worldwide. The inclusion of textual information on these documents in international databases and information resources is required for international research, possibly within the European Research Infrastructure for Heritage Science (Pezzati 2019). Effective inclusion of Ukrainian into NLP systems implies relevant alphabetical and phonemic Romanization mechanisms, that is useful for translation of borrowed internationalisms and proper names.

In this article, we will consider the system of Latinization of the historic Ukrainian alphabets that uses both letters with diacritical marks and those with the ASCII codes 33–127, which grounds the Ukrainian transliteration standard “Cyrillic–Latin transliteration and Latin–Cyrillic retransliteration of Ukrainian texts. Writing rules” (DSTU 9112:2021).

## 2. latinization methods

To warrant effective inclusion of Ukrainian language into multilingual corpora and NLP instruments, we will use isomorphic (bijective) transliteration of Cyrillic texts into Latin script (Striova 2019), which ensures the complete preservation of the information contained in these texts. The scientific transliteration approach is based on the principle of mutual unambiguity between the original graphemes and transliterated characters (Maslov 1987, 284), which is important for reverse transliteration and prevents information loss. This kind of relation exists between *gajevica* and *vukovica* in the languages of former Jugoslavija. Reformatskij (1960, 96) noted that it is not necessary to strive for adequate reading of proper names in other languages. The scientific transliteration does not involve the most “convenient” or “easy” reading of the converted text in another language but takes into account the rules of the original pronunciation of graphemes.

Based on the above, we propose isomorphic transliteration and retransliteration tables for the Ancient Ukrainian alphabet widely known also as the Old Slavic or Church Slavic (10th century – second half of the 14th century), for the Old (Medieval) Ukrainian alphabet (second half of the 14th century – 1798), and for the New Ukrainian alphabet (since 1798). This periodization is commonly agreed upon (Shevelov 1979; Nimchuk & Purjajeva 2004; Mozer 2018).

A non-one-to-one (non-injective) approach will be applied to phonemic transcription of modern Ukrainian letters with IPA symbols. This tactic is motivated by the more general character of the phonemic representation of texts and by violations of the phonetic principle of writing, so that one phoneme may correspond to different graphemes and vice versa.

The transliteration choices account for reconstructed readout of Ancient, Old, and New Ukrainian Cyrillic letters and the graphical traditions of the Slavic languages, where we use diacritics and combinations of basic Latin letters (with the ASCII codes 33–126 – to be compatible with root NLP procedures). Such combinations are needed because the Cyrillic alphabet has more letters than the number of basic Latin letters. In these combinations, we use the modifiers **h** – introduced by Jakobson (1965) – and **w**, which have no own phonetic meaning and denote phonemic modification of other letters combined with them. So, in the Appendix, we present transliteration and retransliteration (reverse transliteration) tables for each period using Latin letters with diacritical marks (System A) and letter modifiers (System B). The phonemic transcription table is provided for the modern Ukrainian.

### 3. Transliteration decisions

The development of the Ukrainian language was accompanied by characteristic phonological changes (Sobolevskij 1907, 20–151; Istrina 1915, 8–35; Meillet 1951, 15–125; Bezpaljko et al. 1957, 27–171) which should be displayed in the Latinized alphabets. On the one hand, the origin of Old Ukrainian letters from Ancient Ukrainian (Old Slavic) presupposes the presence of graphic similarity between their Romanized counterparts, and on the other hand, the appearance of specific phonetic features inherent in the Ukrainian language necessitates appropriate graphic modifications. Thus, we consider Ancient Ukrainian, Old Ukrainian, and New Ukrainian as three different, though close to each other languages. The corresponding Latinized alphabets must be similar, but at the same time reflect the characteristics of the historical pronunciation. This primarily concerns the Latinization of the letters **ѣ**, **ѥ**, **Ѧ** in different periods of Ukrainian language history.

The role of proto-Ukrainian dialects. Let us draw attention to the fact that the influence of proto-Ukrainian dialects on the formation of the Ancient Ukrainian and Old Slavic language and alphabet is not understood to the full extent. This impact is not only due to the great role of ancient Kiev (sic) in the cultural, trade, and religious life of Eastern Slavs of the 9th – 14th centuries. Not widely known are the historical monuments and artifacts evidencing the importance of the Ukrainian component in the Slavic language history.

The proto-Cyrillic script had existed in Kiev in the 9th century, which is proved by finding of the Sophia alphabet and artifacts of that time (Brajchevsjkyj 2009, 29–30, 142). Definitely, it was a favorable substrate for Cyrillic alphabet adoption and its spread on the territories inhabited by Eastern

Slavs. The facts of early language contacts are also documented. For example, Constantine VII Porphyrogenetos (Κωνσταντῖνος Ζ' Πορφυρογέννητος) transcribes in 949 into the Hellenic script the name of Kiev and the names of some thresholds on the river Dniro: *το Κίαβο*, *το Κιοάβα* (sic), *τον Κιοβα* (sic) (Shevelov 1979, 209); *Νεασήτ* (< Нѣасѣтъ), *Νεσσονπή* (< Несѣпи), *Βερούτζη* (< Вѣрѣшти < Вѣрѣти 'seethe, popple') (Sobolevskij 1907, 20, 41) that reflect the proto-Ukrainian speech in writing. The Ancient Ukrainian verb *вѣрѣти* corresponds to the modern Ukrainian *вирувати*, the Russian equivalent of which is different: *бурлить*.

These facts should be kept in mind when considering the Ancient Ukrainian alphabet (which is the same as the Old Slavic alphabet). However, the detailed analysis of phonological dynamics of proto-Ukrainian and Ancient Ukrainian dialects goes beyond the scope of this article.

The register of the Old Slavic Cyrillic letters is presented in (Istrina 1915, 22; Cejtin et al. 1994, 56–57). The register of Old Ukrainian letters is given (with certain variations) in (Zjizanjij 1596; Smotryskij 1619; Bewhrywnda 1627). It should be noted that the authors of that time used the name “Slavic” to denote the Ukrainian language. The register of New Ukrainian letters includes the alphabets of O. Pavlovsjkyj, M. Luchkaj, M. Shashkevych, Ja. Gholovacjkyj, I. Vaghylevych, M. Maksymovych, P. Kulish, M. Draghomanov, M. Ghatcuk, Je. Zhelekhivskyj and the modern Ukrainian alphabet (Pivtorak 2004; Nimchuk & Purjajeva 2004).

On the territory of modern Ukraine, elements of Latin script based on Polish, Czech, German, Hungarian, Latin, Romanian, English, and other languages have been used since the 14th century (Shevelov 1979, 451). Let us pay special attention to the letters that cause the most discord in their Romanization.

The letter *r*. Pavlenko pointed out the Hellenic roots of the Proto-Cyrillic alphabet, which already existed at the time of the educational activity of Cyril and Methodius and which was used in Kiev at that time (Brajchevsjkyj 2009, 15). This alphabet included the Ukrainian Cyrillic letter *r*, as evidenced by written monuments of the 9th century (Brajchevsjkyj 2009, 29–30, 142). So, the letter *r* comes from the ancient Greek gamma *γ*, which in Latin-script languages corresponds to the *g*: *Gregory* (English), *geology* (English), *giro* (Italian), *gusto* (Spanish), *grafolog* (Czech). This origin presupposes the presence of the graphic element “g” in the transliteration of Ancient Ukrainian. The preservation of this element in the transliteration of the letter *g* in later periods would reflect the continuity of the Ukrainian written heritage, the succession of alphabets that existed in the history of the Ukrainian language.

This letter was read out as a plosive sound [g] until, at least, the 12th century (Sobolevskij 1907, 43; Shevelov 1979, 451). The spirantization of the corresponding phoneme in Ancient Ukrainian, Ancient Czech, and Ancient Slovak took place between 1157 and 1215 when the voiced pharyngeal fricative consonant rose in place of the stop [g] (Shevelov 1979, 450–454). In the International Phonetic Alphabet (IPA 2018), this sound is denoted by ɣ (which represents the modified Latin letter G). This provides phonetic evidence that the Ancient Ukrainian (Old Slavic) *r* should be romanized as a *g*, and that the element “g” should be kept for transliteration of the Ukrainian *r* in the subsequent historic periods.

However, at least since 1334, the Ukrainian letter *r* in toponyms, anthroponyms and common names began to be rendered by Latin *h*: *Hryczkone Kossaczowicz*, *Behohosc*, *haliciensis*, *Torhowycze*, *Drohobicz*, *Halicz*, *Hrubeschow*, *Halicie*, *Horbach*, etc. (Shevelov 1979, 451). Meanwhile, the sound [g] started to be denoted by the digraph *kr* (Sobolevskij 1907, 43). However, in place of a *r*, there occurs also a *g* and a digraph *gh*: *Bogdano-*, *mogilla*, *Bogdanowicz*, *Golosa*, *Galich*, *Gallicia*, *Mogula*, *Bereg*, *Igrischtya*; *Beregh*, *Ugh* (Shevelov 1979, 451). On the other hand, according to Aghatangel Krymsjkyj, the followers of the Galician Jakub Ghavatovych, who in 1619 used Polish writing for the Ukrainian language, transliterated into *h* the letter *x*, not *r*: *xpih* – *hrin* (Nimchuk and Purjajeva 2004, 398–399).

All these examples of Latinization of Ukrainian names can hardly be considered as scholarly approaches to create a holistic and comprehensive Ukrainian transliteration system providing an equivalent Latin writing of the original text: at that time, the Ukrainian language did not even have an established Cyrillic alphabet. As indicated by characteristic endings and letter combinations in their Romanized forms, these were rather attempting to write Ukrainian names in such a way that they could be read more or less close to the original sound by native speakers of Polish, German, Hungarian, Latin, and other target languages. Apparently, the variance in the rendering of the Ukrainian *r* is explained by the fact that neither *g* nor *h* provided its accurate readout: the first letter is associated with a plosive consonant which was no longer present in the original sound, and the second corresponds in these languages not to a voiced but to a voiceless consonant, and it was not used at the end the word as a separate grapheme.

Likely, the use of the digraph *gh* in the words *Beregh*, *Ugh* was an attempt to introduce a transliteration correspondence for the letter *r* based on graphemic considerations accounting for its Greek origin and the fact of spirantization of the associated sound. In modern Ukrainian, the final *r* is read as a partially devoiced velar fricative [ɣ̥] (Vakulenko 2019, 42), so this notation is phonetically motivated.

Shevelov emphasizes the importance of the morphonological factor in the change [g] > [ɣ] because the alternants to /g/ were fricatives. At the same time, the stop [g] lost the phonemic status. Further transformation of a [ɣ] into a deeper articulated pharyngeal sound had no phonological or morphological consequences. The reason for this change, as the researcher notes, was the rise of a prothetic sound with natural pharyngeal articulation (Shevelov 1979, 453-454).

The experimental phonetic data indicate that the palatalized variant of the Ukrainian phoneme /r/ (Latinized as /gh/) is realized by the velar fricative [ɣ] (Tocijka 1981, 83, 90). In view of the fact that palatalization, velarization, and pharyngealization are mutually exclusive (Chomsky & Halle 1968, 307), it is unlikely that glottal and pharyngeal allophones [ɦ] and [ʕ] will appear regularly. A similar situation has developed in the Lithuanian language, where the phoneme /ɣ/ is sometimes realized as a glottal [ɦ]: since the palatalized variant is always velar [ɣ], a [ɣ] has an advantage over a [ɦ] (Pakerys 1995). Therefore, taking into account the softened allophones of the phoneme /gh/ also leads to the need to use the element “g” in the Romanization of the corresponding letter in the Old and New Ukrainian alphabets.

It should be noted that Shevelov's conclusion about the absence of phonological consequences of deeper articulation of a /gh/ is extremely important. On the one hand, it reflects the tendency of the Ukrainian language to transform the plosive sound [g] (and the corresponding phoneme) into a fricative one. Despite intensive contacts with languages where the phoneme /g/ is widespread, this tendency results in the situation that the “similar” Ukrainian phoneme /r/ (Latinized as a /g/) resides on the periphery of the Ukrainian phonological system. This is evidenced by the facts: (i) in the dictionary of Ghrinchenko (1958-1959) there are relatively few words with the letter r (g), the vast majority of which have parallel forms with a r (gh), and (ii) the frequency of the corresponding plosive velar phoneme /g/ is the lowest of all Ukrainian phonemes, less than 0.1% (Zhovtobryukh 2004, 765).

Lavrentij Kukilj (Zizanjij) titles his work “Граматика” (‘Grammatics’), using the letter r. Then in the text, there is the word combination “наѡкъ кѡрамматѡкъ” (Zjizanjij 1596, 4). This indicates the progressive assimilation of the fricative sound, which corresponds to the pronunciation of r, in the plosive consonant under the influence of the previous stop [k]. In addition, this appearance of a plosive allophone indicates that in the Old Ukrainian period there were no separate phonemes /r/ (/gh/) and /r/ (/g/), and the second only acted as a peripheral variant of the first. This is an additional reason to include the element “g” in the transliteration of the letter r.

On the other hand, this observation of Shevelov about fricative alternants gives more weight to the velar allophone [ɣ] compared to the pharyngeal [ʕ] and glottal [h]. The existence in the Ukrainian language of a parallel alternation of voiced and voiceless phonemes (resulting from the first and second palatalization of velars) /ɣ/ - /ʒ/ - /z/ (нога 'leg' - ніжка 'leg' - на нозі 'on the leg') and /x/ - /χ/ - /s/ (ucho 'ear' - вушко 'ear' - у вусі 'in the ear') indicates on the phonemic nature of this allophone (Vakulenko 2019, 44).

Such phonemic symmetry arose in the Ukrainian language due to the spirantization of a /g/. In the Russian language, for example, where this tendency did not gain strength, there is no such symmetry. The third element in the phonemic triads has degenerated, and the alternation of the plosive /g/ into the /ʒ/ corresponds to the alternation of the fricative /x/ into the /χ/: нога - ножка ('leg'), ухо - ушко ('ear').

On the other hand, the use of the letter **h** to represent a voiced pharyngeal fricative sound is not correct, as the IPA symbol **h** corresponds to a voiceless glottal sound (IPA 2018). And, as already noted, the use of an **h** as a modifier makes it possible to provide an isomorphic correspondence between the manifolds of Cyrillic letters and Latin graphemes, where the latter set has fewer basic members. The possible use of an **h** also as a separate letter would lead, for example, to a false identification of letter combinations **зr**, **кr**, and **сr** with the **ж**, **х**, and **ш**, respectively.

Moreover, the fricative pronunciation of a **r** is not the indicative marker that distinguishes Ukrainian from Russian. Sobolevskijh observes a similar pronunciation not only in some dialects, but also in literary Russian: *благодарить* 'to thank', *господина*, 'of the master', *бога* 'of the master', *богатъ* 'rich', *мязок* 'soft', *лёзок* 'light', *дѣзоть* 'tar', and sometimes in the words *голубь* 'pigeon', *горох* 'pea' (1907, 126). Other forms indicate the presence in the Russian language of a devoiced velar fricative sound [ɣ̥] before consonants: *мяхкій* 'soft', *дѣхтя* 'of tar' (Sobolevskijh 1907, 126) which fully corresponds to the pronunciation of Ukrainian words *возкий* 'moist', *лезкий* 'easy', etc. (Bilodid 1969, 257, 398).

Thus, in the Romanization system that covers the Old Ukrainian and New Ukrainian alphabets, the letter **r** is transliterated through **ǧ**, **gh**.

The letter **є**. According to Sobolevskijh (1907, 40) and Istrina (1915, 24), the pronunciation of the Old Slavic (Ancient Ukrainian) **є** varied from [je] to [e] that prompts its generalized Romanization as **ê**, **ew**.



In Old Ukrainian, this letter was read out as [ɛ] in the Hebrew, Greek and Latin words (Smotryskij 1619, 12; see also Nimchuk & Purjajeva 2004, 135) and after consonants: “мєнє” ‘me’, “добрє” ‘good’, “ключєм” ‘with the key’ (Zjizanjij 1596, 3). At the beginning of the word and after the vowel, its pronunciation was [je]: “оуєдинєнїє” ‘solitude’, “изглашенїє” ‘proclamation’, “єстєство” ‘nature’ (Smotryskij 1619, 12); “потрєбнє” ‘needed’, “єй” ‘her’, “єсть” ‘is’, “єстєственнє” ‘of natural’, “нєбываєт” ‘does not happen’, “моєи” ‘of mine’ (Zjizanjij 1596, 4); “тлѣкованїє” ‘interpretation’, “Києвскѣ” ‘Kievan’ (Bewhrywnda 1627, 3). There was a positional distinction between uppercase and lowercase letters (Zjizanjij 1596, 3). In the New Ukrainian alphabets (except for the systems of M. Ghatcuk and M. Maksymovych), the letter “e” became common after consonants (Nimchuk & Purjajeva 2004). Therefore, the Old Ukrainian є, as well as the Ancient Ukrainian є, is transliterated into ê, ew; and the New Ukrainian є is Latinized into je (excluding the alphabets of M. Ghatcuk and M. Maksymovych).

The letter s is reported to sound as a combination of a “c” and a “д” (Zjizanjij 1596, 9). Such a pronunciation of the letter “zelo” is heard in some Ukrainian dialects: \*зѣцѣ [z<sup>d</sup>ji’-st̪i+] ‘eat’, \*зѣло [z<sup>d</sup>lo’] ‘evil’ (see the Ukrainian phonetic set in Vakulenko 2018; Vakulenko 2019), so the projection of this pronunciation on the earlier period is reasonable. The forms \*зѣцѣ, \*зѣло are not known. Thus, we propose s – **з**, **zdh**.

The letter и was derived from the Hellenic eta η, with corresponding raised and advanced articulation that is preserved in descendant phonemes in most modern Slavic languages. In Ancient Ukrainian, it was read out as [i] (Zhovtobrykh & Kulyk 1965, 139). Until the 13th century, this phoneme had a palatalizing effect on a preceding Ukrainian consonant (Bezpaljko et al. 1957, 153; Shevelov 1979, 48). This warrants its Latin transliteration by the letter i for the Ancient Ukrainian (Old Slavic) period.

Sobolevskij notes that this “pure” Old Slavic sound disappeared in the second half of the 11th century. It was superseded by the [j], which once stood between the previous consonant and an и (Sobolevskij 1907, 46). This indicates the iotated pronunciation of the Ancient Ukrainian letter и after vowels, which is confirmed by the rise of the letter ѣ from the и (Zjizanjij 1596, 4; Nimchuk & Purjajeva 2004, 33).

Cases of using an ы instead of an и and vice versa, which indicates the depalatalization of vowels before an и, appear in Galician-Volhynian monuments as early as in the 12th century, but by the 14th century they are very rare (Sobolevskij 1907, 135). Since the 14th century, Ukrainian monuments have been constantly mixing the letters и and ы (Bezpaljko et al. 1957, 154). The examples of confusion of

these letters, given by Shevelov (1979, 483), indicate that the readout of an **и** approached a high mid sound [i] in the position after consonants. This change in the sound of an **и** led to the fact that in the 16th and 17th centuries, the foreign sound [i] began to be rendered not with an **и**, as before, but through a **ѣ** (Shevelov 1979, 484).

However, the presence of the Old Ukrainian forms “в Вилни” ‘in Vilno’, “в дрѣкарни” ‘in the printing house’ (Zjizanjij 1596, 2); “и” ‘and’, “искѣство” ‘art’, “досконали” ‘perfect’, “которїи” ‘who’ (Zjizanjij 1596, 3); “всакии” ‘all sorts’, “чеснои философїи” ‘of honest philosophy’, “естественнои богословїи” ‘of natural theology’, “моєи” ‘of mine’, “тыи” ‘those’, “рєчи” ‘things’ (Zjizanjij 1596, 4); “имаймо” ‘(we) have’, “drѣzi” ‘friends’ (Zjizanjij 1596, 5); “изглашенїє” ‘proclamation’ (Smotryskij 1619, 12); “имєнѣ” ‘of names’, “Київѣ” ‘Kiev’ (Bewhrywnda 1627, 3), etc., indicates that during this period, the pronunciation of an **и** varied: in addition to the already mentioned sound [i], at the beginning of the word and after some consonants (in particular, in some cases after **л**, **ч**, **з**) it sounded close to the modern **і**, and after vowels (as in ancient Ukrainian times) it denoted an iotated sound.

Since transliteration does not take into account the positional variations of pronunciation, only one notation should be chosen. Given the modern practice of Latinization, trends in the development of the corresponding phoneme and its characteristics in the modern Ukrainian language, we prefer the correspondence **и** – **y** (see Vakulenko 2018).

The letter **ѣ**. The readout of the Old Slavic **ѣ** has been reported as variable and geographically dependent: [fj] or [j] (Sobolevskij 1907, 44), [jt] (Istrina 1915, 24), [jt] and [fj] (Shevelov 1979, 85–86). All possible pronunciations are covered by the Latinized equivalents **ŝ**, **shh**.

In the Old and New Ukrainian, its readout was [fj] (Zjizanjij 1596, 9; Sobolevskij 1907, 44) that suggests the Latinized graphemes **ŝ**, **shch**.

The letters **ѣ**, **ѥ**. In the pre-historic (Ancient Slavic) period, the letters **ѣ** (“jer”) and **ѥ** (“jerchyk”) were read out as short closed [o] or [u] and [i] or [e], respectively (Sobolevskij 1907, 41; Meillet 1951, 17; Bezpaljko et al. 1957, 79; Shevelov 1979, 112). In the language of the Eastern Slavs, the reduced vowels **ѣ** and **ѥ** existed until the mid of the 12th century (Sobolevskij 1907, 41; Bezpaljko et al. 1957, 117; Shevelov 1979, 113).

In the process of evolution of the Eastern-Slavic languages, the [ѣ] in the strong position has developed into an [o] (Bezpaljko et al. 1957, 128) that give grounds to transliterate the **ѣ** into **ŏ**, **oh**. The

Ѣ that originates from the Indo-European *ǵ* (Meillet 1951, 41), enters the complementary distribution relationship with the *ѣ* (Alpatov et al. 1983, 76) that provides phonetic grounds to transliterate the Ѣ similarly to the *ǵ*: Ѣ – *j* (Jakobson 1965; Tilkov 1982, 238; see also Zima 1986; Vakulenko 2004, 221), and in the isolated position Ѣ – *ǵ*, *hj*. The apostrophe sign denotes the phonation interruption in the International Phonetic Alphabet, and the absence of palatalization in Ukrainian, so this choice makes it possible to avoid incorrect use of an apostrophe in place of the Ѣ and the resulting text identification errors (Vakulenko 2004, 216; Vakulenko 2015a, 50; Vakulenko 2015b, 247).

The letter Ѣ. In the Ancient Ukrainian period, the letter Ѣ was read out first as a diphthong [ie], then as a closed [e] (see Shevelov 1979, 260). In turn, Sobolevskij notes that in the Galician-Volhynian monuments of the 14th and 15th centuries, the letter Ѣ was read out close to [i], possibly as a diphthong [ie] (Sobolevskij 1907, 74). Therefore, a Ѣ is transliterated into *é*, *ieh*.

The letters Ѧ, ѧ and Ѩ, ѩ. The corresponding nasal sounds in the proto-Ukrainian, proto-Russian, proto-Belorussian, proto-Czech, and proto-Slovak dialects had disappeared amid the 10th century (Sobolevskij 1907, 19–20; Istrina 1915, 23; Shevelov 1979, 187–188). Shevelov states that in the Ancient Ukrainian period, the letters Ѧ, ѧ and Ѩ, ѩ were read out as [ja] or [ʼa] and [ju] or [ʼu], respectively (Shevelov 1979, 36). However, the nasalization was retained in the Polish language and some Bulgarian dialects. To set the unified Latin transliteration for these, we account for the fact that the most written monuments of the Old Slavic period were written in Cyrillic script, and that they were written on the territory of modern Eastern-Slavic countries. Therefore, contrary to the Library of Congress approach (ALA-LC 2011), we avoid explicit indication of nasalization but imply its possible appearance by: Ѧ – *ä*, *jaw*; ѧ – *ǣ*, *jwaw*; Ѩ – *ü*, *juw*; ѩ – *ǖ*, *jwuw*.

These decisions allow us to keep the same graphemes for the later periods.

The letter Ѧ in the Common Slavic was pronounced as [f] (Meillet 1951, 37) which in the Ukrainian language has not undergone significant changes. Smotryskij writes about the similarity of these sounds in the Old Ukrainian period and, accordingly, the confusion of a Ѧ with an *f* (Smotryskij 1619, 13; see also Nimchuk & Purjajeva 2004, 36). This warrants the transliteration correspondence Ѧ – *f*, *fh*.

Other letters. To ensure that the original text can be restored, it is important to correctly display graphical variations in the spelling of individual letters that are not related to differences in pronunciation. This applies to the letters *ѣ* and *ѣ*, *ѣ* and *ѣ*; *ѣ* and *ѣ*; *ѣ* and *ѣ*. It is also necessary to preserve the historically determined graphic differences between the letters, which in the process of

development of the Ukrainian language acquired the same sound: **ѡ**, **ѣ** and **ю**; **ѧ**, **Ѩ** and **ѩ**; **Ѳ**, **ѳ** and **Ѵ**, etc.

## 4. Discussion

It is expected that Latinization will make Ukrainian historic text compatible with international databases and multilingual information and linguistic tools. Romanization will also bring more similarity of modern Ukrainian texts to those of other languages, given that many international terms of Latin or Greek origin, such as *accumulator*, *osmos*, *mass*, *distillation*, etc., have similar (Latinized) appearance in many languages and also in Ukrainian, and that a significant amount of terms are eponyms or include proper names: *Bernoulli equation*, *Gauss distribution*, *Hertz*, *Watt*, *Ohm*, *Churjumov comet*, *Markov process*, *Nernst theorem*, etc. As we already noted, the proposed transliteration system is isomorphic (simple-correspondent) that warrants a possibility to recover original text after re-transliteration.

The presented approach yields a more comprehensive Romanization mechanism than proposed in the standardized tables of the International Standardization Organization (ISO 9:1995) and the Library of Congress (ALA-LC 2011). In contrast to the latter, we provide also the Latinization table where only the basic Latin letters (with the ASCII codes 33–127) are involved that permits their use in language processing tools. In contrast to both, we provide a complete letter register, and the transliteration conclusions are based on a detailed analysis of phonetic and phonological characteristics of the speech sounds having existed in Ancient Ukrainian and Old Slavic.

Disadvantages of Romanization systems using English as a mediator include the following: violation of the requirement of equivalence of the original and transliterated texts (for letter **ѣ**, iotated letters, softening sign **ѣ**); ignoring the Slavic Latin writing tradition; the use of **h** as a modifier and as a separate letter; fail to transliterate **ѣ** (see details in Vakulenko 2004; Vakulenko 2015a). In particular, lack of bijectivity between the source and transliterated text result in systematic distortion and misidentification of names: *Гальченко* – *Галченко* (Halchenko), *Тронко* – *Тронько* (Tronko), *Воронко* – *Воронько* (Voronko), *Банкова* – *Банькова* (Bankova), *Паньківська* – *Панківська* (Pankivska), *Польова* – *Полова* (Polova), *Лялько* – *Ліалко* (Lialko), *Ліліана* – *Ліліана* (Liliana), *Маріан* – *Мар'ян* (Marian), *медіана* – *медяна* (mediana), *Возіанов* – *Возянов* (Vozianov), *Гундеріан* – *Гундерян* (Hunderian), *Клаузіус* – *Клаузіус* (Klausius), *Пії* – *Пій* (Pii), *Лар'їн* – *Ларін* (Larin), *Левитський* –

*Левицький* (Levytskyi), *Тоцька Тотська* (Totska), *Чернятський Черняцький* (Cherniatskyi), etc. This eliminates the possibility to restore the original form after reverse transliteration.

## 5. Conclusion

In this article, based on phonetic and phonological characteristics of Ancient, Old, and New Ukrainian, we put forward isomorphic transliteration and retransliteration tables for its alphabets, using diacritics and combinations of basic Latin letters with the ASCII codes 33–127. In these combinations, we used the modifiers **h** and **w**. It is argued that due to the complete letter register, compatibility with the language processing tools, and more appropriate phonological motivation, the proposed system, which forms the basis of the Ukrainian transliteration standard DSTU 9112:2021, is more viable than the Romanization tables of the ISO 9:1995 and the Library of Congress. The phonemic transcription table for modern Ukrainian is proposed, which is necessary for machine translation and speech generation tasks. The obtained results may be widely used in historical linguistic studies, written heritage preservation projects, library science, international databases, and in language processing tools.

## 6. Acknowledgments

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## Appendix

**Table 1** – Transliteration of the Old Slavic alphabet by System A

№	Cyrillic alphabet	Latin alphabet	Notes
1	а А	a A	
2	б Б	b B	
3	в В	v V	
4	г Г	g G	
5	д Д	d D	
6	е Е	ê Ê	
7	ж Ж	ž Ž	
8	с С	ѕ S	
9	з З	z Z	
10	и И	i I	
11	і І	î Î	
12	ї Ї	ï Ï	
13	ћ Ћ	ħ Ħ	
14	к К	k K	
15	л Л	l L	
16	м М	m M	
17	н Н	ñ Ñ	
18	о О	o O	
19	п П	p P	
20	р Р	r R	
21	с С	s S	
22	т Т	t T	
23	у У	û Û	
24	ѣ Ъ	ѣ Ъ	
25	ф Ф	f F	

26	x X	x X	
27	ω W	ō Ō	
28	ω W̄	ō Ō	
29	ǫ Ω	ō Ō	
30	ц Ц	c C	
31	ч Ч	č Č	
32	ς Ϛ	q Q	
33	ш Ш	š Š	
34	щ Щ	ș Ș	
35	ѣ Ё	ö Ö	
36	ѣ ЁI	ÿ Ÿ	
37	ь Ь	j J	
38	ь Ь	ĵ Ĵ	In an isolated position
39	ѣ Ё	é È	
40	ю Ю	ju Ju	
41	ѣ IA	ĭa Ĭa	
42	ѣ ĬE	ĭe Ĭe	
43	ѣ Ĭ	ä Ä	
44	ѣ Ĭ	ü Ü	
45	ѣ Ĭa	ĭä Ĭä	
46	ѣ Ĭu	ĭü Ĭü	
47	ѣ Ĭ	k K	
48	ѣ П	þ Þ	
49	ѣ Θ	ř Ř	
50	v V	ÿ Ÿ	

**Table 2** – Transliteration of the Old Slavic alphabet by System B



№	Cyrillic alphabet	Latin alphabet	Notes
1	а А	a A	
2	б Б	b B	
3	в В	v V	
4	г Г	g G	
5	д Д	d D	
6	е Е	ew Ew	
7	ж Ж	zh Zh	
8	с С	zdh Zdh	
9	з З	zw Zw	
10	и И	i I	
11	і І	ih Ih	
12	ї Ї	ji Ji	
13	ћ Ћ	ghj Ghj	
14	к К	k K	
15	л Л	l L	
16	м М	m M	
17	н Н	n` N`	
18	о О	o O	
19	п П	p P	
20	р Р	r R	
21	с С	s S	
22	т Т	t T	
23	у У	uwh Uwh	
24	Ѹ Ѹ	uw Uw	
25	ф Ф	f F	

26	x X	kh Kh	
27	ow W	ow Ow	
28	otw W̄	otw Otw	
29	owh Ŵ	owh Ow h	
30	c C	c C	
31	ch Ч	ch Ch	
32	q Q	q Q	
33	sh Ш	sh Sh	
34	shh Шh	shh Shh	
35	oh Ъ	oh Oh	
36	ywh ЪI	ywh Ywh	
37	j Ь	j J	
38	j' Ь	j' J'	Before e Є, и И, а А, ж Ж
39	h Ь	h j HJ	In an isolated position
40	ieh Ъ	ieh Ieh	
41	ju Ю	ju Ju	
42	jah IA	jah Jah	
43	ihe IЄ	ihe Ihe	
44	jaw А	jaw Jaw	
45	juw Ж	juw Juw	
46	jwaw ЪА	jwaw Jwaw	
47	jwuw ЪЖ	jwuw Jwuw	
48	xh Х	xh Xh	
49	ph П	ph Ph	
50	fh Ф	fh Fh	
51	yh В	yh Yh	

**Table 3** – Retransliteration of the Old Slavic alphabet by System A

№	Latin alphabet	Cyrillic alphabet	Notes
1	a A	а А	
2	ä Ä	ӕ Ӑ	
3	b B	б Б	
4	c C	ц Ц	
5	č Č	ч Ч	
6	d D	д Д	
7	é È	ѣ Ѓ	
8	ê Ê	є Є	
9	f F	ф Ф	
10	ř Ř	Ѡ ѡ	
11	g G	г Г	
12	h H	һ Һ	
13	i I	и И	
14	î Î	ї Ї	
15	ï Ï	і І	
16	ja Ja	ја Ја	
17	ja̋ Ja̋	ѣ Ѓ	
18	je Je	је Је	
19	jü Jü	ѣ Ѓ	
20	j J	ѣ Ѓ	After б Б, с С, ч Ч, д Д, ф Ф, ř Ř, g G, к К, љ Љ, м М, њ Њ, п П, р Р, q Q, r R, s S, š Š, š Š, t T, v V, x X, ž Ž, z Z, ž Ž
21	ĵ Ĵ	ѣ Ѓ	In an isolated position
22	ju Ju	ю Ю	
23	k K	к К	

24	k K	к К	
25	l L	л Л	
26	m M	м М	
27	n N	н Н	
28	o O	о О	
29	ö Ö	ѳ Ѵ	
30	ō Ō	ω Ū	
31	õ Õ	ω W	
32	ō Ō	ω Ū	
33	ø Ø	ø Ø	
34	p P	п П	
35	þ Þ	ψ Ψ	
36	q Q	ς Ϛ	
37	r R	р Р	
38	s S	с С	
39	ŝ Š	щ Щ	
40	š Š	ш Ш	
41	t T	т Т	
42	ü Ü	Ѹ ѹ	
43	ų Ų	ų Ų	
44	v V	в В	
45	x X	х Х	
46	ÿ Ÿ	ѵ Ѷ	
47	ÿ Ÿ	ѵ Ѷ	
48	ž Ž	ж Ж	
49	z Z	з З	

50	ꙗ ꙑ	ꙗ ꙑ	
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**Table 4** – Retransliteration of the Old Slavic alphabet by System B

№	Latin alphabet	Cyrillic alphabet	Notes
1	a A	а А	
2	b B	б Б	
3	c C	ц Ц	
4	ch Ch	ч Ч	
5	d D	д Д	
6	ew Ew	е Е	
7	f F	ф Ф	
8	fh Fh	ө Ö	
9	g G	г Г	
10	ghj Ghj	һ Һ	
11	hj HJ	ь Ь	In an isolated position
12	i I	и И	
13	ieh Ieh	ѣ Ѓ	
14	ih Ih	і І	
15	ihe Ihe	є Ё	
16	j J	ь Ь	After b B, c C, ch Ch, d D, f F, fh Fh, g G, k K, kh Kh, l L, m M, n` N`, p P, ph Ph, q Q, r R, s S, sh Sh, sht Sht, t T, v V, xh Xh, zdh Zdh, zh Zh, zw Zw
17	j' J'	ь Ь	After b B, c C, ch Ch, d D, f F, fh Fh, g G, k K, kh Kh, l L, m M, n` N`, p P, ph Ph, q Q, r R, s S, sh Sh, sht Sht, t T, v V, xh Xh, zdh Zdh, zh Zh, zw Zw before ew Ew, i I, jaw Jaw, juw Juw
18	jah Jah	ја ЈА	
19	jaw Jaw	ѧ ѧ	
20	ji Ji	ї Ї	
21	ju Ju	ю Ю	

22	juw Juw	ꠕ ꠕ	
23	jwaw Jwaw	ꠕ ꠕ	
24	juuw Juuw	ꠕ ꠕ	
25	k K	ꠕ ꠕ	
26	kh Kh	x X	
27	l L	ꠕ ꠕ	
28	m M	ꠕ ꠕ	
29	n` N`	n N	
30	o O	o O	
31	oh Oh	ꠕ ꠕ	
32	otw Otw	ꠕ ꠕ	
33	ow Ow	ꠕ ꠕ	
34	owh Owh	ꠕ ꠕ	
35	p P	ꠕ ꠕ	
36	ph Ph	ꠕ ꠕ	
37	q Q	ꠕ ꠕ	
38	r R	p P	
39	s S	c C	
40	sh Sh	ꠕ ꠕ	
41	shh Shh	ꠕ ꠕ	
42	t T	ꠕ ꠕ	
43	uw Uw	ꠕ ꠕ	
44	uwh Uwh	oy Oy	
45	v V	ꠕ ꠕ	
46	xh Xh	ꠕ ꠕ	
47	yh Yh	v V	



48	ywh Ywh	ѣ Ё	
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**End of Table 4** – Retransliteration of the Old Slavic alphabet by System B

№	Latin alphabet	Cyrillic alphabet	Notes
49	zdh Zdh	s S	
50	zh Zh	ж Ж	
51	zw Zw	з З	

**Table 5** – Transliteration of the Old (Medieval) Ukrainian alphabet by System A

№	Cyrillic alphabet	Latin alphabet	Notes
1	а А	a A	
2	б Б	b B	
3	б Б	b' B'	Before й Ы
4	в В	v V	
5	в В	v' V'	Before й Ы
6	г Г	ǵ Ğ	
7	г Г	ǵ' Ğ'	Before й Ы
8	г Г	g G	
9	г Г	g' G'	Before й Ы
10	д Д	d D	
11	д Д	d' D'	Before й Ы
12	е Е	ê Ê	
13	ж Ж	ž Ž	
14	ж Ж	ž' Ž'	Before й Ы
15	с С	š Š	
16	с С	š' Š'	Before й Ы
17	з З	z Z	
18	з З	z' Z'	Before й Ы
19	з З	z Z	
20	з З	z' Z'	Before й Ы
21	и И	y Y	
22	и И	î Î	
23	і І	í Í	In Greek loanwords
24	ї Ї	ï Ï	
25	й Ы	j J	

26	й Й	j' J'	Before y Y
27	к К	k K	
28	к К	k' K'	Before й Й
29	л Л	l L	
30	л Л	l' L'	Before й Й
31	м М	m M	
32	м М	m' M'	Before й Й
33	н Н	n Ñ	
34	н Н	n' Ñ'	Before й Й
35	о О	o O	
36	п П	p P	
37	п П	p' P'	Before й Й
38	р Р	r R	
39	р Р	r' R'	Before й Й
40	с С	s S	
41	с С	s' S'	Before й Й
42	т Т	t T	
43	т Т	t' T'	Before й Й
44	у У	u U	
45	оу Оу	û Û	

**End of Table 5 – Transliteration of the Old (Medieval) Ukrainian alphabet by System A**

№	Cyrillic alphabet	Latin alphabet	Notes
46	Ѹ Ѹ	Ѹ Ѹ	
47	Ѵ Ѵ	f F	
48	Ѵ Ѵ	f' F'	Before ѣ ѣ
49	Ѷ Ѷ	x X	
50	Ѷ Ѷ	x' X'	Before ѣ ѣ
51	Ѹ Ѹ	c C	
52	Ѹ Ѹ	c' C'	Before ѣ ѣ
53	Ѵ Ѵ	č Č	
54	Ѵ Ѵ	č' Č'	Before ѣ ѣ
55	Ѷ Ѷ	š Š	
56	Ѷ Ѷ	š' Š'	Before ѣ ѣ
57	Ѹ Ѹ	ŝ Ŝ	
58	Ѹ Ѹ	ŝ' Ŝ'	Before ѣ ѣ
59	Ѷ Ѷ	ö Ö	
60	Ѹ Ѹ	y Ÿ	
61	Ѷ Ѷ	j J	
62	Ѷ Ѷ	j' J'	Before y Y
63	Ѷ Ѷ	ĵ Ĵ	In an isolated position
64	Ѹ Ѹ	é È	
65	Ѷ Ѷ	ju Ju	
66	Ѹ Ѹ	ü Ü	
67	Ѹ Ѹ	ÿ Ŵ	
68	Ѹ Ѹ	ō Ō	
69	Ѹ Ѹ	ō Ō	
70	Ѹ Ѹ	ō Ō	

71	o O	ô Ô	
72	ǣ ǣ	ǣ Ä	
73	ǣ ǣ	ǣ Ä	
74	ia IA	ǣ Ä	
75	ie Ie	ǣ Ä	
76	ε E	è È	
77	ž ž	k K	
78	ž ž	k' K'	Before й Ы
79	ψ Ψ	þ Þ	
80	ψ Ψ	þ' Þ'	Before й Ы
81	θ Θ	ī Ī	
82	θ Θ	ī' Ī'	Before й Ы
83	v V	ý Ý	

**Note.** Superior literal characters (under letter titlos) are written in a line in parentheses in place of omitted letters.

Diacritical marks are placed above the corresponding transliterated letters: «'» (soft accent), «~» (macron), «˘» (breve), «^» (arch), «'» (acute accent), «» (grave accent), «' » (titlo), «' » (modifier letter dot slash), «' » (Ukrainian diaeresis).

One letter can bear two diacritical marks – a soft and an acute or a grave accent.

**Table 6** – Transliteration of the Old (Medieval) Ukrainian alphabet by System B

№	Cyrillic alphabet	Latin alphabet	Notes
1	а А	a A	
2	б Б	b B	
3	б Б	b' B'	Before й Ї
4	в В	v V	

**Continuation of Table 6** – Transliteration of the Old (Medieval) Ukrainian alphabet by System B

№	Cyrillic alphabet	Latin alphabet	Notes
5	в В	v' V'	Before й Ы
6	г Г	gh Gh	
7	г Г	gh' Gh'	Before й Ы
8	г Г	g G	
9	г Г	g' G'	Before й Ы
10	д Д	d D	
11	д Д	d' D'	Before й Ы
12	е Е	ew Ew	
13	ж Ж	zh Zh	
14	ж Ж	zh' Zh'	Before й Ы
15	с С	zdh Zdh	
16	с С	zdh' Zdh'	Before й Ы
17	з З	zw Zw	
18	з З	zw' Zw'	Before й Ы
19	з З	z Z	
20	з З	z' Z'	Before й Ы
21	и И	y Y	
22	и И	ih Ih	
23	і І	i' I'	In Greek loanwords
24	ї Ї	ji Ji	
25	й Й	j J	
26	й Й	j' J'	Before у У, ы Ы
27	к К	k K	
28	к К	k' K'	Before й Ы
29	л Л	l L	

30	л Л	l' L'	Before й Ы
31	м М	m M	
32	м М	m' M'	Before й Ы
33	н Н	n N`	
34	н Н	n' N`'	Before й Ы
35	о О	o O	
36	п П	p P	
37	п П	p' P'	Before й Ы
38	р Р	r R	
39	р Р	r' R'	Before й Ы
40	с С	s S	
41	с С	s' S'	Before й Ы
42	т Т	t T	
43	т Т	t' T'	Before й Ы
44	у У	u U	
45	уу Оу	uwh Uwh	
46	Ѹ Ѹ	uw Uw	
47	ф Ф	f F	
48	ф Ф	f' F'	Before й Ы
49	х Х	kh Kh	
50	х Х	kh' Kh'	Before й Ы
51	ц Ц	c C	
52	ц Ц	c' C'	Before й Ы
53	ч Ч	ch Ch	
54	ч Ч	ch' Ch'	Before й Ы
55	ш Ш	sh Sh	



56	ш Ш	sh' Sh'	Before й Ё, ч Ч
57	щ Щ	shch Shch	
58	щ Щ	shch' Shch'	Before й Ё

**End of Table 6** – Transliteration of the Old (Medieval) Ukrainian alphabet by System B

№	Cyrillic alphabet	Latin alphabet	Notes
59	Ѡ ѡ	oh Oh	
60	Ѣ ѣ	yw Yw	
61	Ѥ ѥ	j J	
62	Ѧ ѧ	j' J'	Before y Y, Ѣ ѣ
63	Ѩ ѩ	hj HJ	In an isolated position
64	Ѫ ѫ	ieh Ieh	
65	Ю ю	ju Ju	
66	Ѭ ѭ	juw Juw	
67	Ѯ ѯ	jwuw Jwuw	
68	Ѱ ѱ	otw Otw	
69	Ѳ ѳ	ow Ow	
70	Ѵ ѵ	owh Owh	
71	Ѷ ѷ	oow Oow	
72	Ѹ ѹ	jaw Jaw	
73	Ѻ ѻ	jwaw Jwaw	
74	Ѽ ѽ	jwa Jwa	
75	ѿ Ѿ	ihe Ihe	
76	ѿ Ѿ	ewh Ewh	
77	ѿ Ѿ	xh Xh	
78	ѿ Ѿ	xh' Xh'	Before Ѣ ѣ
79	ѿ Ѿ	ph Ph	
80	ѿ Ѿ	ph' Ph'	Before Ѣ ѣ
81	ѿ Ѿ	fh Fh	
82	ѿ Ѿ	fh' Fh'	Before Ѣ ѣ
83	ѿ Ѿ	yh Yh	

84	' (soft accent)	,^	
85	ˉ (macron)	_^	
86	˘ (breve)	\/	
87	ˆ (arch)	/\	
88	´ (acute accent)	'	
89	` (grave accent)	`	
90	ˊ (titlo)	~^	
91	˙ (modifier letter dot slash)	`/	
92	`` (Ukrainian diaeresis)	\\	

**Note.** The transliterated diacritical marks are used in detailed transliteration and are placed after the corresponding transliterated letters: «,^» (soft accent), «\_^» (macron), «\/>» (breve), «/» (arch), «'» (acute accent), «`» (grave accent), «~^» (titlo), «`/» (modifier letter dot slash), «\\» (Ukrainian diaeresis).

**Table 7** – Retransliteration of the Old (Medieval) Ukrainian alphabet by System A

Nº	Latin alphabet	Cyrillic alphabet	Notes
1	a A	а А	
2	ä Ä	ӕ Ӧ	
3	b B	б Б	
4	b' B'	б Б	Before j J
5	c C	ц Ц	
6	č Č	ч Ч	
7	c' C'	ц Ц	Before j J
8	č' Č'	ч Ч	Before j J
9	d D	д Д	
10	d' D'	д Д	Before j J
11	è È	ε Ε	

**Continuation of Table 7 – Retransliteration of the Old (Medieval) Ukrainian alphabet by System A**

№	Latin alphabet	Cyrillic alphabet	Notes
12	é Ê	ѐ Ё	
13	ê Ê	є Є	
14	f F	ф Ф	
15	ĭ Ĭ	ѳ Ѵ	
16	f' F'	ф Ф	Before j J
17	ĭ' Ĭ'	ѳ Ѵ	Before j J
18	g G	г Г	
19	ǵ Ğ	г Г	
20	g' G'	г Г	Before j J
21	ǵ' Ğ'	г Г	Before j J
22	í Í	í Í	In Greek loanwords
23	î Î	и И	
24	ï Ì	й Й	
25	ia Ĭa	ia IA	
26	ïä Ĭä	ѡ Ѣ	
27	ĭe Ĭe	Ѥ ѥ	
28	ïü Ĭü	Ѧ ѧ	
29	j J	й Й	
30	j J	ь Ь	After b B, c C, č Č, d D, f F, ħ Ħ, g G, ğ Ğ, k K, k K, l L, m M, n N, p P, þ Þ, r R, s S, š Š, š Š, t T, v V, x X, z Z, ž Ž, z Z, z Z
31	ĵ Ĵ	ь Ь	In an isolated position
32	j' J'	й Й	Before u U
33	j' J'	ь Ь	After b B, c C, č Č, d D, f F, ħ Ħ, g G, ğ Ğ, k K, k K, l L, m M, n N, p P, þ Þ, r R, s S, š Š, š Š, t T, v V, x X, z Z, ž Ž, z Z, z Z before u U

34	ju Ju	ю Ю	
35	k K	к К	
36	к К	ж Ж	
37	k' K'	к К	Before j J
38	к' K'	ж Ж	Before j J
39	l L	л Л	
40	l' L'	л Л	Before j J
41	m M	м М	
42	m' M'	м М	Before j J
43	n Ñ	н Н	
44	n' Ñ'	н Н	Before j J
45	o O	о О	
46	ô Ô	о О	
47	ö Ö	ѡ Ѣ	
48	ō Ō	Ѡ Ѣ	
49	õ Õ	ѡ Ѣ	
50	ō Ō	Ѡ Ѣ	
51	ø Ø	ø Ø	
52	p P	п П	
53	þ Þ	ψ Ψ	
54	p' P'	п П	Before j J
55	þ' Þ'	ψ Ψ	Before j J
56	r R	p P	
57	r' R'	p P	Before j J
58	s S	c C	
59	ŝ Š	щ Щ	

60	š Š	ш Ш	
61	с' С'	с С	Before j J

**End of Table 7** – Retransliteration of the Old (Medieval) Ukrainian alphabet by System A

Nº	Latin alphabet	Cyrillic alphabet	Notes
62	ŝ' Š'	щ Щ	Before j J
63	š' Š'	ш Ш	Before j J
64	t T	т Т	
65	t' T'	т Т	Before j J
66	u U	у У	
67	ü Ü	ѯ ѯ	
68	û Û	оу Оу	
69	v V	в В	
70	v' V'	в В	Before j J
71	x X	х Х	
72	x' X'	х Х	Before j J
73	y Y	и И	
74	ÿ Ÿ	ѵ ѵ	
75	Ƴ ƴ	ѣ ІІ	
76	z Z	з З	
77	ž Ž	ж Ж	
78	ẓ Ẓ	з̣ З̣	
79	z' Z'	з З	Before j J
80	ž' Ž'	ж Ж	Before j J
81	ẓ' Ẓ'	з̣ З̣	Before j J
82	ż Ż	с С	
83	ż' Ż'	с С	Before j J

**Table 8** – Retransliteration of the Old (Medieval) Ukrainian alphabet by System B



№	Latin alphabet	Cyrillic alphabet	Notes
1	a A	а А	
2	b B	б Б	
3	b' B'	б Б	Before j J
4	c C	ц Ц	
5	c' C'	ц Ц	Before j J
6	ch Ch	ч Ч	
7	ch' Ch'	ч Ч	Before j J
8	d D	д Д	
9	d' D'	д Д	Before j J
10	ew Ew	е Е	
11	ewh Ewh	э Э	
12	f F	ф Ф	
13	f' F'	ф Ф	Before j J
14	fh Fh	ө Ö	
15	fh' Fh'	ө Ö	Before j J
16	g G	г Г	
17	g' G'	г Г	Before j J
18	gh Gh	г Г	
19	gh' Gh'	г Г	Before j J
20	hj HJ	ь Ь	In an isolated position
21	i' I'	і І	In Greek loanwords
22	ieh Ieh	ѣ Ѓ	
23	ih Ih	ї Ї	
24	ihe Ihe	є Є	

25	ј Ј	й Й	
26	ј Ј	ь Ъ	After b B, c C, ch Ch, d D, f F, fh Fh, g G, k K, kh Kh, l L, m M, n N`, p P, ph Ph, r R, s S, sh Sh, shch Shch, t T, v V, xh Xh, z Z, zdh Zdh, zh Zh, zw Zw

**Continuation of Table 8 – Retransliteration of the Old (Medieval) Ukrainian alphabet by System B**

№	Latin alphabet	Cyrillic alphabet	Notes
27	j' J'	й Й	Before u U, uw Uw
28	j' J'	ь Ь	After b B, c C, ch Ch, d D, f F, fh Fh, g G, k K, kh Kh, l L, m M, n N', p P, ph Ph, r R, s S, sh Sh, shch Shch, t T, v V, xh Xh, z Z, zdh Zdh, zh Zh, zw Zw before u U, uw Uw
29	jaw Jaw	ӕ Ӑ	
30	ji Ji	ї Ї	
31	ju Ju	ю Ю	
32	juw Juw	ӕ Ӑ	
33	jwa Jwa	ӕ Ӑ	
34	jwaw Jwaw	ӕ Ӑ	
35	jwuw Jwuw	ӕ Ӑ	
36	k K	к К	
37	k' K'	к К	Before j J
38	kh Kh	х Х	
39	kh' Kh'	х Х	Before j J
40	l L	л Л	
41	l' L'	л Л	Before j J
42	m M	м М	
43	m' M'	м М	Before j J
44	n N`	н Н	
45	n' N`'	н Н	Before j J
46	o O	о О	
47	oh Oh	ѣ Ђ	
48	oow Oow	о О	

49	otw Otw	ᵛ ᵛ̄	
50	ow Ow	ᵝ W	
51	owh Owh	ᵞ ᵞ̄	
52	p P	ɸ Π	
53	p' P'	ɸ Π	Before j J
54	ph Ph	ɸ Ψ	
55	ph' Ph'	ɸ Ψ	Before j J
56	r R	ɹ P	
57	r' R'	ɹ P	Before j J
58	s S	c C	
59	s' S'	c C	Before j J
60	sh Sh	ɬ III	
61	sh' Sh'	ɬ III	Before j J, ch Ch
62	shch Shch	ɬ̚ III̚	
63	shch' Shch'	ɬ̚ III̚	Before j J
64	t T	ɬ T	
65	t' T'	ɬ T	Before j J
66	u U	y Y	
67	uw Uw	ɸ ɸ	
68	uw h Uwh	oy Oy	
69	v V	ɸ B	
70	v' V'	ɸ B	Before j J
71	xh Xh	ɬ ɬ̚	
72	xh' Xh'	ɬ ɬ̚	Before j J
73	y Y	ɬ И	

74	yw Yw	ы Ы	
75	yh Yh	ѡ Ѣ	
76	z Z	з З	
77	z' Z'	з З	Before j J

**End of Table 8 – Retransliteration of the Old (Medieval) Ukrainian alphabet by System B**

№	Latin alphabet	Cyrillic alphabet	Notes
78	zdh Zdh	с С	
79	zdh' Zdh'	с С	Before j J
80	zh Zh	ж Ж	
81	zh' Zh'	ж Ж	Before j J
82	zw Zw	з З	
83	zw' Zw'	з З	Before j J
84	,^	' (soft accent)	
85	_^	˘ (macron)	
86	\/	˘ (breve)	
87	/\	ˆ (arch)	
88	'	´ (acute accent)	
89	`	` (grave accent)	
90	~^	ˆ (titlo)	
91	`/	˙ (modifier letter dot slash)	
92	\	¨ (Ukrainian diaeresis)	

**Table 9 – Transliteration of the New Ukrainian alphabet by System A**

№	Cyrillic alphabet	Latin alphabet	Notes
1	а А	a A	
2	б Б	b B	
3	б Б	b' B'	Before й Ы
4	в В	v V	
5	в В	v' V'	Before й Ы
6	г Г	ğ Ğ	
7	г Г	ğ' Ğ'	Before й Ы
8	г Г	g G	
9	г Г	g' G'	Before й Ы
10	д Д	d D	
11	д Д	d' D'	Before й Ы
12	е Е	e E	
13	є Є	je Je	Except the alphabets by M. Ghatcuk and M. Maksymovych
14	ж Ж	ž Ž	
15	ж Ж	ž' Ž'	Before й Ы
16	з З	z Z	
17	з З	z' Z'	Before й Ы
18	и И	y Y	
19	і І	i I	
20	ї Ї	ï Ï	
21	й Й	j J	
22	й Й	j' J'	Before а А, е Е, у У
23	к К	k K	
24	к К	k' K'	Before й Ы
25	л Л	l L	

26	л Л	l' L'	Before й Ё
27	м М	m M	
28	м М	m' M'	Before й Ё
29	н Н	n N	
30	н Н	n' N'	Before й Ё
31	о О	o O	
32	п П	p P	
33	п П	p' P'	Before й Ё

**End of Table 9** – Transliteration of the New Ukrainian alphabet by System A

№	Cyrillic alphabet	Latin alphabet	Notes
34	р Р	r R	
35	р Р	r' R'	Before й Й
36	с С	s S	
37	с С	s' S'	Before й Й
38	т Т	t T	
39	т Т	t' T'	Before й Й
40	у У	u U	
41	ф Ф	f F	
42	ф Ф	f' F'	Before й Й
43	х Х	x X	
44	х Х	x' X'	Before й Й
45	ц Ц	c C	
46	ц Ц	c' C'	Before й Й
47	ч Ч	č Č	
48	ч Ч	č' Č'	Before й Й
49	ш Ш	š Š	
50	ш Ш	š' Š'	Before й Й
51	щ Щ	ș Ș	
52	щ Щ	ș' Ș'	Before й Й
53	ъ Ъ	j J	
54	ъ Ъ	j' J'	Before а А, е Е, у У
55	ъ Ъ	ĵ Ĵ	In an isolated position
56	ю Ю	ju Ju	
57	я Я	ja Ja	
58	’ ’	’ ’	



59	ě Ě	ö Ö	
60	є Є	è È	In the alphabets by M. Ghatcuk and M. Maksymovych
61	é Ě	jé Jé	
62	ı İ	î Î	
63	í Í	í Í	
64	ŷ Ÿ	ű Ű	
65	ҕ Ҥ	ҕ Ҥ	
66	ҕ Ҥ	ҕ Ҥ	
67	ѱ Ѳ	dž Dž	
68	ѱ Ѳ	dž' Dž'	Before ѣ ѣ
69	ѣ ѣ	ő Ő	
70	ы Ы	у У	
71	ѣ ѣ	é Ě	
72	э Э	ē Ē	
73	ж Ж	ü Ü	
74	ӕ Ӓ	ä Ä	
75	ӑ Ӓ	k K	
76	ӑ Ӓ	k' K'	Before ѣ ѣ
77	ѱ Ѳ	р Р	
78	ѱ Ѳ	р' Р'	Before ѣ ѣ
79	ѣ ѣ	ř Ř	
80	ѣ ѣ	ř' Ř'	Before ѣ ѣ
81	v V	ý Ý	
82	g G	ġ Ġ	
83	g G	ġ' Ġ'	Before ѣ ѣ
84	j J	ï Ï	

**Note.** The diacritical marks are placed above the corresponding transliterated letters: «^» (circumflex), «¨» (Ukrainian diaeresis), «^» (“pajerok”, or zigzag).

**Table 10** – Transliteration of the New Ukrainian alphabet by System B

№	Cyrillic alphabet	Latin alphabet	Notes
1	а А	a A	
2	б Б	b B	
3	б Б	b' B'	Before й Ы
4	в В	v V	
5	в В	v' V'	Before й Ы
6	г Г	gh Gh	
7	г Г	gh' Gh'	Before й Ы
8	г Г	g G	
9	г Г	g' G'	Before й Ы
10	д Д	d D	
11	д Д	d' D'	Before й Ы
12	е Е	e E	
13	є Є	je Je	Except the alphabets by M. Ghatcuk and M. Maksymovych
14	ж Ж	zh Zh	
15	ж Ж	zh' Zh'	Before й Ы
16	з З	z Z	
17	з З	z' Z'	Before й Ы
18	и И	y Y	
19	і І	i I	
20	ї Ї	ji Ji	
21	й Й	j J	
22	й Ы	j' J'	Before а А, е Е, і І, у У, ґ ґ
23	к К	k K	
24	к К	k' K'	Before й Ы
25	л Л	l L	

26	л Л	l' L'	Before й Ы
27	м М	m M	
28	м М	m' M'	Before й Ы
29	н Н	n N	
30	н Н	n' N'	Before й Ы
31	о О	o O	
32	п П	p P	
33	п П	p' P'	Before й Ы
34	р Р	r R	
35	р Р	r' R'	Before й Ы
36	с С	s S	
37	с С	s' S'	Before й Ы
38	т Т	t T	
39	т Т	t' T'	Before й Ы
40	у У	u U	
41	ф Ф	f F	
42	ф Ф	f' F'	Before й Ы
43	х Х	kh Kh	
44	х Х	kh' Kh'	Before й Ы
45	ц Ц	c C	
46	ц Ц	c' C'	Before й Ы
47	ч Ч	ch Ch	
48	ч Ч	ch' Ch'	Before й Ы
49	ш Ш	sh Sh	
50	ш Ш	sh' Sh'	Before й Ы, ч Ч
51	щ Щ	shch Shch	

52	щ Щ	shch' Shch'	Before й Й
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**End of Table 10** – Transliteration of the New Ukrainian alphabet by System B

№	Cyrillic alphabet	Latin alphabet	Notes
53	ѣ ѣ	j J	
54	ѣ ѣ	j' J'	Before a A, e E, i I, y Y, ѣ ѣ
55	ѣ ѣ	hj HJ	In an isolated position
56	ю Ю	ju Ju	
57	я Я	ja Ja	
58	’ ’	’ ’	
59	ѥ ѥ	jow Jow	
60	є Є	ew Ew	In the alphabets by M. Ghatcuk and M. Maksymovych
61	ѥ ѥ	je' Je'	
62	ї І	ih Ih	
63	і І	i' I'	
64	ѣ ѣ	uh Uh	
65	ѣ ѣ	uw Uw	
66	ѣ ѣ	uw' Uw'	
67	ѣ ѣ	dh Dh	
68	ѣ ѣ	dh' Dh'	Before ѣ ѣ
69	ѣ ѣ	oh Oh	
70	ѣ ѣ	yw Yw	
71	ѣ ѣ	ieh Ieh	
72	ѣ ѣ	ehw Ehw	
73	ѣ ѣ	juw Juw	
74	ѣ ѣ	jaw Jaw	
75	ѣ ѣ	xh Xh	
76	ѣ ѣ	xh' Xh'	Before ѣ ѣ
77	ѣ ѣ	ph Ph	

78	ψ Ψ	ph' Ph'	Before й Ы
79	ø Ø	fh Fh	
80	ø Ø	fh' Fh'	Before й Ы
81	v V	yh Yh	
82	g G	gw Gw	
83	g G	gw' Gw'	Before й Ы
84	j J	jh Jh	
85	^ (circumflex)	^	
86	~ (Ukrainian diaeresis)	\\	
87	` ("pajerok" / zigzag)	#	

**Note.** The transliterated diacritical marks are placed after the corresponding transliterated letters: «^» (circumflex), «\\» (Ukrainian diaeresis), «#» ("pajerok", or zigzag).

**Table 11** – Retransliteration of the New Ukrainian alphabet by System A

Nº	Latin alphabet	Cyrillic alphabet	Notes
1	a A	а А	
2	b B	б Б	
3	b' B'	б Б	Before j J
4	c C	ц Ц	
5	č Č	ч Ч	
6	c' C'	ц Ц	Before j J
7	č' Č'	ч Ч	Before j J
8	d D	д Д	
9	d' D'	д Д	Before j J

**Continuation of Table 11 – Retransliteration of the New Ukrainian alphabet by System A**



№	Latin alphabet	Cyrillic alphabet	Notes
10	e E	е Е	
11	f F	ф Ф	
12	f' F'	ф Ф	Before j J
13	g G	г Г	
14	ğ Ğ	г Г	
15	g' G'	г Г	Before j J
16	ğ' Ğ'	г Г	Before j J
17	i I	і І	
18	ï Ì	і І	
19	j J	й Й	
20	j J	ь Ь	After b B, c C, č Č, d D, dž Dž, f F, ħ Ħ, g G, ğ Ğ, ğ Ğ, k K, k K, l L, m M, n N, p P, p P, r R, s S, š Š, š Š, t T, v V, x X, z Z, ž Ž
21	ĵ Ĵ	ь Ь	In an isolated position
22	j' J'	й Й	Before a A, e E, u U
23	j' J'	ь Ь	After b B, c C, č Č, d D, dž Dž, f F, ħ Ħ, g G, ğ Ğ, ğ Ğ, k K, k K, l L, m M, n N, p P, p P, r R, s S, š Š, š Š, t T, v V, x X, z Z, ž Ž Before a A, e E, u U
24	ja Ja	я Я	
25	je Je	є Є	Except the alphabets by M. Ghatcuk and M. Maksymovych
26	ju Ju	ю Ю	
27	k K	к К	
28	k' K'	к К	Before j J
29	l L	л Л	
30	l' L'	л Л	Before j J
31	m M	м М	

32	m' M'	м М	Before j J
33	n N	н Н	
34	n' N'	н Н	Before j J
35	o O	о О	
36	p P	п П	
37	p' P'	п П	Before j J
38	r R	р Р	
39	r' R'	р Р	Before j J
40	s S	с С	
41	ŝ Š	щ Щ	
42	š Š	ш Ш	
43	s' S'	с С	Before j J
44	ŝ' Š'	щ Щ	Before j J
45	š' Š'	ш Ш	Before j J
46	t T	т Т	
47	t' T'	т Т	Before j J
48	u U	у У	
49	v V	в В	
50	v' V'	в В	Before j J
51	x X	х Х	
52	x' X'	х Х	Before j J
53	y Y	и И	
54	z Z	з З	
55	ž Ž	ж Ж	
56	z' Z'	з З	Before j J
57	ž' Ž'	ж Ж	Before j J

**End of Table 11 – Retransliteration of the New Ukrainian alphabet by System A**

№	Latin alphabet	Cyrillic alphabet	Notes
58	’ ’	’ ’	
59	ä Ä	Ӑ Ӑ	
60	dž Dž	Ѡ Ѡ	
61	dž’ Dž’	Ѡ Ѡ	Before j J
62	ē Ē	э Э	
63	è È	е Е	In the alphabets by M. Ghatcuk and M. Maksymovych
64	é Ê	ѣ Ћ	
65	ĥ Ħ	ө Ө	
66	ĥ’ Ħ’	ө Ө	Before j J
67	ġ Ġ	г Г	
68	ġ’ Ġ’	г Г	Before j J
69	í Í	і І	
70	î Î	ı І	
71	ĵ Ĵ	ј Ј	
72	ĵé Ĵé	џ Џ	
73	ķ K	ķ ķ	
74	ķ’ K’	ķ ķ	Before j J
75	ö Ö	ё Ё	
76	ő Ő	ѡ ѡ	
77	ø Ø	ø ø	
78	ŕ Ŗ	ŗ Ŗ	
79	þ Þ	ψ Ψ	
80	þ’ Þ’	ψ Ψ	Before j J
81	ü Ü	ӱ ӱ	
82	ÿ Ÿ	ӷ ӷ	

83	ÿ Ÿ	v V	
84	у у	ы Ы	

**Table 12** – Retransliteration of the New Ukrainian alphabet by System B

№	Latin alphabet	Cyrillic alphabet	Notes
1	a A	а А	
2	b B	б Б	
3	b' B'	б Б	Before j J
4	c C	ц Ц	
5	c' C'	ц Ц	Before j J
6	ch Ch	ч Ч	
7	ch' Ch'	ч Ч	Before j J
8	d D	д Д	
9	d' D'	д Д	Before j J
10	e E	е Е	
11	f F	ф Ф	
12	f' F'	ф Ф	Before j J
13	g G	г Г	
14	g' G'	г Г	Before j J
15	gh Gh	г Г	
16	gh' Gh'	г Г	Before j J
17	hJ HJ	ь Ь	In an isolated position
18	i I	і І	
19	j J	й Й	
20	j J	ь Ь	After b B, c C, ch Ch, d D, dh Dh, f F, fh Fh, g G, gw Gw, k K, kh Kh, l L, m M, n N, p P, ph Ph, r R, s S, sh Sh, shch Shch, t T, v V, xh Xh, z Z, zh Zh

**Continuation of Table 12 – Retransliteration of the New Ukrainian alphabet by System B**

№	Latin alphabet	Cyrillic alphabet	Notes
21	j' J'	й Й	Before a A, e E, i I, u U, uw Uw
22	j' J'	ь Ь	After b B, c C, ch Ch, d D, dh Dh, f F, fh Fh, g G, gw Gw, k K, kh Kh, l L, m M, n N, p P, ph Ph, r R, s S, sh Sh, shch Shch, t T, v V, xh Xh, z Z, zh Zh Before a A, e E, i I, u U, uw Uw
23	ja Ja	я Я	
24	je Je	є Є	Except the alphabets by M. Ghatcuk and M. Maksymovych
25	ji Ji	ї Ї	
26	ju Ju	ю Ю	
27	k K	к К	
28	k' K'	к К	Before j J
29	kh Kh	х Х	
30	kh' Kh'	х Х	Before j J
31	l L	л Л	
32	l' L'	л Л	Before j J
33	m M	м М	
34	m' M'	м М	Before j J
35	n N	н Н	
36	n' N'	н Н	Before j J
37	o O	о О	
38	p P	п П	
39	p' P'	п П	Before й Й
40	r R	р Р	
41	r' R'	р Р	Before й Й
42	s S	с С	

43	s' S'	c C	Before j J
44	sh Sh	ш Ш	
45	sh' Sh'	ш Ш	Before j J, ch Ch
46	shch Shch	щ Щ	
47	shch' Shch'	щ Щ	Before j J
48	t T	т Т	
49	t' T'	т Т	Before j J
50	u U	у У	
51	v V	в В	
52	v' V'	в В	Before j J
53	y Y	и И	
54	z Z	з З	
55	z' Z'	з З	Before j J
56	zh Zh	ж Ж	
57	zh' Zh'	ж Ж	Before j J
58	' '	' '	
59	dh Dh	д Д	
60	dh' Dh'	д Д	Before j J
61	ehw Ehw	э Э	
62	ew Ew	е Е	In the alphabets by M. Ghatcuk and M. Maksymovych
63	fh Fh	ф Ф	
64	fh' Fh'	ф Ф	Before j J
65	gw Gw	г Г	
66	gw' Gw'	г Г	Before j J
67	i' I'	і І	



68	ieh Ieh	ѣ ѣ	
69	ih Ih	ї ї	
70	jaw Jaw	ґ ґ	
71	je' Je'	є є	

**End of Table 12 – Retransliteration of the New Ukrainian alphabet by System B**

№	Latin alphabet	Cyrillic alphabet	Notes
72	jh Jh	ј Ј	
73	jow Jow	ѐ Ё	
74	juw Juw	ґ ґ	
75	oh Oh	ѣ ѣ	
76	ph Ph	џ џ	
77	ph' Ph'	џ џ	Before j J
78	uh Uh	ґ ґ	
79	uw Uw	ґ ґ	
80	uw' Uw'	ґ ґ	
81	xh Xh	ґ ґ	
82	xh' Xh'	ґ ґ	Before j J
83	yw Yw	ы Ы	
84	yh Yh	џ џ	
85	^	^ (circumflex)	
86	\	`` (Ukrainian diaeresis)	
87	#	` ("pajerok" / zigzag)	

**Table 13** – Phonemic representation of the Modern Ukrainian alphabet

№	Cyrillic alphabet	IPA	X-SAMPA	Notes
1	а А	ɑ	A	
2	б Б	b	b	
3	в В	ʋ	P	
4	г Г	ɣ	G	
5	г' Г'	ɣ	G	
6	д Д	ɖ	d_	Not preceding є Є, і І, ь Ь, ю Ю, я Я
7	д Д	dʲ	d^j	Before є Є, і І, ь Ь, ю Ю, я Я
8	дж Дж	dʒ	d^j_z	Except prefixes від Від, од Од, над Над, під Під, пред Пред, перед Перед
9	дз Дз	d͡z	d_-_z	Except prefixes від Від, од Од, над Над, під Під, пред Пред, перед Перед
10	дз Дз	d͡zʲ	d_-_z^j	Except prefixes від Від, од Од, над Над, під Під, пред Пред, перед Перед. Before є Є, і І, ь Ь, ю Ю, я Я
11	е Е	ɛ	E	
12	є Є	jɛ	jE	In initial position, after apostrophe, and after а А, е Е, є Є, и И, і І, ї Ї, й Й, о О, у У, ь Ь, ю Ю, я Я
13	є Є	ɛ	E	After б Б, в В, г Г, г' Г', д Д, ж Ж, з З, к К, л Л, м М, н Н, п П, р Р, с С, т Т, ф Ф, х Х, ц Ц, ч Ч, ш Ш, щ Щ
14	ж Ж	ʒ	Z	
15	з З	z	z	Not preceding є Є, і І, ь Ь, ю Ю, я Я
16	з З	zʲ	z^j	Before є Є, і І, ь Ь, ю Ю, я Я
17	и И	ɪ	1	
18	і І	i	i	
19	ї Ї	ji	ji	
20	й Й	j	j	
21	к К	k	k	

22	л Л	ł	l-	Not preceding є Є, і І, ь Ь, ю Ю, я Я
23	л Л	lj	l^j	Before є Є, і І, ь Ь, ю Ю, я Я
24	м М	m	m	
25	н Н	n	n_-	Not preceding є Є, і І, ь Ь, ю Ю, я Я
26	н Н	n	n_-^j	Before є Є, і І, ь Ь, ю Ю, я Я
27	о О	o	o	
28	п П	p	p	

**End of Table 13** – Phonemic representation of the Modern Ukrainian alphabet

№	Cyrillic alphabet	IPA	X-SAMPA	Notes
29	р Р	r	r	
30	с С	s	s	Not preceding е Є, і І, ь Ь, ю Ю, я Я
31	с С	sʲ	sʌj	Before е Є, і І, ь Ь, ю Ю, я Я
32	т Т	t̪	t_-	Not preceding е Є, і І, ь Ь, ю Ю, я Я
33	т Т	tʲ	tʌj	Before е Є, і І, ь Ь, ю Ю, я Я
34	у У	u	u	
35	ф Ф	f	f	
36	х Х	x	x	
37	ц Ц	t͡s	t_s	Not preceding е Є, і І, ь Ь, ю Ю, я Я
38	ц Ц	t͡sʲ	t_sʌj	Before е Є, і І, ь Ь, ю Ю, я Я
39	ч Ч	t͡ʃ	tʌj_s	
40	ш Ш		s	
41	щ Щ	t͡ʃ	stʌj_s	
42	ь Ь	-	-	
43	ю Ю	ju	ju	In initial position, after apostrophe, and after а А, е Е, є Є, и И, і І, ї Ї, й Й, о О, у У, ь Ь, ю Ю, я Я
44	ю Ю	u	u	After б Б, в В, г Г, ґ Ґ, д Д, ж Ж, з З, к К, л Л, м М, н Н, п П, р Р, с С, т Т, ф Ф, х Х, ц Ц, ч Ч, ш Ш, щ Щ
45	я Я	ja	ja	In initial position, after apostrophe, and after а А, е Е, є Є, и И, і І, ї Ї, й Й, о О, у У, ь Ь, ю Ю, я Я
46	я Я	a	A	After б Б, в В, г Г, ґ Ґ, д Д, ж Ж, з З, к К, л Л, м М, н Н, п П, р Р, с С, т Т, ф Ф, х Х, ц Ц, ч Ч, ш Ш, щ Щ
47	’ ’	-	-	

## References

- Abbas, M. R., & Asif, K. H. (2020). Punjabi to ISO 15919 and roman transliteration with phonetic rectification. *ACM Transactions on Asian and Low-Resource Language Information Processing*, 19(2). DOI: 10.1145/3359991.
- ALA-LC Romanization Tables. Church Slavic romanization table. (2011). Retrieved August 3, 2020 from <https://www.loc.gov/catdir/cpsol/romanization/churchsl.pdf>.
- Alpatov, V. M. et al. (1983). *Lingvisticheskie zadachi [Linguistic tasks]*. Moskva: Prosveshhenie. 223 p.
- Bewhrywnda, Pamvo. (1627). *Lewxhihkoow'n slavewnorow'sskij, y' y'/mewnoh tlohkova'njiEw [Slavic Rosj lexicon and explanation of names]*. Kihyo'vjijaw [in Ukrainian]. Retrieved September 15, 2020 from <http://litopys.org.ua/index.html>.
- Bezpaljko, O. P., Bojchuk, M. K., Zhovtobryukh, M. A. et al. (1957). *Istorychna ghramatyka ukrajinsjkoji movy [Historical grammar of Ukrainian]*. Kyjiv: Rad. shkola. 474 p. (in Ukrainian).
- Bilodid, I. K. (ed.). (1969). *Suchasna ukrajinsjka literaturna mova. Fonetyka [Contemporary standard Ukrainian. Phonetics]*. Kyjiv: Naukova dumka. 436 p. (in Ukrainian).
- Bogacz, B., Klingmann, M., & Mara, H. (2017). Automating Transliteration of Cuneiform from Parallel Lines with Sparse Data. *Proc. of the International Conference on Document Analysis and Recognition, ICDAR 1*, pp. 615–620.
- Brajchevsjkyj, M. (2009). *Pokhodzhennja slov'jansjkoji pysemnosti [Origin of Slavic Writing]*. Kyjiv: Akademija (in Ukrainian).
- Cai, Zhengqi, & Wang, Weilan. (2018). 2DLDA-based Compound Distance for Similar Online Handwritten Tibetan Transliteration of the Sanskrit Character Recognition. *Proc. of International Conference on Frontiers in Handwriting Recognition, ICFHR. AUG 05–08, 2018. Niagara Falls, NY, USA*. Pp. 223–228.
- Cejtin, R. M., Večerka, R., & Blagova, E. (eds.). (1994). *Staroslavjanskij slovarj (po rukopisjam 10–11 vekov) [Old Slavonic dictionary (based on manuscripts of the 10–11 centuries)]*. Moskva: Russkij jazyk. 842 p.
- Chaudhary, Aditi et al. (2018). Adapting Word Embeddings to New Languages with Morphological and Phonological Subword Representations. *Proc. of the 2018 Conference on Empirical Methods in Natural Language Processing*, pp. 3285–3295. Brussels, Belgium, October 31 – November 4, 2018.
- Chomsky, Noam, & Morris Halle. (1968). *The Sound Pattern of English*. New York, Evanston, and London: Harper & Row Publishers. 470 p.

- *DSTU 9112:2021 (ISO 9:1995, NEQ)*. (2022). Kyrylychno-latynychna transliteracija ta latynychno-kyrylychna retransliteracija ukrajinsjkykh tekstiv. Pravyla napysannja [Cyrillic-Latin transliteration and Latin-Cyrillic retransliteration of Ukrainian texts. Writing rules]. Kyjiv: DP UkrNDNC, 2022. 32 p.
- **Ghrinchenko, Borys (comp.)**. (1958-1959). *Slovarj ukrajinsjkiji movy [printed from the 1907-1908 edition]*. Kyjiv: Vydavnytvo AN URSR. Vol. 1-4. [In Ukrainian].
- *IPA charts and sub-charts in four fonts*. (2018). Retrieved August 3, 2020 from [https://www.internationalphoneticassociation.org/IPAcharts/inter\\_chart\\_2018/IPA\\_2018.html](https://www.internationalphoneticassociation.org/IPAcharts/inter_chart_2018/IPA_2018.html).
- *ISO 9:1995. Information and documentation – Transliteration of Cyrillic characters into Latin characters – Slavic and non-Slavic languages*. (1995). Retrieved August 3, 2020 from <https://www.iso.org/standard/3589.html>.
- **Istrina, E.** (1915). *Rukovodstvo po istoriji russkago jazyka [Guide to the history of the Russian language]*. Petrograd. Izdanie Ja. Bashmakova i K<sup>o</sup>. 114 p. (in Russian).
- **Jakobson, R. O.** (1965). O latinizaciji mezhdunarodnykh telegram na russkom jazyke. *Voprosy jazykoznanija* 1: 111-113.
- **Maslov, Jurij S.** (2007). *Vvedenie v jazykoznanie [Introduction to linguistics]*. Moskva: Academia; Saint Petersburg: Filol. fak. SPbGU. 304 p. (in Russian).
- **Meillet, A.** (1951). *Le Slave commun*. Moskva: Inostrannaja literatura. 491 p. (in Russian).
- **Mozer, M.** (2018). *Istorija ukrajinsjkoji movy [History of Ukrainian language]*. Kyjiv: Likbez. 27 p. (in Ukrainian).
- **Naji, N., & Allan, J.** (2016). On cross-script information retrieval. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* 9626: 796-802.
- **Nimchuk, V. V., & Purjajeva, N. V.** (2004). *Istorija ukrajinsjkogho pravopysu XVI-XX stolittja: khrestomatija*. Kyjiv: Naukova dumka. 583 p. (in Ukrainian).
- **Pakerys, Antanas.** (1995). *Bendrinės lietuvių kalbos fonetika [Phonetics of the general Lithuanian language]*. Vilnius: Enciklopedija, Valiulio Leidykla. 242 p. (in Lithuanian).
- **Pezzati, Luca.** (2019). Private communication. Odesa. December 6, 2019.
- **Pivtorak, Gh. P.** (2004). Ukrajinsjkyj alfavit [Ukrainian alphabet]. *Ukrajinsjka mova: encyklopedija [Ukrainian language: encyclopedy]* / Eds.: V. M. Rusanivs'kyj, O. O. Taranenko, M. P. Zjabljuk et al. Kyjiv: Publishing house "Ukrajinsjka encyklopedija". 824 p.: il. Pp. 737-738 (in Ukrainian).

- **Razak, Sitti Munirah Abdul et al.** (2018). *Transliteration Engine for Union Catalogue of Malay Manuscripts in Malaysia: E-JAWI Version 3*. *Proc. of International Conference on Information and Communication Technology for the Muslim World, ICT4M*. Kuala Lumpur, Malaysia. 23–25 July 2018. Pp. 58–63.
- **Reformatskij, A. A.** (1960). Transliteracija russkikh tekstov latinskimi bukvami [Transliteration of Russian texts by Latin letters]. *Voprosy jazykoznanija* 5: 96-103.
- **Shevelov, G. Y.** (1979). *A Historical Phonology of the Ukrainian Language*. Heidelberg: Carl Winter. 808 p.
- **Smotryskij, Mewlewtij.** (1619). *Ghrammatihky. Slavewnskyjaw pravylnoew syhntagma* [Grammatics. Slavic correct syntagma] [in Ukrainian]. Retrieved September, 15, 2020 from <http://litopys.org.ua/index.html>.
- **Sobolevskij, A. I.** (1907). *Lekcihi po istorihi russkago jazyka* [Lectures on the history of the Russian language]. Moskva: University Printing House, Strastnoj Boulevard. 309 p. (in Russian).
- **Striova, Jana.** (2019). Private communication. Odesa. December 6, 2019.
- **Tilkov, D. (ed.).** (1982). *Gramatika na sahvremennija bahlgarski knizhoven ezik / Vol. 1: Phonetics*. Sofija: Nauka i izkustvo. 299 p. (in Bulgarian).
- **Tocjka, N. I.** (1981). *Suchasna ukrajinsjka literaturna mova: fonetyka, orfoepija, ghrafika, orfoghrafija* [Contemporary standard Ukrainian: phonetics, orthoepics, graphemics, orthography]. Kyjiv: Vyshha shkola. 183 p. (in Ukrainian).
- **Tsvetkov, Yulia, & Dyer, Chris.** (2016). Cross-lingual bridges with models of lexical borrowing. *J. Artif. Int. Res.* 55(1): 63–93.
- **Vakulenko, Maksym.** (2004). Simple-correspondent transliteration through a Slavonic Latin alphabet. *Journal of Language and Linguistics* 3(2): 213–228. Retrieved August, 3, 2020 from <https://www.semanticscholar.org/paper/Simple-Correspondent-Transliteration-through-a-Vakulenko/2e2cfe3563b738ba916ae497cdc657d1635e3e04>.
- **Vakulenko, Maksym O.** (2015a). Practical transcription and transliteration: Eastern-Slavonic view. *Govor* 32 (1): 35–56. Retrieved August, 3, 2020 from [http://www.hfiloloskod.hr/images/HFD/Casopisi/Govor/web-GOVOR\\_32\\_1.pdf](http://www.hfiloloskod.hr/images/HFD/Casopisi/Govor/web-GOVOR_32_1.pdf).
- **Vakulenko, M. O.** (2015b). *Ukrajinsjka terminologhija: kompleksnyj lynchvistychnyj analiz* [Ukrainian terminology: complex linguistic analysis]. Ivano-Frankivsk : Foliant (in Ukrainian). 361 p., il. (in Ukrainian). Retrieved August, 3, 2020 from <https://www.ulif.org.ua/bookline/ukrayins-ka-tierminologhiia-kompleksnii-lynhvistichnii-analiz>.



- **Vakulenko, Maksym O.** (2018). Ukrainian vowel phones in the IPA context. *Govor* 35 (2): 189–214. DOI: 10.22210/govor.2018.35.11. Retrieved August, 3, 2020 from <https://www.hfiloloskod.hr/images/HFD/Govor/Govor-2-2018-web.pdf>.
- **Vakulenko, Maksym O.** (2019). Ukrainian Consonant Phones in the IPA Context with Special Reference to /v/ and /gh/. *Linguistica online* 22: 36–61. Published online August 22, 2019. Retrieved August, 3, 2020 from <http://www.phil.muni.cz/linguistica/art/vakulenko/vak-001.pdf>.
- **Widiarti, A. R., & Pulungan, R.** (2020). A method for solving scriptio continua in Javanese manuscript transliteration. *Heliyon*, 6(4). DOI:10.1016/j.heliyon.2020.e03827.
- **Zima, M.** (1986). Transliterace, transkripce a jiné druhy prepisu. *Explizite Beschreibung der Sprache und automatische Textbearbeitung. XII: Questions of Orthography and Transliteration*. S. 101-174. Praha: Matematicko-fyzikální fakulta Univerzity Karlovy.
- **Zhovtobrjukh, M. A.** (2004). Fonologichna systema [Phonological system]. In V. Rusanivskyj, O. Taranenko et al. (Eds), *Ukrajinsjka mova. Encyklopedija* (pp. 764–765). Kyjiv: Ukrajinsjka encyklopedija (in Ukrainian).
- **Zhovtobrjukh, M. A., & Kulyk, B. M.** (1965). *Kurs suchasnoji ukrajinskoji literaturnoji movy [A course of modern Ukrainian literary language]*. In 2 parts (3rd edition). Kyjiv: Rad. shk. Part 1. 160 p. (in Ukrainian).
- **Zjizanjij, Lavrentij.** (1596). *Ghramati'ka slovewnska [Slavic grammar]*. Vylno (in Ukrainian). Retrieved August, 3, 2020 from <http://litopys.org.ua/zyzgram/zy09.htm>.

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