

Typeface design for cultural identity – An exploration with Assamese typeface design.

Thesis submission in partial fulfillment of the
Requirements for the degree of
Doctor of Philosophy

Abhijit Padun

Roll no. 156105017

Under the Supervision of
Professor Amarendra Kumar Das

Department of Design



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
Guwahati-781039, Assam, India
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Dedicated to my family



DECLARATION

“I, Abhijit Padun, declare that the Ph.D. thesis “**Typeface design for cultural identity – An exploration with Assamese typeface design**” contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my work.”


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Date: 24th February 2021

Place: Guwahati



CERTIFICATE OF AUTHENTICITY

This thesis entitled “Typeface design for cultural identity – An exploration with Assamese typeface design” submitted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy at the Indian Institute of Technology Guwahati has been carried out under my supervision and is a bona fide work of Mr. Abhijit Padun.

I confirm that this thesis is an original work of Mr. Abhijit Padun except where due acknowledgment has been made and has not been submitted previously, in whole or part, to qualify for any academic award within or outside this institution.

I also confirm that Mr. Abhijit Padun has fulfilled all the mandatory requirements as per the rules and regulations necessary for the award of the degree of Doctor of Philosophy at the Indian Institute of Technology Guwahati.



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Guwahati - 781039

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Place: Guwahati



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Abstract

The identity of a culture is contributed significantly by the language. A language describes the essence of that particular culture. In a country like India which is known for its diversity in culture, each language that exists establishes a cultural identity. Be it Hindi, Tamil, Bengali, Punjabi, Assamese, and so on. Again a language can be divided into two types, colloquial and written. Colloquial language encourages the identity of a culture within the community more strongly than outside of it. But written language or more precisely the script of a language spread the identity of that culture outside of the community. Hence script is very important for a language to survive which in turn helps the culture to grow beyond its geographical boundary. There are many languages in India which do not have their script. Due to which these languages are fighting hard to establish their cultural identity as well as their existence. In this era of technological advancement, many languages lost their identity and becomes extinct due to the non-availability of their script. Many languages adopt other scripts to survive. Some of the examples in the Indian context are, Khasi language of Meghalaya adopted Roman script, the Bodo language of Assam adopted Devanagari script, and many more.

Again in terms of script, with the advancement of technology, the originality of a script has been re-structured to move out of its traditional boundary. In today's digital world almost all the script around the world has been digitized. The Indic scripts are also not an exception. Though digitization opens up a huge scope to explore the creative angles of a script, but on other hand, the traditional essence present in the scripts in their historical form gradually disappeared. Hence there may be a need to bring that traditional essence of a script to preserve the original identity as well as uniqueness which in turn may help retain the identity of that culture.

In this research an exploration was conducted on reviving the identity of Assamese script which represents the Assamese language and Assamese culture of India. The exploration outlines initially the need, the resources, the applicability, and the design considerations. Then further it proposes a design alternative of Assamese script in the form of a Typeface which may address the need to bring back the original essence of Assamese script which was present in its historical form. The very idea of this exercise is an effort to create an identity for Assamese language in the digital world with the help of the script which will be represented by a new Typeface that addresses the originality and tradition with historical essence.

To explore the exercise, a new typeface has been designed based on historical reference, and with Unicode compliance to experiment with the statement whether a typeface would be able to establish an identity for Assamese language and culture or not. Along with the new typeface, a customized keyboard layout for computers and a typing application for android mobile devices have been also developed to support the typeface for its uses on digital media. The typeface has been then tested for screen display on the computer as well as operating system compatibility, display on mobile and digital devices, and ease of typing on devices. Finally, a user survey conducted on the uses of the new typeface showed the result that satisfies the justification of the statement as stated.

The conclusion of the research successfully meets the aim and objectives proposed initially as well as offers promising future scope to explore new dimensions.

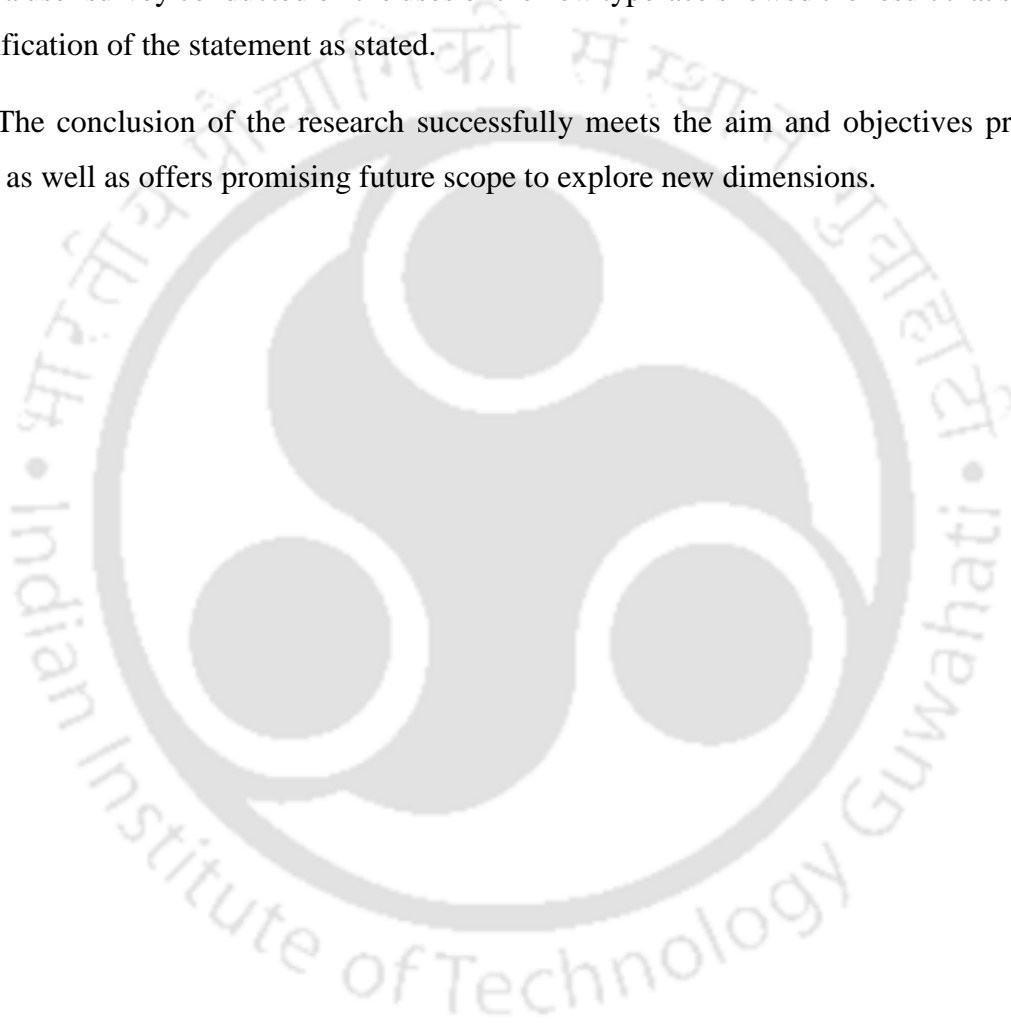


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LIST OF GLOSSARY

<i>S. No.</i>	<i>Word/words</i>	<i>Meaning</i>
1	<i>Ankiya naat</i>	Ankia Naats are a class of one-act plays performed in Assam, India. The invention of the Ankiya Naat is usually attributed to the medieval saint and social reformer Srimanta Sankardeva.
2	<i>Ahom</i>	A people of the Tai race who migrated from settled in Assam around the 13 th century. They ruled Assam for over 600 years till the late 18 th century.
3	<i>Ammonite</i>	Extinct or one that no longer exists.
4	<i>Anandaram Dhekial Phukan</i>	One of the pioneers of Assamese literature in the <i>Arunodoi</i> era joined in the literary revolution initiated by the Christian missionaries. He was remembered for his efforts in promoting the Assamese language. (1829 – 1859).
5	<i>Anusvara</i>	Anusvara is a symbol used in many Indic scripts to mark a type of nasal sound, typically transliterated.
6	<i>Aramaic</i>	Aramaic is the language or group of languages of the ancient region of Syria.
7	<i>Arunodoi</i>	First Assamese printed journal published from Sibsagar town of Assam in 1846.
8	<i>Asomiya Pratidin</i>	Assamese newspaper published in the Assamese language from Assam.
9	<i>Atmaram Sarmah</i>	Assamese scholar who was known for designing the first Assamese script for printing.
10	<i>Bamuniya</i>	It was a writing style in Assamese script initiated by Brahmins of Assam during the medieval period.
11	<i>Bijoy</i>	Bijoy keyboard layout is a proprietary layout of Mustafa Jabbar. It is licensed under the Bangladesh Copyright Act 2005. Bijoy keyboard, with related software and fonts, was first published in December 1998 for Macintosh computer. Windows version of Bijoy Keyboard was first published in March 1993.
12	<i>Bodo</i>	The Boro is the largest ethnolinguistic group in the Assam state of India.
13	<i>Borgeets</i>	Borgeets are a collection of lyrical songs that are set to specific ragas but not necessarily to any tala. These songs, composed by Srimanta Sankardeva and Madhavdeva in the 15 th - 16 th centuries, are used to begin prayer services in monasteries.

14	<i>Brahmic</i>	Related or belonging to a certain family of abugidas used to write many languages of South and Southeast Asia, descended from the Brāhmī script.
15	<i>Buranjis</i>	<i>Buranjis</i> are a class of historical chronicles and manuscripts written initially in Ahom Language and afterward in the Assamese language.
16	<i>Calligraphr.com</i>	A website offering free online font design application to develop own custom typeface.
17	<i>Chakradwaj Singha</i>	An Ahom king also known as Supangmung was an important Ahom king under whom the Ahom kingdom took back Guwahati from the Mughals following the reverses at the hands of Mir Jumla and the Treaty of Ghilajharighat. He is known for his fierce pride as an Ahom monarch.
18	<i>Charyapada</i>	The Charyapada is a collection of mystical poems, songs of realization in the Vajrayana tradition of Buddhism from the tantric tradition in Assam, Bengal, Bihar, and Odisha.
19	<i>Design Elements</i>	Distinctive graphic elements present in historic writing style.
20	<i>Devanāgarī</i>	Devanagari, also called Nagari, is a left-to-right abugida, based on the ancient Brāhmī script, used in the Indian subcontinent. It was developed in ancient India from the 1st to the 4th century CE.
21	<i>Edomite</i>	A member of an ancient people living in Edom, a region south of the Dead Sea, in biblical times, traditionally believed to be descended from Esau.
22	<i>Garhgaon</i>	It was the capital of Ahom kingdom situated in the eastern part of Assam at the current Sibsagar district.
23	<i>Garhgayān</i>	It was the ancient writing style that existed in Assam and was initiated by scribes appointed by Ahom kings to write treaties and official documents.
24	<i>Garhgayān Assamese</i>	The name of the new typeface was designed based on the ancient Garhgayān writing style.
25	<i>Gupta</i>	The Gupta script was used for writing Sanskrit and is associated with the Gupta Empire of India which was a period of material prosperity and great religious and scientific developments.
26	<i>Gurmukhī</i>	Gurmukhī is an abugida developed from the Laṇḍā scripts, standardized and used by the second Sikh guru, Guru Angad. Commonly regarded as a Sikh script, Gurmukhi is used in Punjab, India as the official script of the Punjabi language.

27	<i>Halant</i>	A diacritic is used in most writing systems of the Indian subcontinent to signify the lack of an inherent vowel.
28	<i>Hastir-vidyarnava</i>	An 18 th -century book written on elephants in Kaitheli style with an in-depth description and beautiful calligraphic rendition.
29	<i>Hebrew</i>	Hebrew is a Northwest Semitic language native to Israel. In 2013, Modern Hebrew was spoken by over nine million people worldwide. Historically, it is regarded as the language of the Israelites and their ancestors.
30	<i>I-Leap</i>	It is a product of Leap Office, an Indic language writing software.
31	<i>Ishwar Chandra Vidyasagar</i>	Ishwar Chandra Vidyasagar, born Ishwar Chandra Bandyopadhyay, was an Indian educator and social reformer. His efforts to simplify and modernize Bengali prose were significant. He was known to be the father of the modern Bengali writing system.
32	<i>Kaitheli</i>	It was the ancient Assamese writing style initiated by the Kayasthas.
33	<i>Kamarupa</i>	Kamarupa, an early state during the Classical period on the Indian subcontinent was the first historical kingdom of Assam. Though Kamarupa existed from 350 CE to 1140 CE, Davaka was absorbed by Kamarupa in the 5th century CE.
34	<i>Kamarupi script</i>	It is the ancient Assamese script used in the region of Kamrupa that developed independently from the Gupta and Siddham script.
35	<i>Kanai-Boroxiboa</i>	A place with several big rocks where early Kamrupi script was found as rock inscriptions.
36	<i>Karnasubarna</i>	Karnasubarna or Karnasubarna was the capital of Gauda Kingdom during the reign of Shashanka, the first important king of ancient Bengal who ruled in the 7th century.
37	<i>Kayasthas</i>	They were known to be the writer caste people in medieval Assam. They initiated the writing style known as Kaitheli.
38	<i>Kharosthi</i>	The Kharosthi script, also spelled Kharoshthi was an ancient Indian script used in Gandhara (now Pakistan and eastern Afghanistan) to write Gandhari Prakrit and Sanskrit.
39	<i>Khasi</i>	Khasi's are the indigenous people living in the state of Meghalaya in India. Their language is also called Khasi.
40	<i>King Bhaskarvarman</i>	Bhaskaravarman, the last of the Varman dynasty, was perhaps the most illustrious of the kings of the medieval

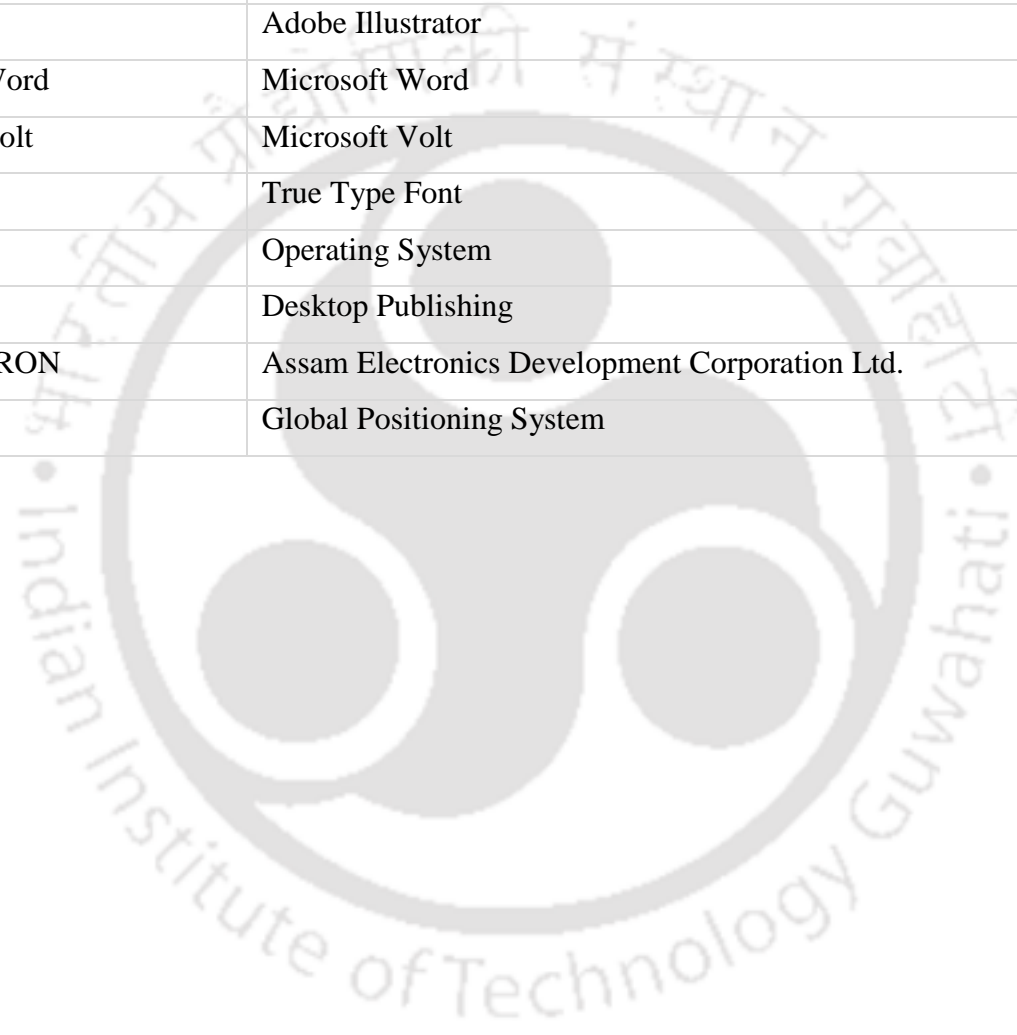
		Kamarupa. After being captured by the Gauda king during the reign of his father, he was able to re-establish the rule of the Varman's.
41	<i>Kotha Ramayana</i>	Kotha Ramayana is a poem written by the powerful Assamese poet Madhava Kandali during the 14 th century and is one of many versions of Ramayana in a regional Indian language other than Valmiki's Ramayana in Sanskrit. This work is also considered one of the earliest written examples of the Assamese language.
42	<i>Kundalis</i>	Known as horoscope writing in Indian culture.
43	<i>Kutila</i>	The Kutila inscription of Bareilly is an inscription in the Kutila script dating to 992 CE that provides crucial evidence in tracing the shared descent of the Devanagari and Bengali-Assamese scripts of Northern and Eastern India from the predecessor Gupta script.
44	<i>Lakhari</i>	It was another commonly known name of Kaitheli writing style.
45	<i>Leap Office</i>	It is a complete Indian language software for office applications developed by CDAC.
46	<i>lingua franca</i>	A language that is adopted as a common language between speakers whose native languages are different.
47	<i>Linotype</i>	The Linotype machine was a "line casting" machine used in printing sold by the Mergenthaler Linotype Company and related companies. It was a hot metal typesetting system that cast blocks of metal type for individual uses.
48	<i>Lipikaar</i>	It is an in-script Assamese typing application for digital devices.
49	<i>Madhava Kandali</i>	Kaviraja Madhava Kandali was an Indian poet from the state of Assam. His Saptakanda Ramayana is considered the earliest translation of the Ramayana into an Indo-Aryan language, Assamese.
50	<i>Matra</i>	It is the horizontal line drawn above characters in some Indic scripts such as Devanagari, Bengali, Gurmukhi, etc.
51	<i>Matres lectionis</i>	Matres lectionis are consonants that are used to indicate a vowel, primarily in the writing down of Semitic languages such as Arabic, Hebrew, and Syriac.
52	<i>Mising</i>	It is the 2 nd largest indigenous tribal group of Assam mostly populated in the upper Assam region.
53	<i>Moabite</i>	Moabite is an extinct Canaanite language, the Canaanite languages being a branch of Northwest Semitic languages, formerly spoken in Moab (modern-day central-western Jordan) in the early 1st millennium BC.

54	<i>Monotype</i>	Monotype Imaging Holdings Inc. is an American company that specializes in digital typesetting and typeface design for use with consumer electronics devices. The company has been responsible for many developments in printing technology — in particular the Monotype machine, which was a fully mechanical hot-metal typesetter, that produced texts automatically, all single type.
55	<i>Nagajari Khanikar Gaon</i>	The Nagajari-Khanikargaon rock inscription is a 5 th -century land grant discovered in the Nagajari area of the Golaghat district.
56	<i>Nidhanpur</i>	Nidhanpur is a village in Sylhet District, Bangladesh. This ancient village, earlier within the Kamrupa Kingdom, is known for the discovery of many Copper plate grants of Kamarupa kings such as Bhutivarman and Bhaskaravarman. Inscription of Bhaskaravarman gives a detailed account of land grants given to Brahmins.
57	<i>Old Aramaic</i>	Old Aramaic refers to the earliest stage of the Aramaic language, considered to give way to Middle Aramaic by the 3rd century.
58	<i>Ôxômiya lipi</i>	It is the writing script of the Assamese language.
59	<i>Perso-Arabic</i>	The Persian alphabet or Perso-Arabic alphabet is a writing system used for the Persian language spoken in Iran and Afghanistan.
60	<i>Phoenician</i>	The Semitic language of the Phoenicians, written in an alphabet that was the ancestor of the Greek and Roman alphabets.
61	<i>Pujas</i>	It is a social ritual performed for a holy cause.
62	<i>Ramdhenu</i>	It is keyboard layout software for Assamese script typing.
63	<i>Rodali</i>	A typing app for mobile devices with an in-script Assamese keyboard.
64	<i>Saanchi</i>	It is the name of a tree, the bark of which was used for writing in ancient Assam.
65	<i>Serabit el-Khadim</i>	Serabit el-Khadim is a locality in the southwest Sinai Peninsula, Egypt, where turquoise was mined extensively in antiquity, mainly by the ancient Egyptians.
66	<i>Shabdaliipi</i>	Shabdaliipi is a keyboard software for computer uses. Sabdaliipi uses a phonetic style keyboard in the sense that the key for a particular Assamese character is a similar-sounding English character.
67	<i>Siddham</i>	Siddham was also known in its later evolved form as Siddhamātrkā, is a medieval Brahmic abugida, derived

		from the Gupta script and ancestral to the Assamese alphabets, Bengali alphabet, and Maithili alphabet.
68	<i>Sirorekha</i>	Means headlines in Devanagari script.
69	<i>Srerampore</i>	It is the place in the Bengal region where printing presses were established by Baptist missionaries during British rule.
70	<i>Srimanta Sankardeva</i>	Srimanta Sankardev was a 15 th – 16 th -century Assamese polymath: a saint-scholar, poet, playwright, social-religious reformer, and a figure of importance in the cultural and religious history of Assam, India.
71	<i>Swarachakra</i>	A typing app for mobile and digital devices developed by IDC, IIT Bombay to write Indic scripts.
72	<i>Umachal</i>	The Umachal rock inscription is one of the earliest epigraphic sources discovered in Assam.
73	Unicode	Unicode is an information technology standard for the consistent encoding, representation, and handling of text expressed in most of the world's writing systems. The standard is maintained by the Unicode Consortium, a non-profit organization that originated from the United States of America.
74	<i>Vaishnava Satras</i>	The Institution of Satra is a unique feature of Vaishnavism in Assam, founded by Sankardeva, the father of Assamese culture. The Satras are not just monasteries, but centers of traditional performing arts. In the 15 th century, the first Satra was founded in Majuli.
75	<i>Virama</i>	Virama is a generic term for the diacritic in many Brahmic scripts, including the Devanagari and Eastern Nagari scripts, used to suppress the inherent vowel that otherwise occurs with every consonant letter.
76	<i>Visarga</i>	Visarga means "sending forth, discharge". In Sanskrit phonology, visarga is the name of a phone, written as “:”.
77	<i>Xaansi</i>	It is the name of a tree, the bark of which was used for writing in ancient Assam. Also written as Saanchi.
78	<i>Xaansi paat</i>	It is the dried bark of Xaansi ready for writing.

LIST OF ABBREVIATIONS

<i>Abbreviations</i>	<i>Full meaning</i>
AD	Anno Domini
IBM	International Business Machines
ANN	Artificial Neural Network
OCR	Optical Character Reader
DSLR	Digital single-lens reflex camera
AI	Adobe Illustrator
MS Word	Microsoft Word
MS Volt	Microsoft Volt
TTF	True Type Font
OS	Operating System
DTP	Desktop Publishing
AMTRON	Assam Electronics Development Corporation Ltd.
GPS	Global Positioning System





LIST OF PUBLICATIONS (Published)

1. Padun, A. & Das A. K. (2021). Significance of Assamese script and its progression from traditional media to digital platform: An exploration. *The Heritage (Aitihya): Multilingual Research Journal on Indology*. ISSN 2229-5399. UGC CARE Listed Research Journal.
2. Padun, A. & Das A. K. (2021). Typeface design for cultural identity – An exploration with Assamese typeface design and its future scope. *ICoRD 2021 – Design for Tomorrow*. A. Chakrabarti et al. (eds.), *Design for Tomorrow—Volume 1*, Smart Innovation, Systems and Technologies 221, (https://doi.org/10.1007/978-981-16-0041-8_46)
3. Padun, A. & Das A. K. (2020). Digital identity for Assamese script: Challenges and possibilities. *NCRAS 2020 - 3rd National Conference on Recent Advances in Science and Technology*.
4. Padun, A. & Das A. K. (2019). Exploring historical letterforms to design unique Assamese typeface for digital devices: Experimenting possibilities. *TYPODAY 2019 – International Conference on Typography*
5. Padun, A. & Das A. K. (2019). Study of Assamese letterform and its structure: An exploratory approach. (A. Chakrabarti, Eds.). *ICoRD 2019 – Research into Design for a Connected World*. (doi.org/10.1007/978-981-13-5974-3_13)
6. Padun, A. & Das A. K. (2018). Designing a new Assamese typeface for digital media: Challenges and possibilities. *Journal of Assam Science Society (JASS)*. J. Assam Sc. Soc. Vol. 58. No. 1 / June 2017; Pp. 14 – 24 / ISSN 0587-1921.





CHAPTER 1

PREFACE



Chapter 1: Preface

1.1 Assam and Assamese script

To introduce with, Assam is a state located in the Northeast part of India and situated south of the eastern Himalayas along the Brahmaputra and Barak River valleys. Assam covers an area of 78,438 km². The geographical location of Assam is Latitude: 24-28 degree North and Longitude: 90-96 degree East. The state is bordered by neighboring countries Bhutan and Bangladesh. It is surrounded by the six states of northeast India comprises Arunachal Pradesh, Nagaland, Manipur, Meghalaya, Tripura, and Mizoram along with West Bengal to the west that connects the state to the rest of India. The population of Assam as per the 2011 census is 31,205,576. Assamese is the official language of Assam, out of 23 official languages recognized by the Republic of India. The Assam Secretariat functions in the Assamese language (Assam, 2017).

Assamese script is the writing system of the Assamese language. The script has a rich history that evolved from the 5th century to recent times. The evolution went through many phases from rock inscription to manuscript to letterpress printing to offset technology to modern-day digital publication. It used to be the script of choice in the Brahmaputra valley for Sanskrit as well as other languages such as *Bodo* (now Devanagari), *Khasi* (now Roman), *Mising* (now Roman), etc. (Assamese alphabet, 2016).

The current form of the script has seen continuous development from the 5th century *Umachal/Nagajari-Khanikargaon* rock inscriptions written in an eastern variety of the Gupta script, adopting significant traits from the *Siddham* Script along the way (Assamese alphabet, 2016). The earliest evidence of Assamese script was found in the *Charyapada*, the Buddhist songs. They were supposed to have been composed within a time-frame of four hundred years from the 8th century AD to the 12th century AD.

Kamarupi script was the script used in the ancient *Kamarupa* region (which covered the entire Brahmaputra valley, North Bengal, Bhutan, and the northern part of Bangladesh, and at times portions of what is now West Bengal and Bihar as shown in Figure 1.1) from early times to the 13th century, from which the Assamese script evolved. In the development of the Assamese script, this phase was followed by the medieval and then by the modern Assamese scripts. The *Kamarupi* script originated from the *Gupta* script, which in turn developed from the Brahmi script. It developed on its own in *Kamarupa*, till the *Nidhanpur* copper-plate inscription issued by *King Bhaskarvarman* from his military camp at *Karnasubarna*, which took on *Kutila* characteristics. The *Kamarupa* inscriptions were engraved during this

development period, and they display the development of this script in this period. The scripts of the 5th century *Umachal* and *Nagajari-Khanikargaon* rock inscriptions are nearly identical to the eastern variety of the *Gupta* script, which over the centuries evolved into the proto-Assamese script of the 13th-century *Kanai-Boroxiboa* inscriptions (Kamrupi script, 2016).

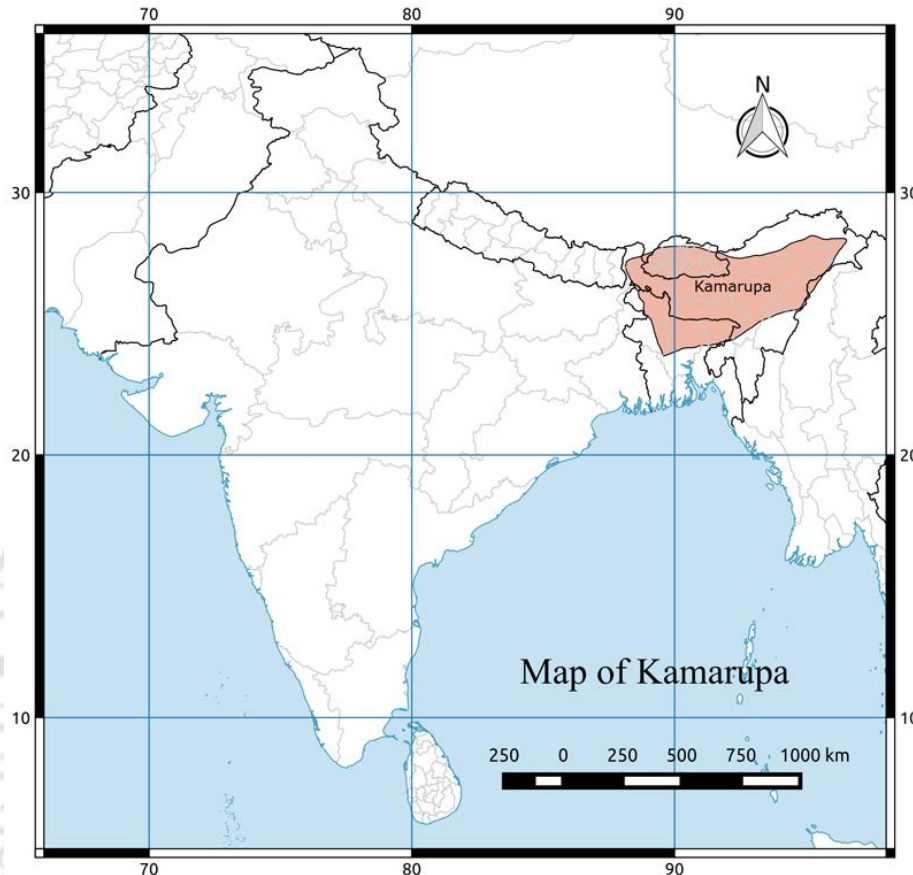


Figure 1.1: Ancient map of Kamrupa kingdom (source: Wikipedia/Kamrupa)

In the 14th century, *Madhava Kandali* used Assamese script to compose the famous *Kotha Ramayana* which was the first translation of *Ramayana* in a regional Indian language after *Valmiki Ramayana* in Sanskrit. Later, *Srimanta Sankardeva* used it in the 15th and 16th centuries to compose his oeuvre in Assamese and *Brajavali*, the language of the *Bhakti* (devotional) poems known as *Borgeets* and Dramas known as *Ankiya naat* (Assamese alphabet, 2016).

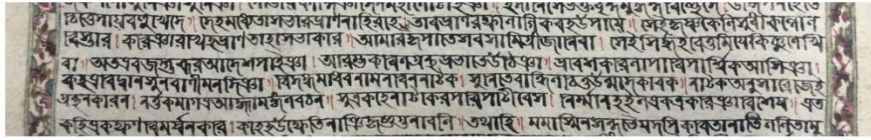
The Ahom king *Chakradwaj Singha*, (1663–1670 AD) was the first ruler who started issuing coins with Assamese script cast on them for his kingdom. Similar scripts with minor differences were used to write Maithili, Bengali, Manipuri, and Sylheti language. *Buranjis* (chronicles) were written during the Ahom dynasties in the Assamese language using Assamese script (Assamese alphabet, 2016).

In the 18th and 19th century, the Assamese script could be divided into three varieties: *Kaitheli* (also called *Lakhari* in *Kamrup* region, used by non-Brahmins), *Bamuniya* (used by *Brahmins*, for Sanskrit), and *Garhayan* (used by state officials of the Ahom kingdom) — among which the *Kaitheli* style of scriptwriting was the most popular, with medieval books (like the *Hastir-vidyarnava*) and *sattras* (religious institutions) using this style (Bhattacharyya, 2013).

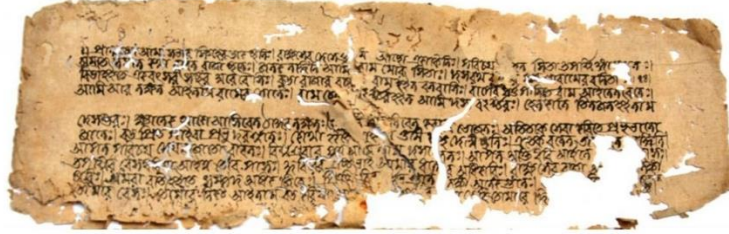
In the early part of the 19th century, *Atmaram Sarmah* an Assamese scholar designed the first Assamese script for printing in *Serampore* (a place situated in the Hoogly district of West Bengal state where the first printing press in India was established during the reign of the British) under the influence of British and Baptist Missionaries (Serampore Mission Press, 2019). In 1846 the first Assamese journal *Arunodoi* was printed and published by the Baptist missionaries from the current Sibsagar town of eastern part Assam. That started the beginning of modern Assamese script in the printing press era (Assamese language, 2016).

As both Assamese and Bengali scripts evolved from the same source so they are similar in structure except few typographical differences. Bengali script progressed long before Assamese under the influence of British rule. Therefore a clear inclination has been observed in Assamese script towards Bengali during commercial developments of the script from the early printing period to the current time. There may be differences in styles of writing between Bengali and Assamese script if history would be re-visited thoroughly, but during machine reproduction both the scripts were given similar structure for universal use except few typographical differences. This was because at the early stage printing presses were located in Bengal. This was also a reason for the Bengali language and literature to influence the Assamese socio-cultural scenario during the early stage of the printing press era.

But the writing styles of Bengali and Assamese script in the pre-printing era have many differences due to regional and cultural diversity, people involved in writing the script, and tools used in writing. Historical evidences says that both Bengali and Assamese script evolved from Brahmi script and later Assamese script diverted from Bengali script in the early medieval period. But no concrete evidences found in this regard. However if we look into the pre-printing era script writing styles of Bengali script from Bengal region and that of Assamese script from Assam region there are many differences. Following images shows the differences in script writing styles of both Bengali and Assamese.



Bengali script of 18 - 19 century found in the region of Bengal

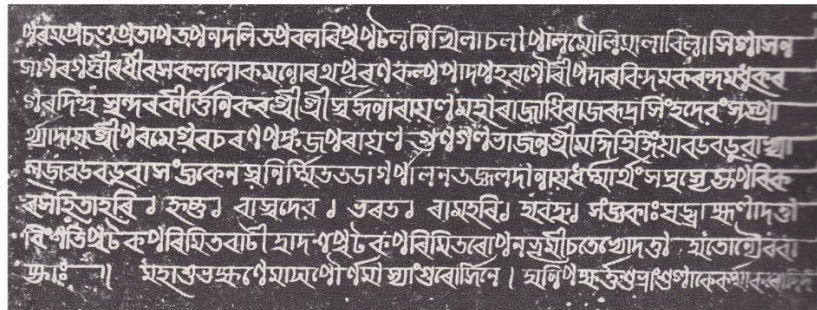


Punthis (books) of late 18th to early 19th century showing Bengali script



Manasa Mangal (1805), an illustrated book written in Bengali script style

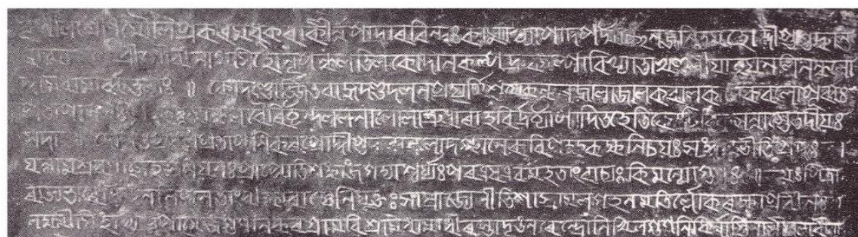
Figure 1.2: Bengali script writing styles in pre-printing era



17th century copperplate inscription by Rudrasingha (Garhayan Style)



18th century Illustrated book "Hastir Vidyarnava" (Kaitheli style)



18th century copperplate inscription found in Kamakhya (Bamuniya style)

Figure 1.3: Assamese script writing styles in pre-printing era

From the examples shown above it can be said that although both the scripts have similarities in their script characters, but the writing styles found in the regions of Bengal and Assam are different and have their own unique style of writing. The Bengali script writings are more calligraphic in style whereas the Assamese script writings are rather methodical and distinct in display.

Anandaram Dhekial Phukan (1829–1859) was one of the pioneers of Assamese literature in the *Arunodoi* era who joined in the literary revolution initiated by the Christian missionaries. He was remembered for his efforts in promoting the Assamese language. He played a major role in replacing the Bengali language with the Assamese language as the official language in Assam in the 1850s. From then onwards British rulers re-introduced Assamese language and script as the official language and script in Assam (Neog, Dr. Maheswar, 2008).

But even though due to lack of resources or limitations in exposure, the Assamese script was not been explored in-depth as compared to the Bengali script. Therefore even in today's scenario almost all the typefaces available in print or digital format for Assamese script have their roots from typefaces created for Bengali script. Due to this Assamese script could not establish an identity of its own culturally as well as literarily. This may be due to the easy adaptability of existing Bengali typefaces or fonts for Assamese script. However the area of type design and development specifically for Assamese script still has many scopes to explore if we look into historical evidence. But to achieve that, it is essential to study and analyze the original Assamese script or letterforms used in the region of Assam in the pre-printing press era. Many of the historical articles are still available in museums such as copper plate inscriptions, rock inscriptions, *Xaansi* (pronounced as *Saanchi*) tree bark manuscripts, and coins. By exploring such historical articles there may be a very high opportunity to represent the Assamese script in a new form through unique Typeface design, which in turn may represent Assamese culture and its identity not only to the literary world but also in today's digital world which could establish an international identity all over the world.

1.2 Research Context

Assamese script has a long history of evolution from its early ancient form to modern printed form. But in this entire journey of progression, the script changes many forms and styles. Due to the demand of commercial need, the current print and digital form of the script follows a machine-compatible style and form created for Bengali script due to its similarities

as well as wide acceptability of Bengali script. The historical style of script characters found in the manuscripts was then left out gradually in this conversion phase. Hence the Assamese script in its printed or digital form today does not possess any unique identity which is different from the Bengali script. This created a crisis of cultural identity for Assamese in the literary as well as social space. However historical evidence showed that both Assamese and Bengali scripts possess differences in writing styles which is still unexplored. Hence there could be a scope of research into exploring the originality and uniqueness of Assamese script that may justify the context of doing the research exploration.

This study focuses on bringing back originality and uniqueness to the modern Assamese script in the form of a new typeface that represents the Assamese culture and language through its script to the masses. It focuses on three major aspects that will represent Assamese culture and language through a new Typeface design for Assamese script with a unique identity.

- **Historical essence:** Exploring the visual essence of historical writing styles and identification of unique characteristics
- **Modern identity:** Implementing unique characteristics into the modern Assamese script in the form of a new Typeface.
- **Assamese typeface design:** Investigating the applicability of new typeface design that could represent Assamese culture and language with independent identity in the digital world.

Shown below in Figure 1.4 is a schematic diagram to represent the three major aspects.

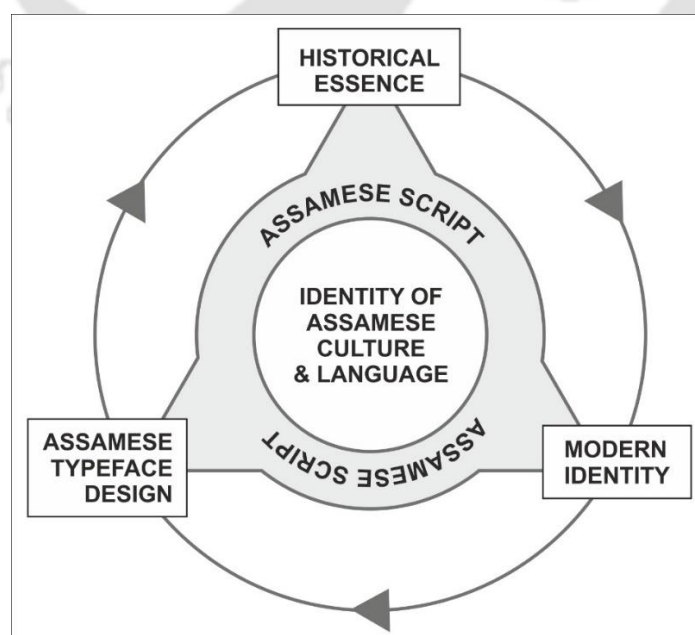


Figure 1.4: Three major aspects to evaluate the identity of Assamese culture and language

1.2.1 Historical essence: The historical writing style of the Assamese script was divided into three different categories known as *Kaitheli*, *Bamuniya*, and *Garhayan* based on caste/community who initiated the style and region/place where it was initiated. Each writing style followed unique patterns and characteristics which were created by the initiator. By exploring the visual essence, forms, and characteristics of these historical writing styles offers major information about finding a unique identity and character forms.

1.2.2 Modern identity: The existing typefaces used for Assamese script and language do not describe any emotional connection to its culture and tradition. Moreover, the typefaces that are used today have their base from Bengali typeface design as well as addresses a more universal value and commercial demand rather than emotional connection. Hence if unique identities traced from historical writing styles could be implemented in new typeface design then it may represent Assamese culture and language with emotional bonding.

1.2.3 Assamese typeface design: The new typeface design incorporated with unique identities traced from historical writing styles might give a new identity to Assamese culture and its language. As everything today revolves around digital technology with all the languages in India have their digital presence with their typeface to represent their script, hence the new typeface may promise a very strong identity to represent Assamese language and culture through its script in the digital world.

1.3 Research Justification

At present the typefaces or fonts that are being used for typing or writing Assamese script come from typefaces designed for Bengali script. This is because earlier during the time of letterpress printing most of the printing presses were located in the Bengal region. Hence the casting of metal typeset for script characters was also made in Bengal and for Bengali script. Later on due to the commercial demand additional Assamese characters were added to the Bengali script to fulfill the need. This trend continued and even now also it follows the same tradition.

Due to the commercial demand of Bengali script and lack of strong background knowledge about typeface design by Assamese scholars leads to mixing up of Assamese script with that of Bengali which made a cultural dilemma. Today there is no proper typeface available that can represent Assamese script and language with a unique identity which could be traced from historical references of Assamese script writing styles.

By proposing a standard methodology through which a new typeface design could be conceived which may represent the Assamese culture and language with a unique identity that has a strong connection with the historical Assamese writing style might present a resourceful result. Also, it will define a new standardization for typeface design to represent Assamese script, language, and culture.

1.4 Research Gap

The typeface that has been designed to represent a script mostly follows commercial demand and technical aspects rather than socio-cultural connection. Therefore typefaces that are designed to represent a script addresses universal needs rather than cultural aspects. Due to the similarity in Assamese and Bengali script, the typefaces designed are mostly addressing commercial needs rather than other individual preferences for both languages. The following key aspects could be pointed out here.

- Universally designed typefaces that lack individual identity.
- Lack of emotional connection with a language and its culture.
- The missing link between culture, language, and script with that of a particular typeface.
- The commercialization of typefaces makes them more universal to delink from cultural aspects.

1.5 Research Questions

The study involves the representation of script with a cultural connection that may go beyond commercial aspects and universal need but at the same time represent on digital media for a unique identity, the research questions have been set up with following directions –

- Question 1:** Is there a need to have a typeface to represent a culture?
- Question 2:** What are the commercial aspects of a typeface and its demand to represent a particular language and culture?
- Question 3:** What is the significance of the presence of a script in the digital world for a culture?

Sub-questions that may be set up based on the above questions –

Based on question 1:

- Why a typeface is needed to represent culture?

- How will a typeface represent culture?
- Where will it be applied and how?

Based on question 2:

- What will be the commercial need?
- What are the probable media that will use a new typeface for Assamese cultural identity?
- Are commercial aspects necessary for such new typefaces?
- What will be the consequences of the commercial need for a typeface to represent cultural identity?

Based on question 3:

- Why is digital presence necessary for a new typeface?
- Who will be the user?
- How digital media can help the typeface to familiarize?
- How cultural identity could be established through digital media?

1.6 Problem Statement

Due to the similarity of the Assamese script with that of Bengali, the script has been considered as a subset of Bengali script. Therefore Assamese script does not have any individual identity even though history says contrarily. The historical writing style of the Assamese script has many differences from that of writing styles found in the Bengal region. The writing styles found in the medieval period of Assam portray Assamese culture and language during that period. But due to the commercial demand and evolving technology in printing the script style lost its original identity. This leads to the disconnection of culture and language from the script style being used today.

Hence the problem statement can be described as: **“Assamese script lost its original identity during the technological conversion from handwritten script to printed form because of the commercial need in the early 20th century. Due to its diversion from original identity, the script lost its connection to represent Assamese culture that is essential to be incorporated in the typefaces used to write Assamese script.”**

1.7 Research Aim and Objectives

Research Aim: To design a new Assamese typeface that can represent Assamese script to establish an identity culturally as well as literarily in the digital world.

To achieve the research aim, it also requires exploring the uniqueness of Assamese script by investigating the writing styles present in the region of Assam in the pre-printing press era.

Thus objectives can be formulated as –

- a) To study the historical resources of Assamese script from different periods found in the region of Assam.
- b) To explore and analyze the unique characteristics present in the script.
- c) To compare the unique characteristics with that of Bengali for apposite differentiation.
- d) To bring back the essence of historical Assamese writing styles through unique characteristics to revive the cultural connection.
- e) To apply the unique characteristics in a new typeface design for digital media and examine its practicality.

1.8 Method used

Broadly the historical approach was initially chosen as the method for study but due to limited accessibility of resources made the interpretative approach to bring into the study as well. As there was a technological as well as cultural changeover during the conversion from a handwritten form of the script to a machine-printed form, the connection between culture and tradition with that of the scriptwriting style got lost. To revive the cultural connection that existed earlier, it needs a comprehensive approach and denotative meaning to study the subject where the method used is descriptive and interpretative.

Since there are a large number of commercial typefaces available currently to represent Assamese and Bengali script designed by many people and organization, it will be difficult to examine each one for their originality and uniqueness with a particular culture and language, an exploratory approach has been considered with following broad parts –

- i. To study and examine the historical writing style of Assamese script practiced during the medieval period in the region of Assam.
- ii. To extract the unique characteristics and design elements present in the medieval writing style.
- iii. To implement and test those unique characteristics into a new typeface design.

- iv. To check the applicability and usefulness of the new typeface whether it addresses the need and objectives.

1.8.1 Discussion on method used

From the methodology point of view, it is a difficult task to find out the common underlying uniqueness among Assamese, Bengali and other languages which adopted the similar scripts during that time. In the pre-printing era different script writing style evolved in different places of eastern and north eastern part of India where similar script characters used, got influenced by many factors. The languages spoken in different regions also influenced the script writing style if that language adopted the same script. Then people involved in writing the script, tools and medium used for writing the script etc. also highly influenced the script styles across the entire region. Therefore to find out a common underlying uniqueness may be a difficult task due all such variations.

But the methodology also tries to figure out how different script writing styles evolved in the region of Assam in pre-printing era and how those styles can convey a meaning to represent the socio-cultural status and behaviour of Assamese society during that time. Therefore the primary aim of the methodology is to explore and examine the evolution of writing styles used to write Assamese script in the pre-printing era and whether or not these writing styles can represent the Assamese culture and heritage of that era effectively.

1.9 Overview of Research

Shown in Figure 1.5, schematic diagram of the research flow as planned (Aim and Objectives at the top). The diagram explains the step-by-step process of every task to be accomplished during the research.

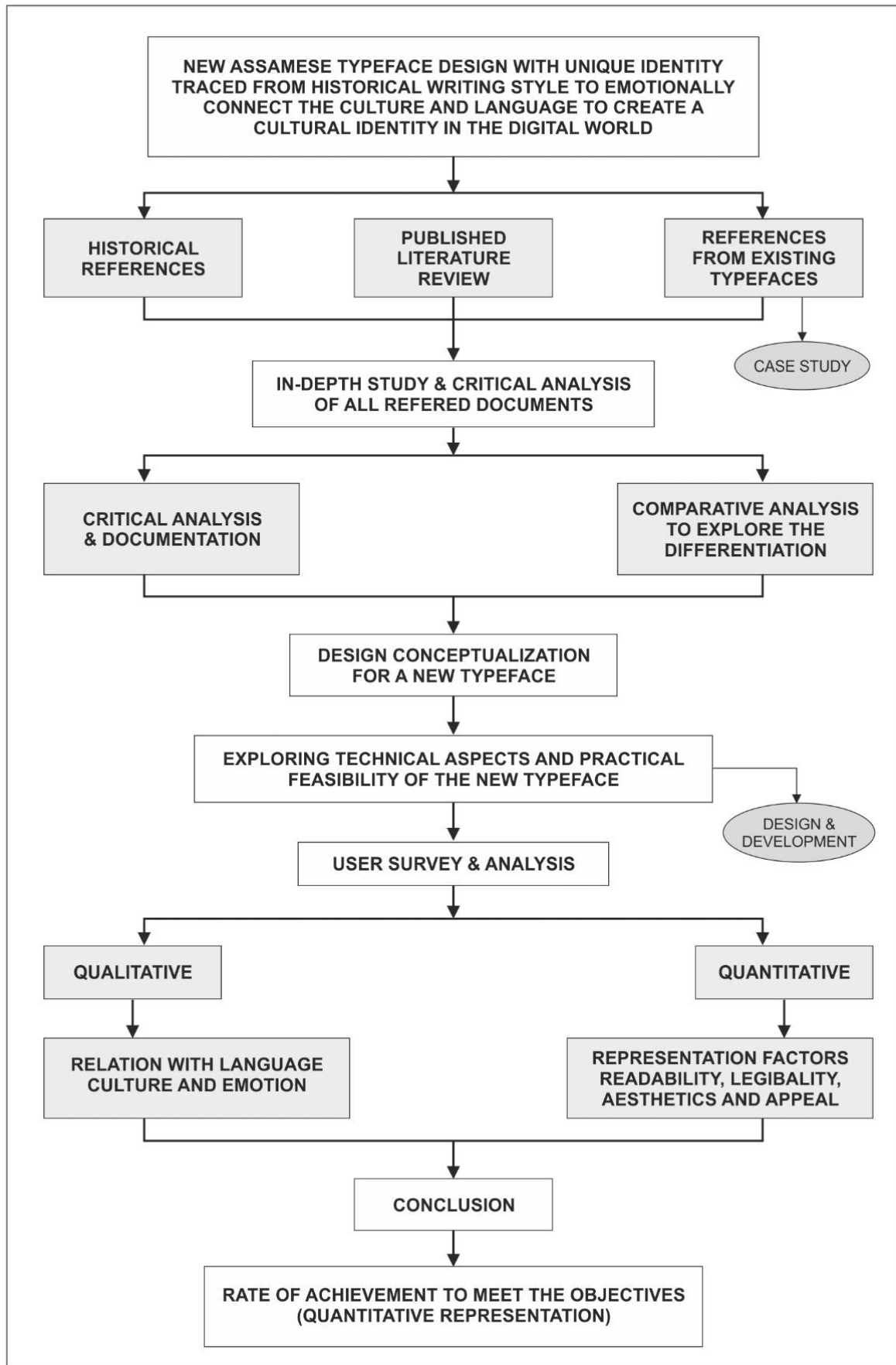


Figure 1.5: Illustrative representation of research overview

1.10 Research strategy

To address the research objectives laid out in the research flow diagram, integration of analysis of historical resources (literature review), field study, and case study base analysis of existing typefaces was adopted. Figure 1.6 below shows the research strategy chart.

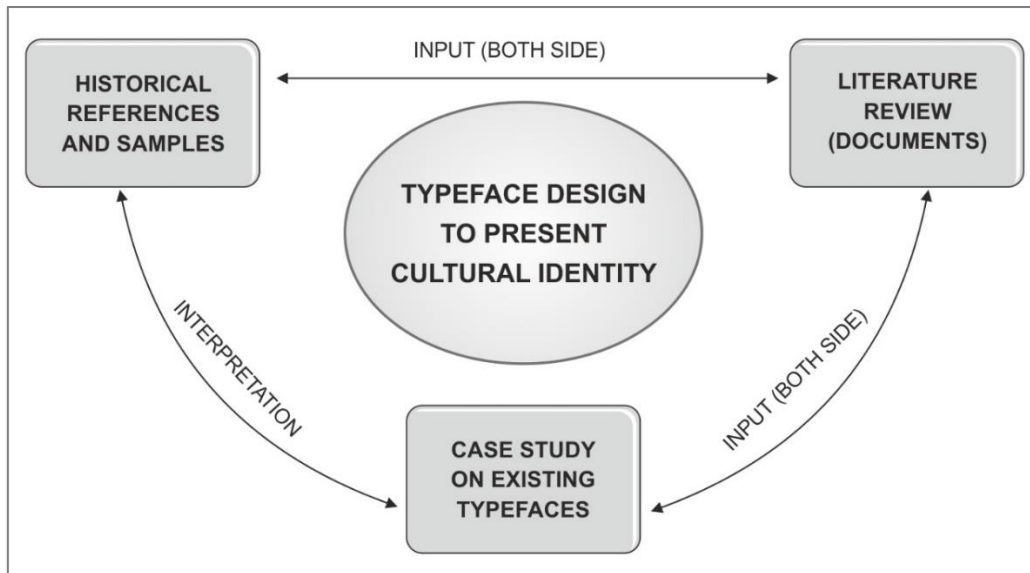


Fig 1.6: Research strategy chart

1.11 Analysis & Inference

Based on a preliminary reference study of historical references and literature review, the study will attempt to analyze the basic form and characteristics of scriptwriting style and its connection with cultural and social identities. Particularly the study will focus on the following:

- The study of analysis leads to an understanding of scriptwriting style and its significance on socio-cultural behavior.
- The script characteristics or scriptwriting style leads to an understanding of unique identity extraction.

1.12 Checking and Validation

The data collected from the literature review and historical references have been tabulated in chronological order to examine the changes in forms and characteristics of the script over a certain period. The periods have been set up in a phased era to appropriately evaluate the properties and characteristics of the script such as –

- Early period: 5th century to 13th century
- Vaishnava era: 14th century to 16th century
- Ahom era: 17th century to 19th century

Visuals taken from original resources were digitally scanned and traced using Adobe Photoshop CS6 software and re-illustrated in Adobe Illustrator CS6 software to analyze the nature and characteristics closely. Then extracting the unique identities of the script and compare them among different periods to evaluate and finalization.

1.13 Scope and limitations

1.13.1 Limitation of research:

- Due to the variation in writing style over a different period, it is difficult to make a concrete decision about its characteristics and identity elements.
- Different writing styles followed by different people and varied regions of use make it a bit complex about which scriptwriting style to follow as a guided reference. Therefore *Garhgayan* writing style was chosen over others based on its universal characteristics maintained throughout periods.
- As the case studies on current typefaces could not give any clear statement about their connection with culture, language, and emotion with a community or a region, therefore it cannot be taken as a standard for design reference.

1.13.2 Future scope and suggestion for further study:

The study involves designing a new typeface for the Assamese script that could be identified with unique characteristics traced back to historical writing styles. That will create a cultural identity for the Assamese language and the script on digital media. It also opens up a new scope of designing a typeface for Assamese script with a unique identity for the digital media.

It is suggested that other historical writing styles such as *Kaitheli* and *Bamuniya* could also be explored in a similar direction.

1.13.3 Discussion on scope of other writing styles for exploration:

In the medieval period of Assam, three different writing styles evolved. They are known as *Bamuniya*, *Kaitheli* and *Garhgayan*. *Bamuniya* style was initiated by the Brahmins (higher

priest class). They used to write Sanskrit slokas and religious documents using Assamese script. *Kaitheli* style was initiated by the Kayasthas (the writer caste). They used to write various books, documents and other religious journals. *Garhgayan* style was initiated by the Ahom rulers. They appointed special people to write royal chronicles, royal orders, treaties, and other official documents in Assamese script. They developed a unique writing styles, the origin of which evolved from the centre of Ahom kingdom called Garhgaon. Hence the writing style also known as Garhgayan.

But since Bamuniya style initiated by the Brahmins mostly influenced from northern and eastern India as Brahmins originally migrated from North India region, hence Bamuniya style could not be considered as pure Assamese origin. *Kaitheli* style was the most popular among three writing styles due to its ornamental writing with a calligraphic essence. But this style has many variations in different time periods as well as different regions within Assam due to diverse visuo-cultural scenario. Whereas, Garhgayan style initiated by the Ahom kings and evolved from the heart of Ahom kingdom Garhgaon, with its methodical and distinct writing styles have been considered for further exploration.

But the other writing styles can also be explored in similar way keeping in view that the influence and uses of the scripts during medieval time or pre-printing era were largely effective in the region of Assam. The exploration done on these script styles may lead very good typeface design for Assamese script due its beautifully crafted and ornamental styles.

1.14 Research contribution and the expected outcome

This research is an attempt to find unique characteristics and design elements present in the historical writing styles of Assamese script that could be incorporated in the modern typeface design which can represent Assamese culture and language with a trace from history as well as create an identity in the digital world. The following outcomes are expected –

- i. Extracting unique identity for Assamese script from the historical writing style.
- ii. Implementing unique identity and characteristics into modern typeface design to create a new identity for Assamese script.
- iii. New typeface design to represent Assamese language and culture on digital media.
- iv. Opening up a new scope in the field of Assamese typeface design.
- v. A probability in proposing separate Unicode characterization for Assamese script.

1.15 Outline of the thesis report

The thesis is divided into 8 chapters and various topics covered under each chapter is as follows:

Chapter 1: The chapter starts with an introduction to the research subject followed by research context, research justification, research gap, research questions, problem statement, research aims and objectives, the method used, an overview of research flow, research strategy, analysis, and inference, checking and validation, scope, and limitations, research contributions, and outline of the thesis.

Chapter 2: This chapter covers the literature review. It starts with an introduction to Assamese script followed by history, comparison between Assamese and Bengali script and Assamese script in the digital era where some of the very important points discussed such as entry of offset printing technology in Assam, entry of Indic language typing software, the influence of Unicode compliances for Assamese script, progressing into the digital world and Assamese script for digital devices.

Chapter 3: This chapter covers the research methodology part. It starts with research strategy planning followed by field visit, design of research questionnaire, validation of research questionnaire, research methodology approach, analysis tools for design element identification, discussion, and summary of the chapter.

Chapter 4: This chapter covers data collection, analysis, and interpretation. It starts with an overview followed by various types of data collection methods such as interviews, documents collection, and historical data. Then goes with data analysis and arrangement, data interpretation, data scanning and digitization, digital tracing and observation of data, observational outcome and finishes the chapter by a conclusion note.

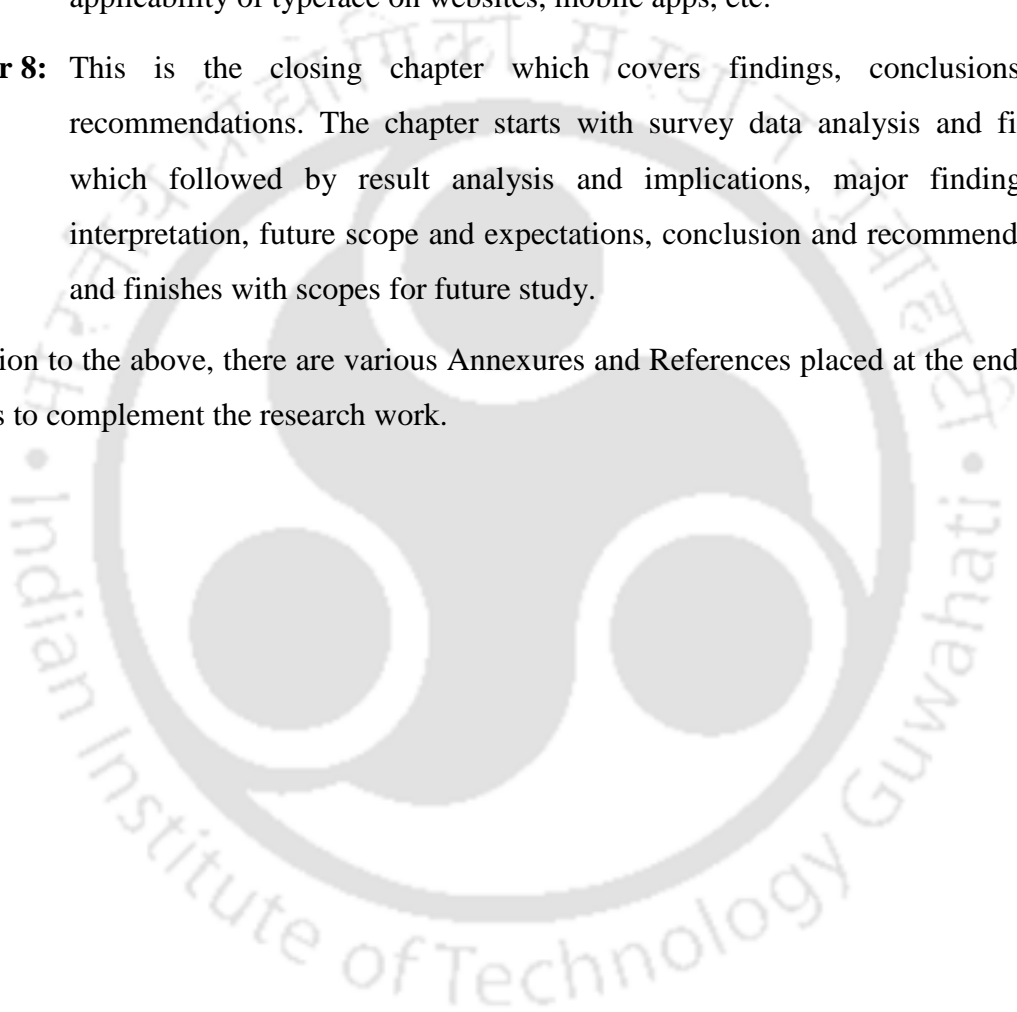
Chapter 5: This chapter discusses design exploration. It starts with historical resource arrangement followed by the analysis of historical resources, finding unique characteristics from historical resources, observation and description of unique characteristics, designing of concept typeface, digitizing, user review, modification, finalization, consideration of technical aspects, testing on devices and finishes with a discussion and feedback note.

Chapter 6: This chapter discusses technical aspects of typeface design. It starts with anatomical structure explanation of the typeface designed followed by font development, hinting, Unicode number allocation, font proofing and correction, and usability check for screen and print display.

Chapter 7: This chapter discusses Typeface application. It starts with testing for in-script keyboard applicability followed by customized keyboard design for computer uses then typing application design for mobile and digital devices and testing for applicability of typeface on websites, mobile apps, etc.

Chapter 8: This is the closing chapter which covers findings, conclusions, and recommendations. The chapter starts with survey data analysis and findings which followed by result analysis and implications, major findings and interpretation, future scope and expectations, conclusion and recommendations, and finishes with scopes for future study.

In addition to the above, there are various Annexures and References placed at the end of the chapters to complement the research work.





CHAPTER 2

LITERATURE REVIEW

Assamese Script and its Evolution



Chapter 2: Literature review - Assamese script and its evolution

Assamese is an Eastern Indo-Aryan language spoken mainly in the Indian state of Assam, where it is an official language. It is the easternmost Indo-European language, spoken by over 20 million speakers, and serves as a *lingua franca* in the region. Many of the local languages spoken in the region of Assam use Assamese script to describe their languages. As already mentioned in the Introduction section of Chapter-1, the Assamese script is the writing system of the Assamese language. The script has a rich history that evolved from the 5th century to recent times. The evolution went through many phases from rock inscription to manuscript to letterpress printing to offset technology to modern-day digital publication. The origin of the script has a trace from *Brahmi* script which is the ancient Indian script and then to *Gupta* and *Siddham* script before it developed independently as *Kamrupi* script in the ancient *Kamrupa* region (Assamese language, 2016).

2.1 Introduction to Assamese script

A brief description of the origin of the Assamese script in structured format has been laid out in Table 2.1 which can describe its traces in chronological order (Assamese alphabet 2016).

Table 2.1: Description of Assamese language origination (source: Wikipedia/Assamese alphabet)

Language	Assamese
Type	Abugida
Time	8 th century to the present
Parent systems	Proto-Sinaitic script
	Phoenician alphabet
	Aramaic alphabet
	Brahmi script
	Gupta script
	Siddham script
	Kamrupi script
	Assamese script (Ôxômiya lipi)

Abugida: An Abugida is a writing system between syllabic and alphabetic scripts. They have sequences of consonants and vowels that are written as a unit, each based on the consonant letter.

Proto-Sinaitic script: Proto-Sinaitic, also referred to as Sinaitic, and Proto-Canaanite (when found in Canaan), is a Middle Bronze Age (Middle Kingdom) script attested in a small corpus of inscriptions found at *Serabit el-Khadim* in the Sinai Peninsula, Egypt, considered the earliest trace of alphabetic writing, and the common ancestor of the Ancient South Arabian script and Phoenician alphabet.

Phoenician alphabet: The Phoenician alphabet is an alphabet of the abjad type, consisting of 22 consonant letters only, leaving vowel sounds implicit, although certain late varieties use *matres lectionis* for some vowels. In the Early Iron Age, the Phoenician alphabet was used to write Northwest Semitic languages, more specifically early *Phoenician*, *Moabite*, *Ammonite*, *Edomite*, *Hebrew*, and *Old Aramaic*.

Aramaic Alphabet: The ancient *Aramaic* alphabet was adapted from the Phoenician alphabet and became a distinct script by the 8th century BC. It was used to write the *Aramaic* language and had displaced the *Paleo-Hebrew* alphabet, itself a derivative of the Phoenician alphabet, for the writing of *Hebrew*. The letters all represent consonants, some of which are also used as *matres lectionis* to indicate long vowels.

Brahmi Script: *Brahmi* is the modern name for the writing system of ancient India. The *Brahmi* writing system, or script, appeared as a fully developed universal one in South Asia in the third century BCE and is a forerunner of all writing systems that have found use in South Asia except for the Indus script of the third millennium BCE, the *Kharosthi* script, which originated in what today is northwestern Pakistan in the fourth or possibly fifth century BCE, the *Perso-Arabic* Scripts of the medieval period, and the Latin scripts of the modern period. Its descendants, the *Brahmic* scripts, continue to be in use today not only in South Asia but also in Southeast Asia. *Brahmi* is an abugida that uses a system of diacritical marks to associate vowels with consonant symbols.

Gupta Script: The *Gupta* script (sometimes referred to as *Gupta Brahmi* Script or Late *Brahmi* Script) was used for writing Sanskrit and is associated with the *Gupta* Empire of India which was a period of material prosperity and great religious and scientific developments. The *Gupta* script was descended from *Brāhmī* and gave rise to the *Nāgarī*, *Śāradā* and *Siddham* scripts.

These scripts in turn gave rise to many of the most important scripts of India, including *Devanāgarī* (the most common script used for writing Sanskrit since the 19th century), the *Gurmukhī* script for the *Punjabi* Language, the *Bengali-Assamese* script, and the *Tibetan* script.

Siddham Script: *Siddham*, also known in its later evolved form as *Siddhamāṭṛkā*, is a medieval *Brahmic* abugida, derived from the *Gupta* script and ancestral to the Assamese alphabets, Bengali alphabet, Maithili alphabet, and the Tibetan alphabet. The word *Siddham* means "accomplished" or "perfected" in Sanskrit. The script received its name from the practice of writing *Siddham*, or *Siddham astu* (may there be perfection), at the head of documents. *Siddham* is an abugida rather than an alphabet, as each character indicates a syllable, including a consonant and (possibly) a vowel. If the vowel sound is not explicitly indicated, the short 'a' is assumed. Diacritic marks are used to indicate other vowels, as well as the *anusvara* and *visarga*. A *virama* can be used to indicate that the consonant letter stands alone with no vowel, which sometimes happens at the end of Sanskrit words.

Kamarupi Script: *Kamarupi* script was the script used in ancient *Kamarupa* from as early as the 5th century to the 13th century, from which the modern Assamese script evolved. In the development of the Assamese script, this phase was followed by the medieval and then by the modern Assamese scripts. The *Kamarupi* script originated from the *Gupta* script, which in turn developed from *Brahmi* script. It developed on its own in *Kamarupa*, till the *Nidhanpur* copper-plate issued by *Bhaskarvarman* from his military camp at *Karnasubarna*, which took on *Kutila* characteristics. Sometimes, *Kamarupi* script origins are traced to *Kutila* script, which is not widely accepted.

Assamese script: Assamese script was originated from the *Kamrupi* script. The evolution of the script started from the post 13th century and diverted from its parent *Kamrupi* script later on. With time it spread throughout the entire Assam region with a variety of writing styles initiated and followed by different writer caste as well as the group of people. The popularly known script writing styles followed in the medieval period were *Kaitheli*, *Bamuniya*, and *Garhgayan*. Elaborative descriptions have been laid out separately. The modern Assamese script used currently has been described below.

2.1.1 Modern Assamese script: Assamese script consists of eleven (11) vowels, thirty-seven (37) consonants, and six (6) consonant extras. Apart from that, the script contains vowel diacritics and conjunct letters to form words. Below are the examples of the script. The script

also contains its number system from zero (0) to nine (9). The script has its phonetic system. Assamese script shares similarities with Bengali script with differences in three letters “WA”, “RA” and “KHYA”.

Shown below are the modern Assamese script characters (refer to Figure. 2.1, 2.2, 2.3 & 2.4) with phonetic pronunciations.

Vowels (11 numbers)

অ	আ	ই	ঈ	উ	ঊ
O	Aa	I	Ie	U	Uu
ঋ	এ	ঐ	ও	ঔ	
Ri	E	Oi	U	Ou	

Figure 2.1: Vowel characters of Assamese script

The vowels diacritics

অ	আ	ই	ঈ	উ	ঊ	ঋ	এ	ঐ	ও	ঔ
ক	কা	কি	কী	কু	কূ	কৃ	কে	কৈ	কো	কৌ
Ko	Ka	Ki	Kii	Ku	Kuu	Kri	Ke	Koi	Ku	Kou

Figure 2.2: Vowel diacritics of Assamese script

Consonants (37 with 6 extras)

ক	খ	গ	ঘ	ঙ	চ	ছ	জ	ঝ	ঞ
Ko	Kho	Go	Gho	Ngo	Pratham So	Dwitiyo So	Borgia Jo	Jha	Nyo
ট	ঠ	ড	ঢ	ণ	ত	থ	দ	ধ	ন
Murdhanyo Ta	Murdhanyo Tha	Murdhanyo Da	Murdhanyo Dha	Murdhanyo Na	Dontiyo Ta	Dontiyo Tha	Dontiyo Da	Dontiyo Dha	Dontiyo Na
প	ফ	ব	ভ	ম	য	ৰ	ল	ৱ	
Pa	Pha	Ba	Bha	Ma	Ya	Ra	La	Wa	
শ	স	ষ	হ	ক্ষ	য়	ড়	ঢ়		
Talobya Xo	Dontiyo Xo	Murdhanyo Xo	Ho	Khyo	Yo	Da-Hra	Dha-Hra		
৩	৴	৵	৶						
Harshanta Ta	Anusar	Bisarga	Chandra bindu						

Figure 2.3: Consonant characters of Assamese script

Description of Consonant extras

ৱ	Hasanta - mutes inherent vowel	ক্	K
৩	Khanda ta - final unaspirate dental	ক্‌ত	KOT
৴	Anuswar - final velar nasal	কং	KONG
৵	Bisarga - adds voiceless breath after vowel	কঃ	KOH
৶	Sandra bindu - nasalises vowel	ক্‌ৎ	KN
৷	Dari - fullstop / period		

Figure 2.4: Extra consonant characters of Assamese script

Conjunct letters

In Assamese, the combination of three consonants is possible without their intervening vowels. There are more than 150 conjunct letters. A few conjunct letters are shown below in Figure 2.5.

ক ক্ক ক্ক্ট ক্ক্ট্ত ক্ক্ট্ত্ত ক্ক ক্ক্ক ক্ক্ক্ক ক্ক্ক্ক্ক
ক্ষ ক্ষ্ক ক্ষ্ক্ক ক্ষ্ক্ক্ক ক্ষ্ক্ক্ক্ক ক্ষ্য ক্ষ্য্য ক্ষ্য্য্য
খ খ্য খ্য্য
গ গগ গগ্গ গগ্গ্গ গ্গ গ্গ্গ গ্গ্গ্গ গ্গ্য গ্গ্য্য গ্গ্য্য্য
ঘ ঘ্ঘ ঘ্ঘ্ঘ
ঙ ঙ্ঙ ঙ্ঙ্ঙ ঙ্ঙ্ঙ্ঙ ঙ্ঙ্ঙ্ঙ্ঙ ঙ্ঙা ঙ্ঙাা ঙ্ঙাাা ঙ্ঙঘ ঙ্ঙঘা ঙ্ঙঘাা ঙ্ঙঘাাা
চ চ্চ চ্চ্চ চ্চ্চ্চ চ্চ্চ্চ্চ চ্চ্চ্চ্চ্চ চ্চ চ্চা
জ জ্জ জ্জ্জ জ্জ্জ্জ জ্জ্জ্জ্জ জ্যা জ্যাা জ্যাাা
ঞ ঞ্ঞ ঞ্ঞ্ঞ ঞ্ঞ্ঞ্ঞ
ট ট্ট ট্ট্ট ট্ট্ট্ট টা টাা টাাা
ড ড্ড ড্ড্ড ড্ড্ড্ড ড় ড়া

Figure 2.5: Examples of conjunct characters of Assamese script

Vowel diacritics and conjunct letter parts – an example is shown in Figure 2.6

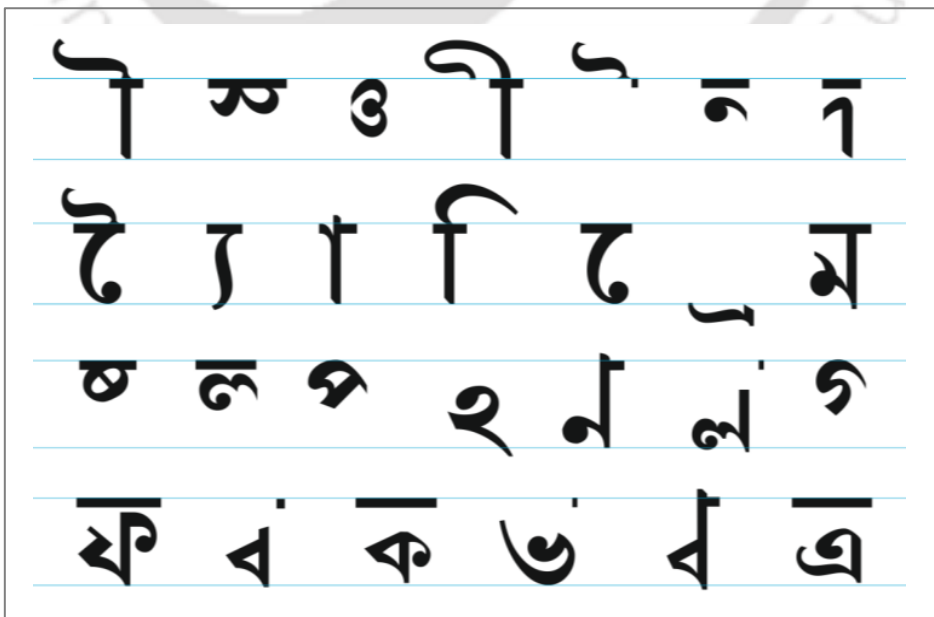


Figure 2.6: Examples of vowel diacritics and half characters of Assamese script

Assamese number system

Shown below are Assamese number systems from “0” to “9” display from left to right (refer to Figure 2.7).











				
0	1	2	3	4
				
5	6	7	8	9

Figure 2.7: Number system of Assamese script

2.2 History of Assamese script

The origin of the script can be traced to the ancient *Brahmi* script and had a strong influence from *Gupta* and *Siddham* script along the way of its continuous developments. The script had an illustrious journey throughout its evolution. It got its proper identification during the medieval period where people like *Madhav Kandali* and *Srimanta Sankardeva* contributed and wrote much literature in the Assamese script. The script developed manifolds in its journey from its origin to the pre-printing press era. During the Ahom rules in Assam and under the influence of *Madhav Kandali*, *Srimanta Sankardeva*, and few other pioneering personalities, the script went through its best phase of development. During the British regime, many Baptist Missionaries came for preaching Christianity in the region. For that purpose, they also brought printing tools and machines to print religious articles to spread Christianity in the region. *Atmaram Sharma* an Assamese scholar was invited by the Baptist Missionaries to develop an Assamese script for printing machines. Henceforth *Atmaram Shamra* created the first modern Assamese script which was adapted to use in printing machines to publish religious articles.

2.2.1 Early stage

The origin of the Assamese script evolved as an independent script of eastern India. It has the origin from *Brahmi* script and developed from *Gupta* script. Most of the historical writers described that the script was developed out of *Kutila* variation of *Gupta* script of eastern

India. The script acquired the modern form gradually, evidence of which is present in the stone and copper-plate inscriptions from 9th century A.D., and its tradition was followed in the Assamese and Sanskrit manuscript. In the early stage, *Kamrupi* script was as known ancient Assamese script which got developed into Medieval Assamese script and finally evolved into Modern Assamese Script. This script was developed independently and directly from the *Brahmi* and *Gupta* script, and Assamese, Bengali, Maithili, and Oriya script developed from this *Kamrupi* script. The reason for this origination was due to the cultural and political impact followed from Assam to Bengal and a part of Maithila (now Bihar) falls within the *Kamrupa* region till the 8th century. The *Kamrupa* had a very close connection with Orissa as well at that time (Neog, 1974).

2.2.2 Medieval Stage (Vaishnava Era)

Medieval Assamese script was extensively used for writing manuscripts, royal chronicles, royal charters, declarations, rituals, books, etc. This stage of the script which started in the 13th century onwards was further categorized under three different writing styles found in that period. These are (a) *Garhgayan* style, (b) *Bamuniya* style, and (c) *Kaitheli* style.

(a) Garhgayan style of writing

This style was initiated and primarily followed by the people appointed by the *Ahom* dynasty to write chronicles, various official documents, and public declarations. The name *Garhgayan* came from the capital of the *Ahom* dynasty *Garhgaon* which was also the center of *Ahom* culture and located in the current eastern part of Assam. The writing style followed by the people appointed by *Ahom* rulers eventually developed a unique style known as the *Garhgayan* style as shown in Figure 2.8.

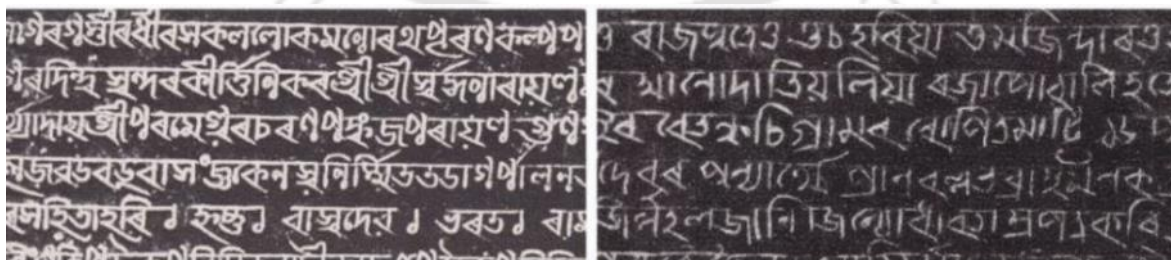


Figure 2.8: *Garhgayan* writing style on copperplate inscription (17th – 18th century).

Source: Assam State Museum

(b) Bamuniya style of writing

This style was created by traditional Sanskrit scholars from *Brahmin* caste (higher priest class who perform *Pujas*, social rituals, and religious events) to write Sanskrit texts, rituals, making

Kundalis (horoscope calculations), etc. Though the *Bamuniya* style was followed by the Sanskrit scholars and *Brahmins*, yet they rather prefer *Kaitheli* because of the popularity of the style. This writing style was in trend among the scribes who were associated with the *Vaishnava Sattras* of Assam. Sample of *Bamuniya* writing style shown in Figure 2.9 below.



Figure 2.9: *Bamuniya* style of writing on Xaansi tree bark manuscript (16th – 17th century)
Source: Assam State Museum

(c) *Kaitheli* style of writing

This style was initiated by the *Kayasthas* who used to be known as writer caste. It was also known as the *Lakhri* style. This style used to be found in the manuscripts of various document writings, royal charters, and religious books. The style was also followed by professional scribes employed in royal service. The *Kaitheli* style was very popular among the literature of the lower Assam region at times. In comparison with the other two, this style was more popular due to its ornamental style and artistic patterns (Bhattacharyya 2013) as shown in Figure 2.10.

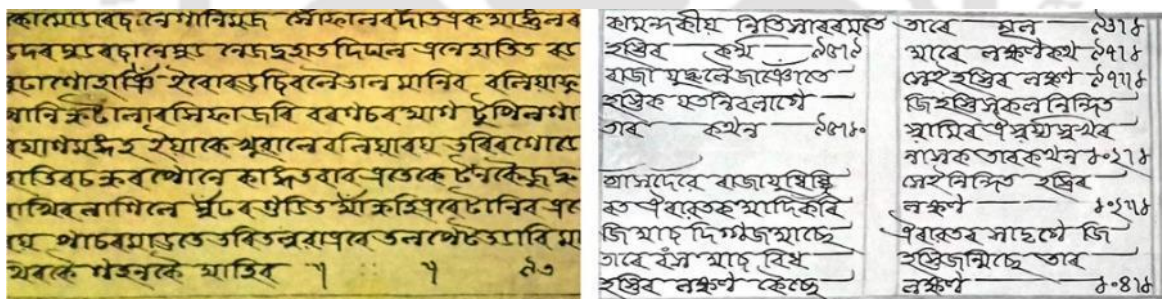


Figure 2.10: *Kaitheli* style of writing on Xaansi tree bark manuscript (16th – 18th century)
Source: Assam State Museum

2.2.3 Post-medieval stage (Ahom era or pre-printing press era)

The *Ahom* dynasty ruled Assam for almost 600 years from the 13th century onwards till the early 19th century. In the *Ahom* era, the Assamese script evolved into its mature level by the late 18th century. Apart from the writing style of *Kaitheli* and *Bamuniya*, the *Garhgayan* style developed significantly with a methodical writing style. Most of the copper plate inscriptions, rock inscriptions, and coins, etc. found during that time showed a very skilled and mature style of the script which was also almost similar to the modern Assamese script of the post-printing press era. Even *Kaitheli* writing style was also been explored extensively during

that time, the result of which produced books like “*Hasthir Vidyar Nava*” a book written on Elephant in the 18th century (Goswami 2014) as shown in Figure 2.11.



Figure 2.11: Kaitheli writing style with illustrations of a page from the book “*Hasthir Vidyar Nava*”
Source: Assam State Museum

2.2.4 Early printing-press era (Missionary era)

Assamese script entered into the printing era when pundit *Atmaram Sarma* first designed the script for the printing press to publish Christian religious books for Baptist Missionaries. At that time printing press was first set up in *Srirampore* (now north Bengal area). Then came the “*Arunudoï*”. It was the first Assamese printed journal published from Sibsagar town of Assam in 1846. From then onwards Assamese script progressed into another level of machine printing era. In the early stage of printing, many Baptist Missionaries contributed to developing the Assamese language, Assamese literature, and the script as well. To name a few personalities were Miles Bronson and Nathan Brown. They were very much instrumental in encouraging the development of the Assamese language, literature, and script. They even wrote an Assamese grammar book to describe the language and the script with proper details. They used original characters of Assamese script in their *Arunudoï* newspaper (refer to Figure 2.12) publication (Neog, 2008).



Figure 2.12: Letterpress and woodblock printing sample of 1st Assamese newspaper “ARUNODOI”, Vol. 6, published in 1951, Place: Sibsagar (Assam). Source: Wikipedia/Arunodoi.

2.3 Assamese and Bengali script – A comparative analysis

Since both Assamese and Bengali script originated from ancient *Kamrupi* (Eastern Nagari) script, hence the characters are mostly similar with few typographical differences. Even though the similarities in characters, the writing styles followed in the Bengal region and Assam region were different as per historical evidence. Due to that, many characters were written in a unique style based on region and time. But while doing the machine re-production, most of the characters were kept identical except a few, to make the printing job easy as well as compatible for both languages. Also as the printing resources used to be available mostly in the Bengal region hence there were limitations in exploring Assamese script for printing machines.

2.3.1 Pre-printing press era

By the 13th century, the ancient *Kamrupi* script was developed independently from *Brahmi* and *Gupta* script. The *Kamrupi* script was widely used in the region of *Kamrupa* which existed during that time from the current *Kamrup* district of lower Assam to a majority of North Bengal to the eastern part of Bihar. It was also associated with the Orissa region during that period. Due to this, the ancient *Kamrupi* script was considered as the origin of Assamese, Bengali, Maithili, and Oriya. The characters of Bengali, Assamese, and Maithili scripts were quite similar to each other with only a few typographic differences. But the writing styles were different in different regions. Due to this the Bengali script and Assamese script do not follow each other in writing styles before the printing era started, even if the characters are similar.

2.3.2 Post printing press era

After the British came, the printing press era started as they introduce printing technology to India. Most importantly, when American Baptist Missionaries came to India for preaching Christianity during the British regime, they brought printing machines along with them to print religious articles and books to spread the religion. They learned the local languages and print books in the native script to get wide publicity and acceptability. This helps the native scripts to get printed and progressed into machine printing technology. As *Ishwar Chandra Vidyasagar* was considered the father of modern Bengali script, similarly *Pundit Atmaram Sharma* was considered as the creator of the first modern Assamese script for printing. He was invited by the Baptist Missionaries to design Assamese script for printing religious books. Initially, his characters were more similar to what was in the historical inscriptions and manuscripts. But due to the complexity, un-availability of resources, and other such factors, the Assamese script and Bengali script were made similar for machine reproduction. As the printing presses and resources were located in the Bengal region during the British regime, the script made for Bengali got more focus and publicity. For machine use, the Bengali script was provided to Assamese for printing necessities due to the similarities in characters by adding the Assamese characters. Those characters were added with the original Bengali script and used as Assamese script to address the demand. Even now also Assamese script has been considered as a subset of Bengali script.

2.4 Assamese script in digital era

Later on, during the progression from letterpress printing to computer-based printing, new typefaces were designed to fit in the computer software. This started with the Bengali script in the late 1970s and 1980s where organizations like Linotype and CDAC were involved in developing computer-based typefaces for Bengali script printing. Assamese script was also part of it by adding the extra characters with Bengali typefaces as earlier in the machine printing.

2.4.1 Entry of Offset printing technology

The entry of offset printing technology changed a lot in the demand for new typefaces for printing. As offset printing uses computers to design layout etc. hence it got more flexibility in accommodating new typefaces. Many typefaces were created for the Assamese script, but almost all have the base from Bengali typeface design just by adding the additional characters used in the Assamese script. Due to the involvement of computers in display and typing of text matters, exploration with different types of typeface or fonts with customized alignments and formatting style with the use of software have been extensively practiced to make the print looked attractive. A sample of offset printing has been shown in Figure 2.12 and Figure 2.14.

পিঠিয়া-পিঠিকৈ বান্ধি শ্মশানৰ গাঁতবোৰত পুতি থ'বলৈ নিৰ্দেশ দিলে, যাতে
ৰাতি হ'লে শিয়াল-কুকুৰে আহি তেওঁলোকক খাই পেলায়।

কোশল ৰজাৰ অনুচৰবোৰে ৰজাৰ হুকুম মতেই কাশীৰাজ আৰু
সকলো লোককে পিঠিয়া-পিঠিকৈ বান্ধি শ্মশানৰ গাঁতত দেহৰ আখালৈকে পুতি
ৰাখিলে।

ইমান যমৰ যাতনা ভোগ কৰিও কাশীৰাজ অচল-অটল হৈ থাকিল।
কোশল ৰজাৰ বিৰুদ্ধে অকণো খং ভাব নেদেখুৱালে। কেৱল তেওঁ
সৈন্যসকলক ক'লে : বন্ধুসকলক, হৃদয়ত মৈত্ৰী স্থাপন কৰা। আন কোনো
অহং মনোভাৱে যাতে হৃদয়ত স্থান পাব নোৱাৰে।

মাজনিশা এজাক শিয়াল নৰ মাংসৰ লোভত শ্মশান ওচৰত উপস্থিত
হ'ল। শিয়ালবোৰক দেখি সৈন্যসকলে আতংকত চিঞৰি উঠিল। তেতিয়া
শিয়ালবোৰে ভয় খাই পলাই গ'ল।

Figure 2.13: Image of an inside page of the book “*Akonir Jatok*” printed in Offset technology



Figure 2.14: Image of an Assamese Newspaper “Agradoot” printed in Offset technology

2.4.2 Entry of Indic language typing software

In the 1990s a few Indic language typing software came into the market such as Leap Office, *Ramdhenu*, etc. which offers typing of Indian script with an in-script keyboard. They use customized typing techniques and formatting methods based on ISCII (Indian Script Code for Information Interchange) standards. They also support the typing of the Assamese script, but there was no separate typeface design exercise done for the script. Here also originally designed Bengali script was used with additional characters of Assamese. But the emphasis that the Assamese script received after the entry of typing software was immense. This may be due to the market demand and the ease of using the software by more people. This transformation gave the Assamese script an identity and people got more conscious and concerned about the script to be designed separately. But due to many reasons, it did not happen in the right direction. Figure 2.15 & 2.16 shows Assamese in-script keyboards.



Figure 2.15: In-script Assamese/Bengali physical keyboard for computer typing developed by *Bijoy*

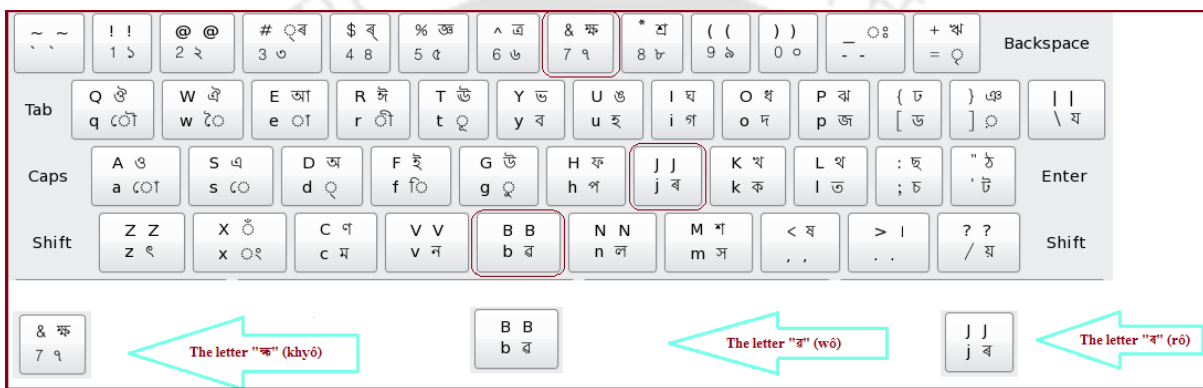


Figure 2.16: On-screen in-script virtual keyboard used for typing Assamese script (standard)

2.4.3 The Unicode influence

Unicode is an international encoding standard for use with different languages and scripts, by which each letter, digit, or symbol is assigned a unique numeric value that applies across different platforms and programs. The Unicode Consortium is a nonprofit organization that coordinates Unicode's development. Full members include most of the main computer software and hardware companies with any interest in text-processing standards, including Adobe, Apple, Google, IBM, Microsoft, and Oracle Corporation.

To date, Assamese script does not have a recognized Unicode identity. Instead, they have given the name of the script as Bangla-Assamese script as characters of both the scripts are similar. Many experts and scholars from Assam have been trying to get the Unicode identity to Assamese script in recent times. But the approach has not been successful yet. There are lots of technical issues as well as commercial concerns also. If Assamese script would get its Unicode identity then there will be a new scope open up for the script which will be highly constructive and effective for the digital platform.

2.4.4 Progressing into the web world

In recent times, many websites have been specifically developed to display Indic language scripts to promote regional language contents by targeting specific audiences. This is because of the advancement of web technology and browser augmentations. Nowadays Google also started supporting Indic language scripts which made a huge change in the web world. Many new typefaces were designed to fit for the digital screen in Indic language scripts also. Assamese script has also tried to move into the same flow. Many interested people have been involved in developing digital typefaces for the script. But due to the limitations in universal acceptability and not being technically sound, the script could not able to make an independent identity and still been known as Bangla-Assamese script in the web world.

As shown below (refer to Figure 2.17) the website of “*Asomiya Pratidin*” a news channel displaying conventional web font used for Assamese and Bengali script on websites.



Figure 2.17: Website of *Asomiya Pratidin* published in the Assamese language

2.4.5 The age of gadgets and apps

Nowadays we are using smartphones, tablets, and other such portable gadgets and access the entire web world in a single click. Mobile phone applications have been very popular in recent times. More people are taking interest in these applications. This in turn generates the demand for digital content creation for such devices and applications. Many of these include Indic script typing applications, social media websites, and blogs, etc. where Indic scripts have

been used extensively. Many freelance developers and designers are working on developing typing applications and other social media applications for Assamese language and script. But they are still way behind from the current similar type of applications of other languages. In other words, most of the applications used to offer only typing in Assamese script with an existing typeface already used in Bengali or modified from the Bengali version rather than offering a new typeface or font for display. But it has a huge scope in progressing into another level by entering the area of Assamese typeface design. An example of the Assamese script used in mobile phone app is shown in Figure 2.18.

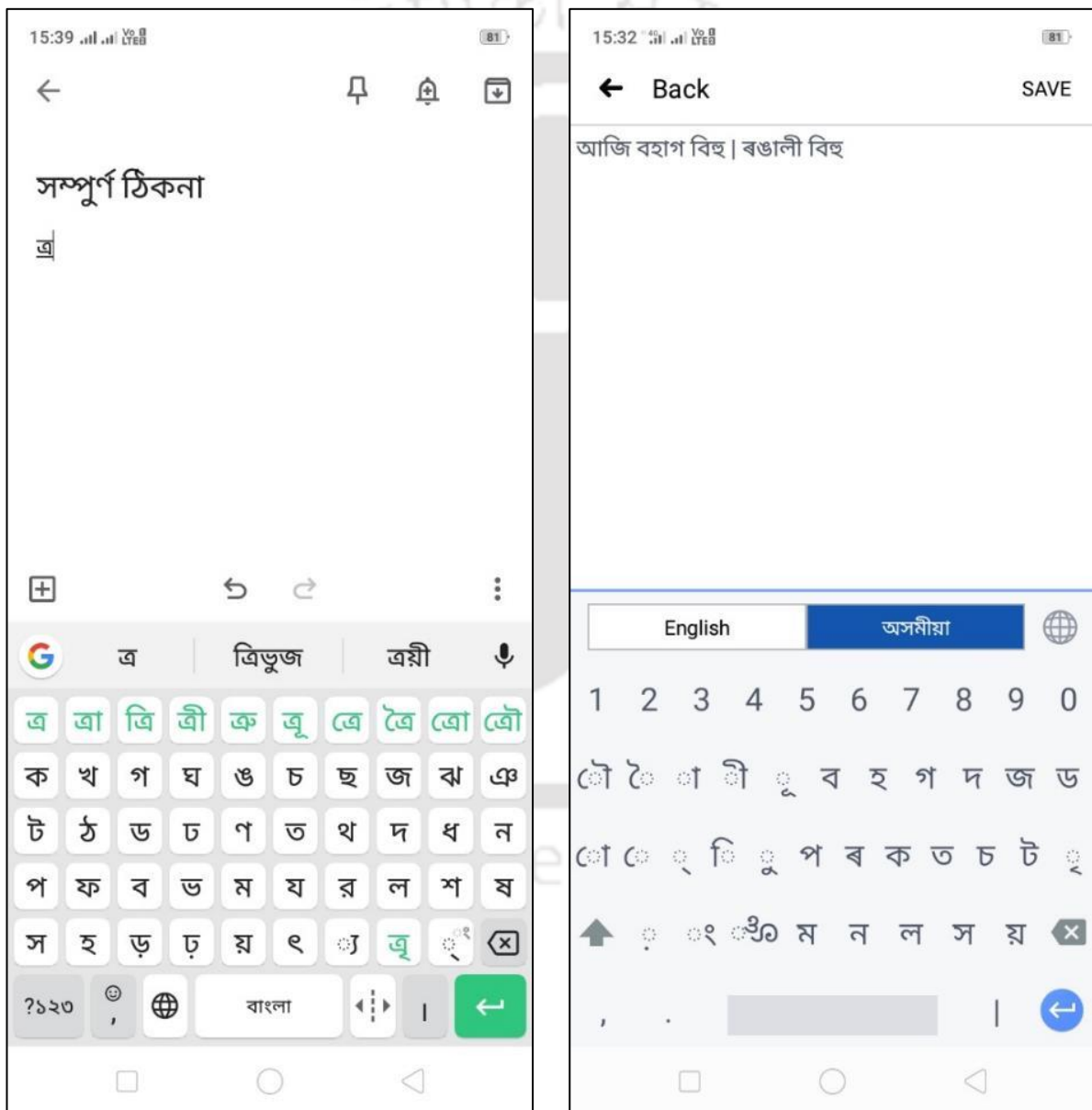


Figure 2.18: Screenshots of typing applications using Assamese script for mobile devices

2.5 Review of research articles related to Assamese script

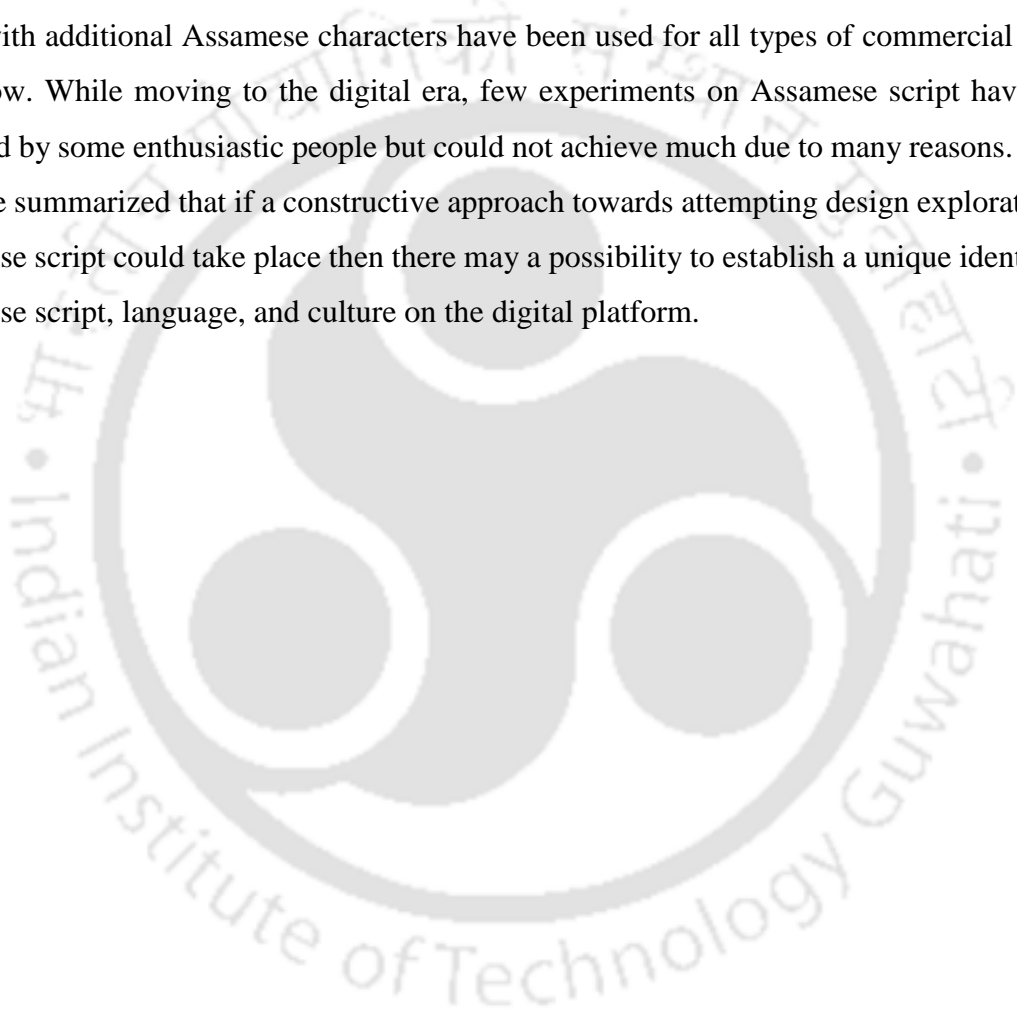
Although concentrated experiments with Assamese script considering design aspects could not be found, there were experiments related to Assamese script performed in other directions available with documentary evidence. Few important case studies have been discussed below.

- i. Dr. Shikhar Kumar Sarma (2016), in his research article, described that similar to the English language development of WordNet has been started for Indian languages also. This is mainly due to the demand for regional language as effective media for the digital world. For such development, he and his team worked on background concepts, language specifications, properties, and characteristics, etc. of the Assamese language and script as well. The paper also focuses on the challenges faced on mapping to the Hindi and English WordNet. The qualitative and quantitative achievements on structuring the core preliminary part of the Assamese WordNet are also presented. But the in-depth exploration of script characteristics and their history has not been considered widely.
- ii. In another research work done by Kaustubh Bhattacharyya (2009) and his team on Artificial Neural Network (ANN), they experimented on scanning Assamese handwritten scripts for recognition through Artificial intelligence. But the experiment did not focus on scriptwriting style or its characteristics rather it gave more importance to obtaining digital data on handwritten scripts for further experimental programming.
- iii. Furthermore, an OCR (Optical Character Reader) research project on Assamese script based on Bangla OCR by Subhankar Ghosh (2012) and his team from IIT Guwahati has been performed. But as they took reference from already existed Bangla OCR based on Bangla script, hence a separate exploration on Assamese script was not studied.

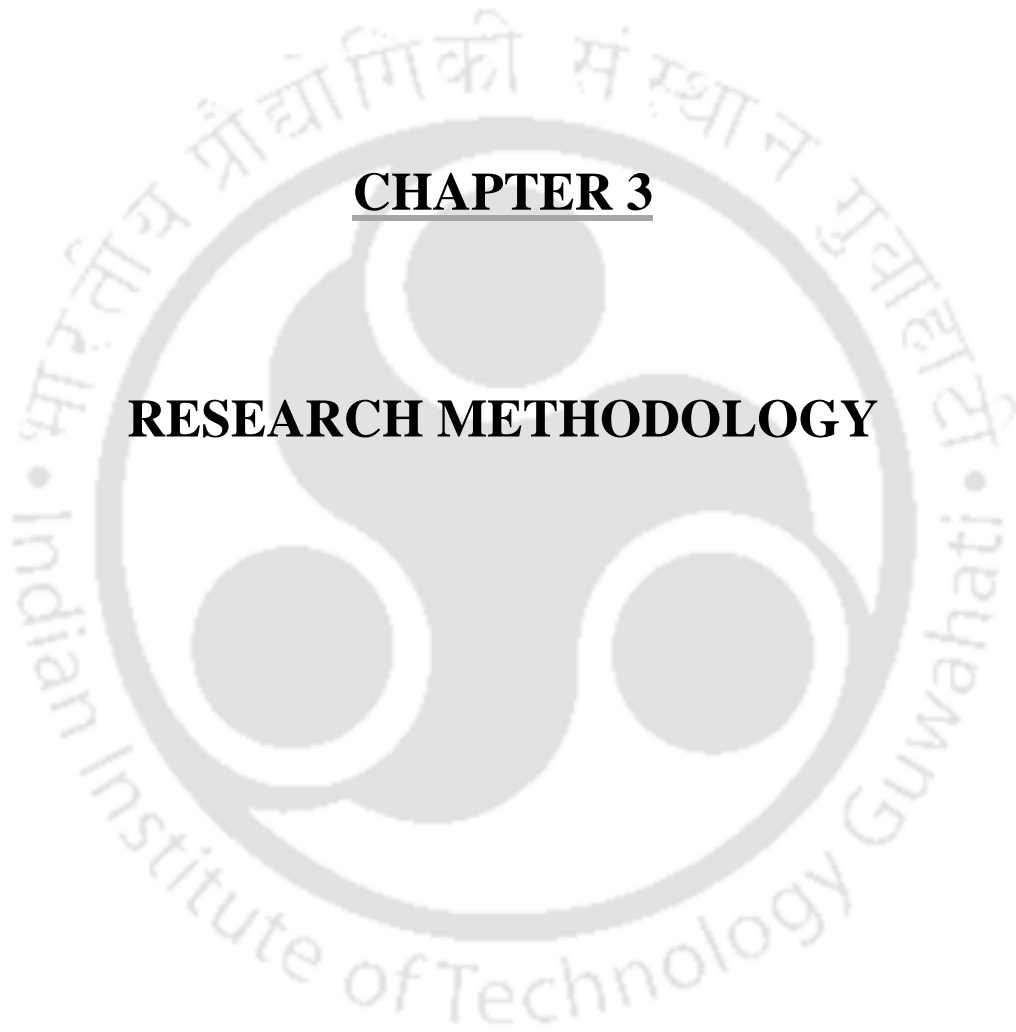
All the three case studies discussed above are research papers that address subject areas primarily related to information technology and computer science. That's why the researchers did not explore the Assamese script in detail rather it covers a limited domain of the script where only descriptive sections have been included. Hence though they provided a few important information about the script related to technology, in-depth information about the Assamese script could not be extracted from these case studies.

2.6 Summary and conclusion

This chapter discusses the Assamese script and its progression from ancient times to the current digital era. As mentioned, from the medieval times to the pre-printing press era the script reached its maturity with the initiation of different writing styles used extensively for various purposes by a different group of people. But during its progression to the machine printing phase, Assamese script was merged with Bengali script to meet the commercial demand due to the similarities of script characters. This happened due to the printing facilities and resources were available in the Bengal region. Hence in machine reproduction, Bengali script with additional Assamese characters have been used for all types of commercial needs, even now. While moving to the digital era, few experiments on Assamese script have been explored by some enthusiastic people but could not achieve much due to many reasons. Hence it can be summarized that if a constructive approach towards attempting design exploration on Assamese script could take place then there may a possibility to establish a unique identity for Assamese script, language, and culture on the digital platform.







CHAPTER 3

RESEARCH METHODOLOGY



Chapter 3: Research Methodology

3.1 Overview

This chapter discusses the research method appropriate for the study of Assamese script and the complexity of typeface design for the script. The research methodology area needs to align with the aim and objectives of the research. The researcher explored the relevant research methods to develop the appropriate methodology for the study.

The present research area involves a web of inter-relations involving layers of meaning in the field of history, culture, script, language, and design domain to extract identity. As a result, the methodology has to be in sync with each area to represent the inter-relations conflict-free. This tends to help in unfolding semantic, semiotic, and connotative meanings associated with the research.

To explore and extract critical information about Assamese script and its writing styles, initially, an interaction session was conducted with few people from the field of academics, literature, print publication, and teaching. After a questionnaire session, their views have been noted about Assamese script, language, writing system, and typeface or fonts used to write the script. Based on preliminary discussions with people from varied fields, the need and direction of research have been composed. Then a research strategy was set up to address the need and direction.

3.2 Research Strategy Planning

The planning of research strategy has been set up with a standard structure that starts with Exploration, then Description, then Explanation, and at the end Application. Various tasks and operations which fall under these stages have been elaborately described ahead.

The figure as shown in Figure 3.1 presents a flow chart illustrating the research strategy adopted for achieving desired objectives.

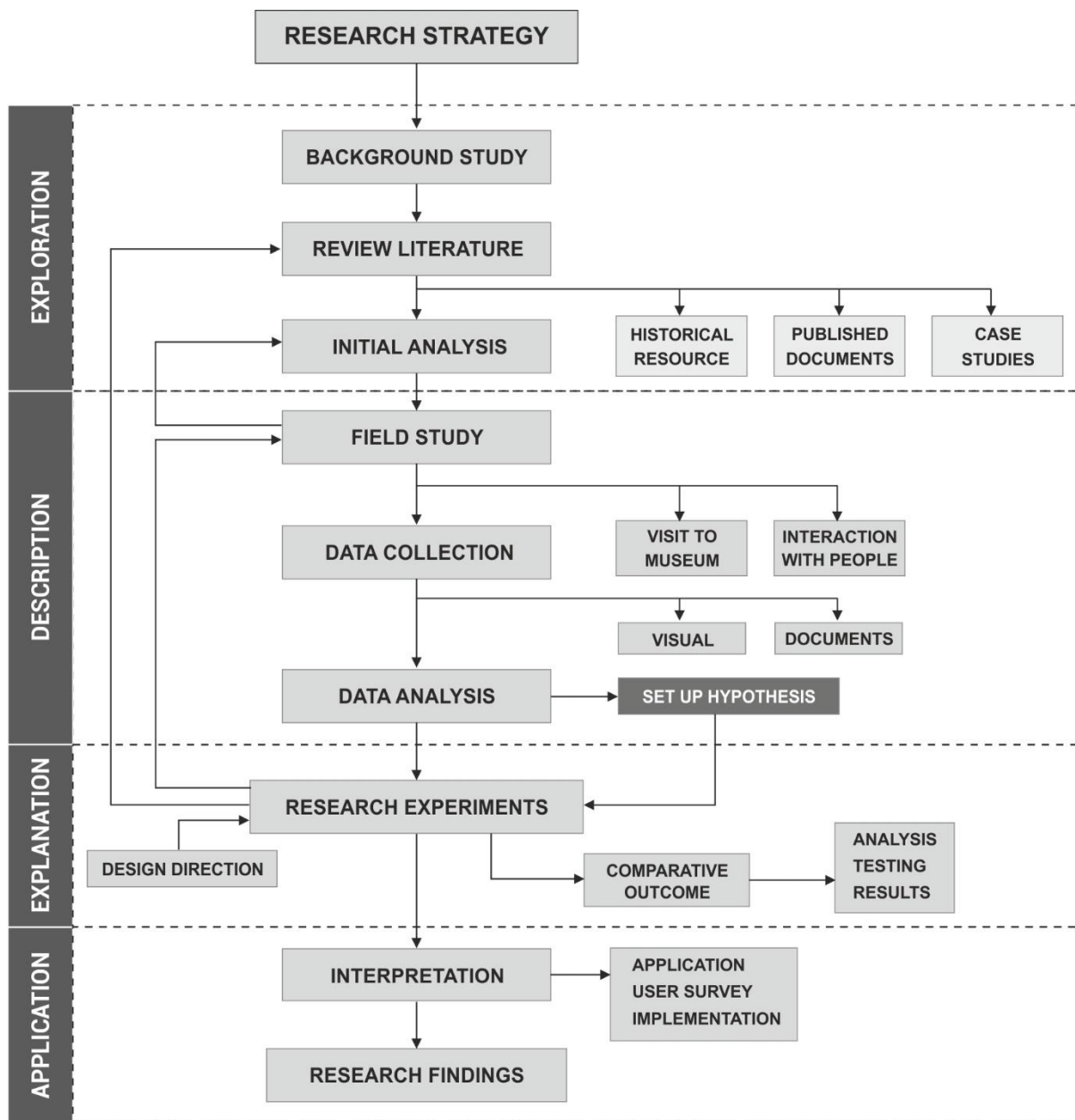


Figure 3.1: Flowchart showcasing research strategy in a step by step manner

Exploration: It is the initial stage of looking into the research subject. Started with a background study on the research interest that looks into the need and justification of the research subject. Then a literature review was conducted to explore the in-depth information on the subject which include exploration of historical resources, a study on published documents such as books, journals, articles, and various publications in print and online media, and case studies on important research findings proposed by previous researchers. After the collection of all these an initial analysis was conducted to verify the information. The analysis sorted out the probable direction to proceed for the next step.

Description: It is the next stage after initial exploration. It started with a field study that includes first, visit the Assam State Museum situated in Guwahati, Assam to collect information and data on various historical resources, and second, interaction with a different group of people from various background to gather basic information and their approach towards to the research subject. The field study gathers collective data on the research subject which has been then divided into two types – visual and documentary. The collected data have been validated using software such as Adobe Photoshop, Adobe Illustrator, and Microsoft Excel. After analysis of the data collected a hypothesis has been proposed to examine the research experiments.

Explanation: This is the next stage that starts with research experiments to validate the hypothesis proposed in the previous stage. The research experiments have been reinforced by design direction which further illustrates a comparative outcome that has been put forward for analysis and testing. After that research result was achieved which have been further considered for interpretation.

Application: It is the final stage of the research strategy where the interpretation of research results has been conducted with the help of various modes. At first, the application of research results has been tested and analyzed. Then a user survey was conducted to verify and validate the application phase. Then at the final level implementation of the finally modified research result has been initiated. In the conclusion, collective research findings have been proposed for further study by projecting future scopes.

3.3 Field Visit

Based on the research strategy plan, a field visit was planned to collect information on historical resources and other relevant data. As Assam State Museum located in Guwahati has a large collection of historical resources, therefore, a thorough visit was planned. The museum also has a separate manuscript section as well as a library with a good collection of valuable and old books. Hi-quality photographs of every resource were taken. Tools used for taking photographs were Canon 1300D DSLR camera and iPad Air tablet camera. Photographs were then color corrected using Adobe Photoshop software for better representation and clarity. Photographs have been then divided into three categories – Manuscript, Historical inscriptions and coins, and Books and documents.



Figure 3.2: Assam State Museum, Guwahati, Assam

Another field visit was planned to go and meet with people of different domain areas for interaction to collect information about what is the approach of people towards Assamese script, language, and culture in combination. Initially, a casual interaction meeting was conducted with various people from the field of academics, teaching, print publication, design, and general background. Basic questions were asked to them about Assamese language, script, and connection with Assamese culture, and collect their answers as the first information resource. The questionnaire was set up keeping in mind the following broad areas:

- Information about the history of Assamese script and its progression from the medieval period to the printing press era.
- Information from the beginning of the printing era to the entry of digital technology.
- Progression of the script after the entry of digital and web technology.
- The current position of the script in the age of mobile gadgets and applications.

Almost all the people who part took in the interactive session provide valuable information based on their individual experience and knowledge. It was a warm session that comes out to be very interactive as well as informative which enlightens some very sensitive areas. From the interaction, the following key points have been summarized:

- i. Most people do not care about the script, its writing styles, and typefaces used for the script. They used to follow the general commercial demand available around them.

- ii. People involved in print publication usually care for the compatibility of the software rather than the type style.
- iii. People from academics and teaching are mostly concerned about teaching the skill of writing at an early age for students. They used to follow the conventional path of teaching Assamese script writing rather than exploring the connection of the writing style with that of culture.
- iv. The books etc. that are available for kids at the preliminary school level used to follow the conventional type style available in the industry.
- v. Most of the new generation people have an idea about mobile apps where Assamese script have been used following the typestyle provided by the service provider or developer. As it is a bit complex and highly technical, hence people never really take an interest to explore the area.

3.4 Design of research questionnaire

In addition to the field survey for collecting historical resources and visual data, different types of questionnaires were designed to collect information at different stages. The type of research questionnaires set up for different stages have been divided into three categories as follows:

- Casual
- Descriptive
- Comparative

The casual category of the questionnaire has been set up to collect the basic information about the research subject, the approach of the people towards the subject, and gathering tentative information by interacting with various levels of people. The descriptive category of the questionnaire explores more into describing conflicts, finding reasons, opinions, and suggestions, and interactive and logical communication with the primary shareholders of the audience. The comparative category examines the comparative analysis with the hypothesis proposed to the finding from the research experiments. Further the schematic figure (refer to Figure 3.3) showing an overview of the strategy adopted for the level of questionnaire and stages of application.

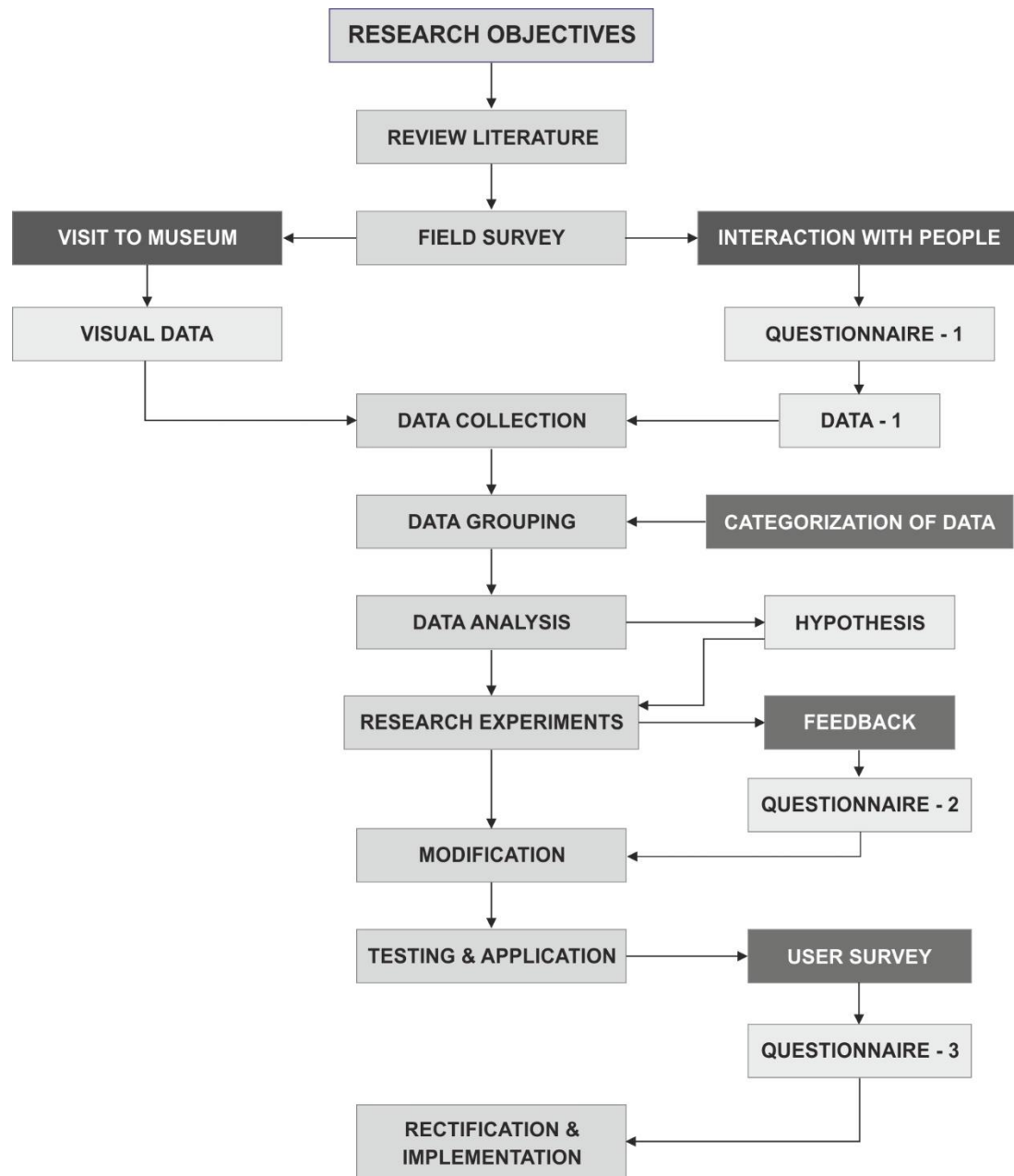


Figure 3.3: Strategy adopted for questionnaire design

At the very beginning, the questionnaire set up was casual which has been proposed during the field survey. In this stage, Questionnaire – 1 has been framed to extract basic information from general people of different levels and professional backgrounds. Since it was to initiate the research subject and its scope with general people hence a casual approach has been considered to design a basic questionnaire pattern (see Appendix – 1a) to familiarize the subject with the people. In the intermediate level during the research experiments, another set of questionnaires was set up to extract descriptive information about the experiments and their probable findings. In this stage, Questionnaire – 2 has been set up to extract descriptive

information about the research experiments to examine and validation of the findings (see Appendix – 1b). Then in the final stage, the last set of questionnaires was set up to extract comparative information and analysis of the research results. In this stage, Questionnaire – 3 has been set up to examine the research results for comparative analysis to find a quantitative outcome that would examine the hypothesis to its practical outcome (see Appendix – 1c). Collectively it can be summarized as follows:

- Questionnaire – 1: Casual category
- Questionnaire – 2: Descriptive category
- Questionnaire – 3: Comparative category

3.5 Validation of research questionnaire

The validation of research questionnaires has been administered through various means of application in the process. At the initial level, the questionnaire was validated by comparing it with the visual data collected from the field study. The validation of the second level of the questionnaire has been conducted through revision of the design proposal. At the final stage, the questionnaire was validated through rectification of the final prototype before implementation.

3.6 Research methodology approach

Initial background study of the subject area prescribed an exploration of the historical resources and collect evidences to extract information on Assamese culture, language, and script of the medieval time. It is, therefore, necessary to take an exploratory approach to the subject at its initial stage as historical exploration could not define any quantitative information about the confined subject area. Figure 3.4 below shows the schematic view of the approach.

3.6.1 Exploratory approach: As the literature study demands every information on Assamese script, language, culture, and its initiation, therefore, resources were collected from all directions such as historical, documentary, case studies, published books, journals, or any relevant contents, etc. To explore such a large pool of information it was, therefore, necessary to consider an exploratory approach at its initial stage. The exploratory approach was then divided into two types – informal qualitative approach and formal qualitative approach.

- i. **Informal qualitative approach:** This approach was considered at the field study stage to initially familiarize the subject with the people who were targeted to approach for

casual interaction. A very basic set of questionnaires (see Appendix 1a), as well as conversational contents, were prepared for the purpose to conduct the session so that an affirmative response could be generated from the audience.

- ii. **Formal qualitative approach:** This approach was considered while compiling field data collected from various resources such as photographs of historical articles from museums, collection of historical books and contents from the library, interview of selective people with relevant professional backgrounds, etc. This has been done by applying various self-inventive methods to accumulate and project field data for appropriate usages in the next stage.

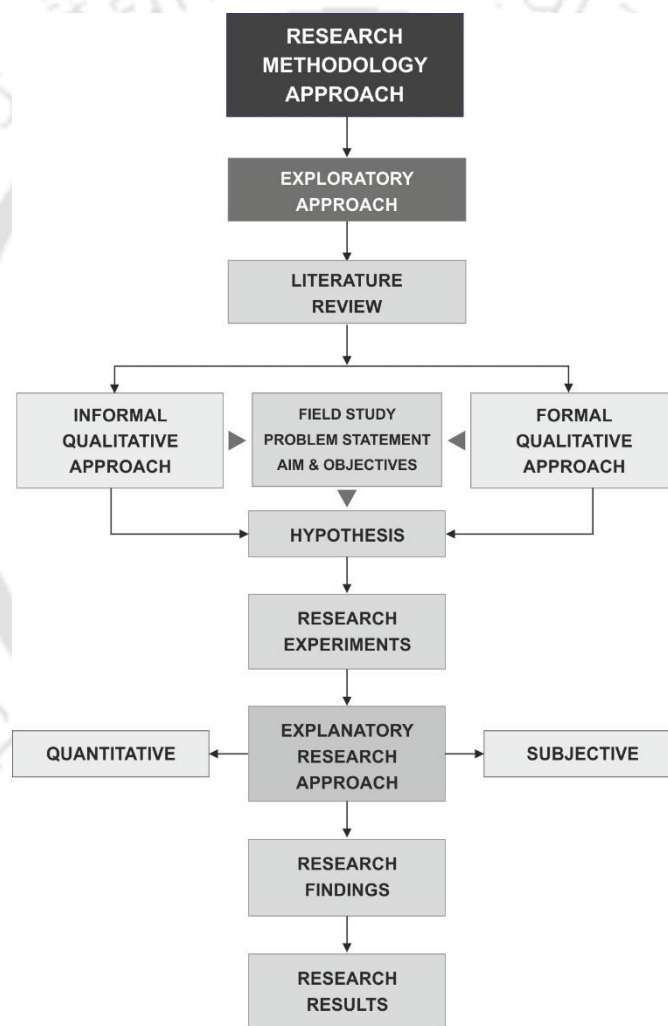


Figure 3.4: Schematic view of research methodology approach

3.6.2 Explanatory approach: The qualitative approaches considered at the field study stage then helped in evaluating the problem statement generated which in turn projected a hypothesis. Based on the hypothesis, aim and objectives have been set up to compose research experiments

to justify the hypothesis. After the research experiments, an explanatory research approach has been considered to verify and validate the results. The outcome of the research experiments was then surveyed among the select group of people through a set of questionnaires (see Appendix 1b) for validation. The explanatory approach again has been divided into two types – quantitative and subjective.

- i. **Quantitative approach:** To verify and validate the outcome of the research experiments comparative data have been generated from the review results projected from the hypothesis. The results have been then analyzed for a numerical outcome to examine the hypothesis.
- ii. **Subjective approach:** While doing the user survey of the research findings, a subjective approach was considered. As the user survey required a very specific audience which includes direct stakeholders of the subject area, selective people took part in the previous survey as well as contributors in the experiments, a targeted questionnaire set (see Appendix 3c) focusing the scope of the experiments, analysis of the research findings and commercial implications on society have been composed for the survey analysis.

In the end, research results have been produced after examining quantitative analysis and subjective outcomes from the research experiments and findings. The results not only showcase the validation of the hypothesis but also proposed future scope of studies.

3.7 Analysis tools for design element identification

Historical Assamese script writing styles were used to follow certain forms, curves, and writing patterns that were created by the people who initiated the styles. These specific properties of those writing styles could be defined as the *Design Elements* present in them. All these writing styles had their own set of *design elements* which used to define their properties as well as uniqueness from each other. But to analyze those *design elements* there need to be some tools to apply which will validate their existence. The following tools were considered to be appropriate for analysis of historical Assamese scriptwriting style for their *design elements*.

- i. **Semiotic interpretation:** Semiotic means signs and symbols. In the analysis, semiotic refers to the symbolic characteristics present in each of the writing styles which differ from each other.

- ii. **Connotative interpretation:** A connotation is a commonly understood cultural or emotional association that some word or phrase carries. In the analysis, the emotional or cultural association depicts the caste or community of people who were associated directly with the initiation of the writing style. Connotative interpretation depicts how people during the medieval period culturally and emotionally connected with a particular scriptwriting style. The writing style used to represent not only a caste or community of people who initiated it, but also represent culture, emotion, and language of their time. The *Kaitheli* style of writing particularly showcases those aspects while examining through connotative interpretation.
- iii. **Pragmatic interpretation:** Pragmatics is a subfield of linguistics and semiotics that studies how context contributes to meaning. In the analysis, how a particular writing style used to portray a specific set of identity and how people accepted it for their nobleness has been discussed.

The below Table 3.1 shows the elaborate description of all the interpretations.

Table 3.1: Analysis of Semiotic, Connotative, and Pragmatic interpretation

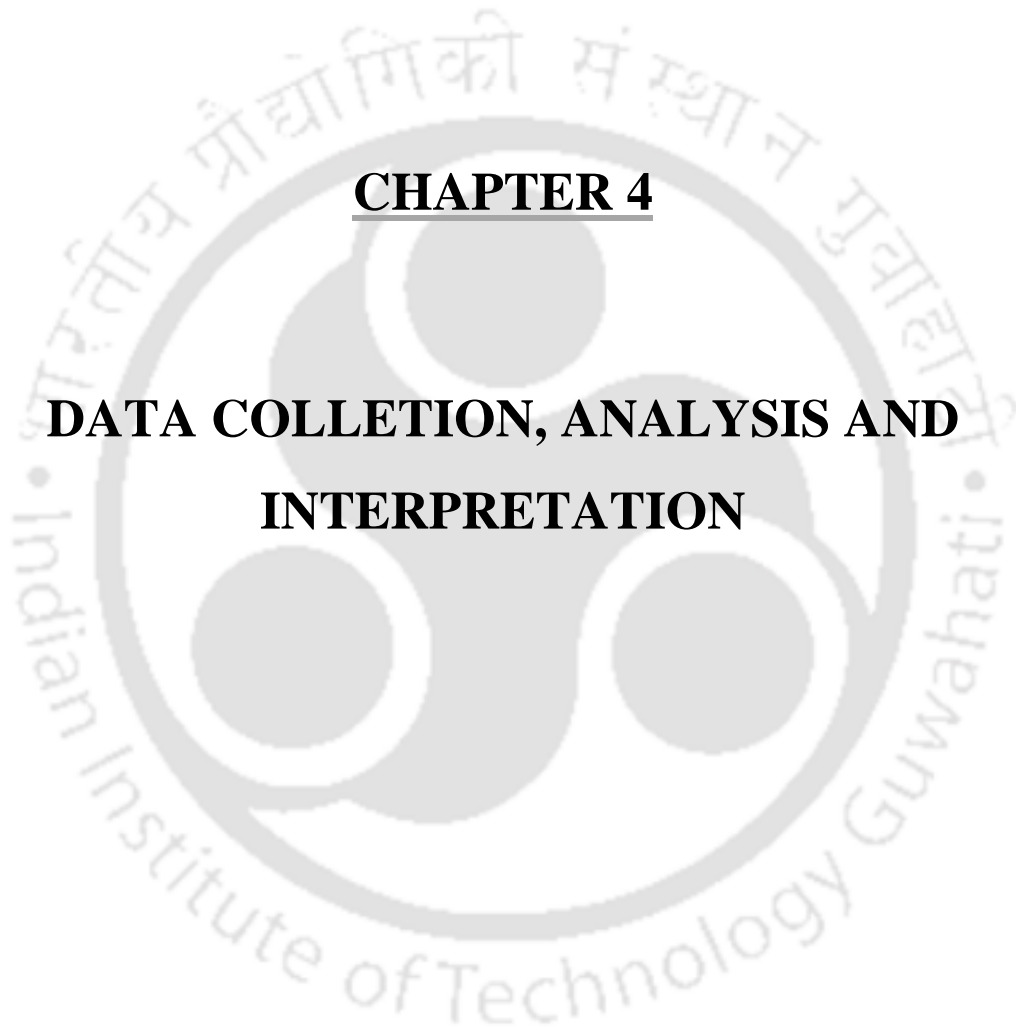
Historical Assamese script writing styles	Semiotic interpretation	Connotative interpretation	Pragmatic interpretation
<i>Kaitheli style</i>	<ul style="list-style-type: none"> Decorative styles present in characters Beautiful illustrations presented with a mix of appealing colors in between texts Text writing styles were kept justified to showcase skilled calligraphy. 	<ul style="list-style-type: none"> Representing <i>Kayastha</i> community known as writer caste. The writing style was very popular in the lower Assam region in medieval times as it was <i>Kayastha</i> dominant region. As <i>Kayastha</i> people were not from upper caste or any royal connection hence the majority of people accepted their writing style due to its connection with common people. 	<ul style="list-style-type: none"> The popularity of the writing style due to its decorative and illustrious characteristics Connecting the common people through simple yet attractive representation. It used to portray the generative nature of writing style which people accepted unanimously.

<i>Bamuniya style</i>	<ul style="list-style-type: none"> • Radical nature • A conventional writing style that follows the Sanskrit style of writing. • Not much decorative but an influence of <i>Kaitheli</i> due to cultural mix-up. 	<ul style="list-style-type: none"> • Representing <i>Brahmin</i> community who used to be considered as upper caste people involved in conducting social rituals, sacred events, etc. • The writing style was mostly seen in books or articles written for religious purposes where Brahmin people used to be associated with. 	<ul style="list-style-type: none"> • The style initiated by <i>Brahmins</i> to write literature of sacred scriptures. • It used to write Sanskrit shlokas in Assamese script. • People used to treat them as sacred and religious due to the involvement of Brahmins.
<i>Garhayan style</i>	<ul style="list-style-type: none"> • Methodical writing style. • Follow characteristics such as sharp, simple, legible, and clear. • The presence of decorative elements is negligible. • Depicts a royal metropolitan identity. 	<ul style="list-style-type: none"> • Initiated by <i>Ahom</i> rulers hence it represented royal identity. • Mostly seen in the copperplate inscriptions and rock inscriptions used to be crafted under royal orders. • Coins issued by the <i>Ahom</i> kings also bear the <i>Garhayan</i> style. Hence people respected the style. 	<ul style="list-style-type: none"> • Due to the royal influence, the script was used for writing official declarations, treaties, etc. for the entire <i>Ahom</i> empire. Therefore people used to accept it as the universal script for all official uses. • The style was termed as esteemed due to its royal influence and official uses.

3.8 Summery

Constructive planning of research strategy allows better opportunities to properly plan out research questionnaire design to be applied at various stages. The strategy also helps setting out the questionnaire pattern design which was considered crucial to extract and validate the information. The research methodology approach was set up based on a strategy that examines in-depth details of the whole research process that include setup hypothesis, research experiments, checking, validation, and testing of research results. The analysis tools for design elements identification in historical writing styles produce a decent outcome that helped in evaluating the historical resources with appropriate validation. The structured detailing of semiotic, connotative, and pragmatic interpretation focuses on the hidden characteristics as well as brought out the universal acceptance of the historical writing styles that helped in framing the research experiments.





CHAPTER 4

DATA COLLETION, ANALYSIS AND INTERPRETATION



Chapter 4: Data collection

Data collection is an intrinsic part of any research work which manufactures the foundation of information. In this research work since gathering information was blurry hence an exploratory approach has been considered at the initial stage to begin the project. A self-conceptualized approach to classify the data has been considered to segregate the data types. Below is a presentative diagram of the same.

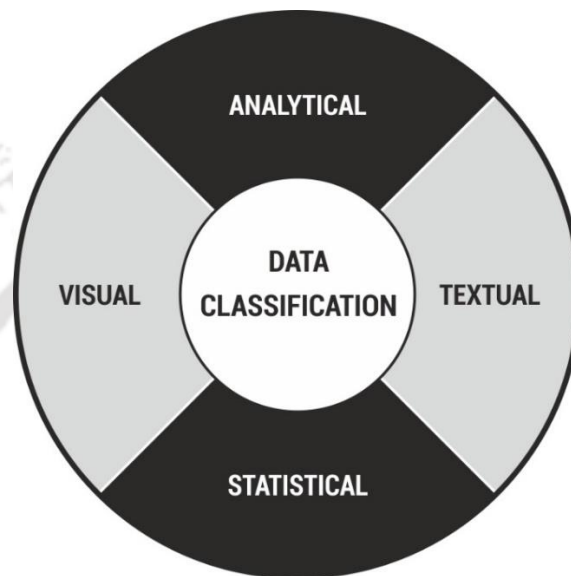


Figure 4.1: Representation of data classification

As the figure describes, all the data have been divided into four categories. Visual, Textual, Analytical, and Statistical. Visual data are those which are photographs of historical articles and resources. Pictures taken from museums, libraries, important books, and other resources could be categorized as visual data. Textual data are the textual or readable information collected from various resources. Analytical data are that information collected from interviews through various questionnaires. And statistical data are the quantitative data generated from comparison and analysis of collected information for a particular task. In the research, all such types of data have been collected by following an exploratory approach to address the projected need.

4.1 Overview – Types of data

Categorizing the types of data to be collected was a little challenging at the beginning due to the adoption of an exploratory approach as the starting point was not clear. To overcome that difficulty an innovative approach to categorize the data types was considered. Types of

data to be collected have been categorized under various heads to make the information transparent. Below is the schematic view of the categorization of types of data.

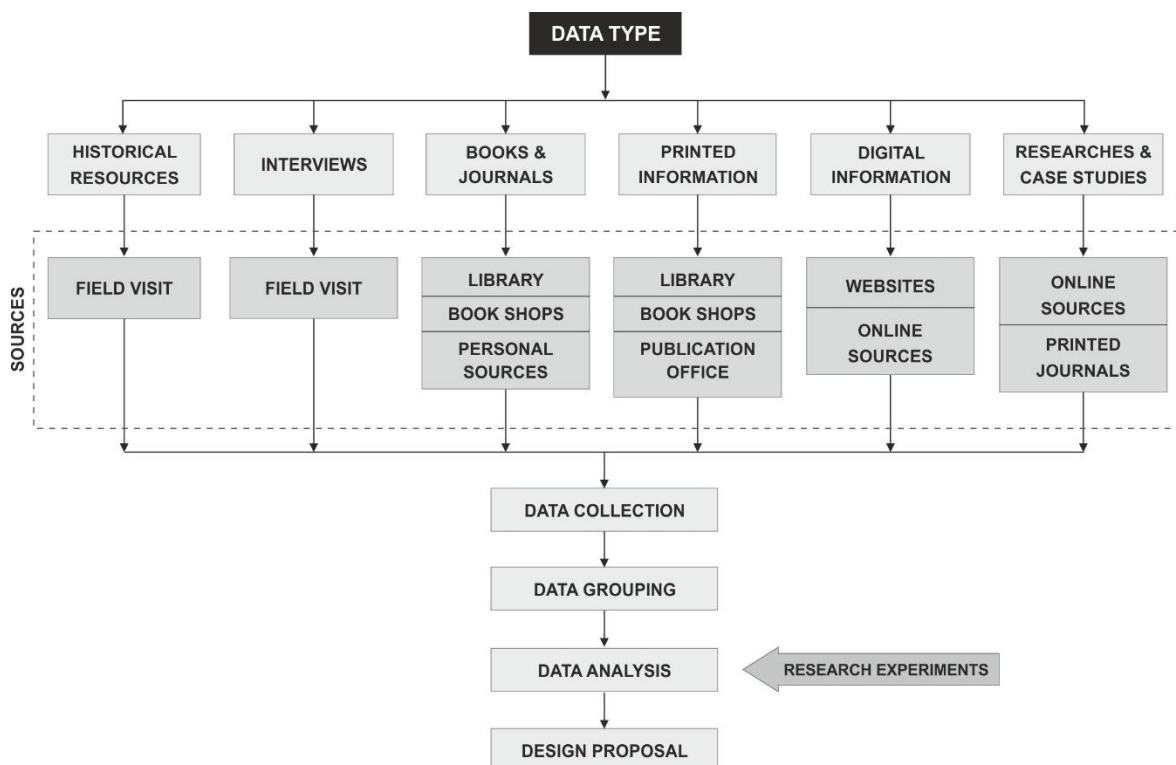


Figure 4.2: Schematic view of the description of types of data

Following heads have been identified to categorize the types of data to be collected:

- Historical resources
- Interview with people
- Books and Journals
- Printed information
- Digital information and
- Researches and case studies conducted by previous researchers.

These heads have been then defined by various sources from where the information was collected. Those sources then provide a pool of data to be compiled for sampling and analysis. After the analysis design proposal was conceived which formulated the research experiments.

4.1.1 Historical Resources

Field visits were conducted for collecting historical resources. As the Assam State Museum has the largest collection of valuable and important historical resources hence it was the first destination of field visit. The museum comprises of a special collection of manuscripts

section, coins collection and collections of copperplate and rock inscriptions from as early as 9th century apart from other historical articles such as dresses, utensils, jewelry, artilleries, weapons and many more. It has a separate library section with a collection of valuable books with historical importance. Below Figures 4.3, 4.4, 4.5, and 4.6 are the image samples collected from the museum.



Figure 4.3: Xaansi bark manuscripts of the medieval period



Figure 4.4: Rock inscription from 9th century to the medieval period



Figure 4.5: Medieval coins from the Ahom era



Figure 4.6: Copperplate inscription of Ahom era (16th to 18th century)

4.1.2 Interview with people

In the other part of the field visit, interaction with people from different professional backgrounds was conducted to have a casual interview session. A set of questionnaires was composed with types of questions ranging from preliminary information gathering to focusing on appropriate information on script, language, and culture along with technology intervention. A casual interview was conducted among people from the field of academics, teaching, print publication, design, and general background. The questionnaire was set up based on specific criteria keeping in mind the broad areas mentioned in the Research Methodology chapter (refer to Annexure – 1, Questionnaire – 1a for this casual interview session). Describing below in Table 4.1 the primary criteria and responses received from the group of people interacted with.

Table 4.1: Details of the interview with people

Sl. no.	Criteria description.	Responses
1	General knowledge of people about Assamese script and its history.	The majority of people don't have a proper idea about the script and its history. But most of them told that it is a continuous process from manuscripts to the current era of print and publication.
2	Knowledge about script and language with Assamese culture.	People have been confused on this subject as the majority of people could not properly respond. For them, scripts don't have a direct connection with language and culture.
3	Knowledge about how to write the script.	Writing practice for the script used to start at the school level. People responded that they used to learn writing skills as taught by their teachers. It does not have any connection with the historical writing styles as those were written on dried leaves of <i>Xaansi</i> trees called <i>Xaansi paat</i> . But nowadays at school, children use paper and pencil or pen which is different. Also writing styles use to follow printed letters shown in books. Hence learning how to write Assamese script nowadays doesn't have any connection or resemblance with the historical writing styles.
4	The Assamese script and its progression to printing technology – the old and the current scenario.	<p>Questions on this subject were asked primarily to people who are related to the print publication industry. Although they could not give any concrete comments but pointed out few important factors as follows:</p> <ul style="list-style-type: none"> • During the time of letterpress printing, they find it difficult to work on variations of typesetting styles. • Unavailability of different typeset styles as those were crafted and imported from outside. • Letterpress printing needs skilled labor and knowledge of the script. • The entry of offset printing removes all those difficulties due to the use of computers and modern technology. • There are more options to design or compose typesetting on a computer. • But it still had limitations in typestyles as new type styles released in the market by various vendors were not available for

		<p>Assamese script. They used to be designed for Bengali script.</p> <ul style="list-style-type: none"> • Typing Assamese script on a computer also was a little complex thing and needed to learn before using it. • Gradually after the entry of many software for typing, Indic script on the computer came up and relaxes those difficulties.
5	Assamese script on digital media – information and experience of practical application.	<p>People who are into academics are more interested and active in exploring digital media. Key points from the responses are as follows:</p> <ul style="list-style-type: none"> • The presence of Assamese script on digital media is very limited. • Very few Assamese websites are there in comparison to other Indian languages. • Due to the creation of the very limited content in the Assamese language for digital media the websites publishing information in the Assamese language could not able to manage a strong presence. • Newspaper publishing companies trying to publish news in the Assamese language but with a limited source. • Most of the people suggested that Govt. bodies, literary bodies, and other associated organizations should come out to promote the Assamese language for digital media to mark a presence.
6	Typing tools for Assamese script on the computer – people’s approach.	<p>People concerned are from the print publication and design industry. The key points are as follows:</p> <ul style="list-style-type: none"> • There are two types of customized keywords for typing Assamese script – virtual in-script keyboard and manual keyboard with a sticker printed on it. • The most commonly used keyboard for Assamese typing is provided by <i>Ramdhenu</i>, the developer of the keyboard software. • I-Leap is another developer used to provide Assamese typing software. • Most of the users also follow Unicode standard typing software. • Another very popular Assamese typing software is the phonetical keyboard. One

		<p>can just type the Assamese words in English using the phonetical method then the software converts the words into appropriate Assamese words.</p> <ul style="list-style-type: none"> • At the initial stage, the software for Assamese typing had lots of problems but nowadays most of those problems have been solved by the developers. • Currently, Unicode has been considered as the standard for typing Assamese script on a computer due to its wide acceptability over devices.
7	Information about Assamese typefaces used in computers.	<p>People concerned are from the print publication and design industry. The key points are as follows:</p> <ul style="list-style-type: none"> • After the entry of typing software for the Assamese script, default typefaces also used come with the software. • The new typefaces provided with the software are based on the classic Bangla typeface originally designed by Linotype. • Many variations of typefaces are available only for Bangla script but printers and designers used to manage with those variations for Assamese script due to its similarities though there are difficulties. • There are a limited number of decorative typefaces for Assamese script that too borrowed from Bengali origin typeface. • For magazine covers, etc. printers and designers used to create custom typefaces by illustration. • After the Unicode recognition, Assamese characters have been added with most of the typefaces designed for Bengali to meet the commercial demand as both the scripts share similar character sets.
8	Assamese script for mobile applications – information and experience of using it.	<p>People concerned are from students, academics, design, and literary background. The key points are as follows:</p> <ul style="list-style-type: none"> • Most of the social media applications nowadays provide regional language support. People got aware of typing in Assamese script in mobile devices from these applications.

		<ul style="list-style-type: none"> • As Unicode recognized Assamese script with Bengali, hence devices were also used to support Assamese script with the in-script keyboard. • Though introduced, most people find it difficult to type in Assamese script due to different typing methods followed by different mobile Apps. • Typefaces for mobile devices also have limited choices. • Nowadays many software developers used to provide free Assamese typing apps for mobile devices but those are still lacking in technical aspects.
9	Information about Unicode – How aware are Assamese people about it.	<p>As the subject has a technical concern most of the people interacted responses with a neutral or no answer due to lack of information. But yet some of them put forward few very important key points as mentioned below:</p> <ul style="list-style-type: none"> • All the latest software supports Unicode standards for all kinds of script systems and typing. • All the websites that publish regional language scripts support Unicode standard. • As Unicode compliance for Assamese script is a new thing hence most of people are yet to understand its applicability. • People with a technical background who used to develop software, apps, develop typefaces, etc. only take concern about Unicode.
10	Future scope of Assamese script – People's opinion.	<p>In this case, most of the people responded quite optimistically but with concern about the following key points:</p> <ul style="list-style-type: none"> • Assamese people should take care of the language and its script more aggressively. • We should write and publish more digital content in Assamese script to make the script and language visible online. • We should increase the user and viewership for Assamese script and language both for web and mobile media to enhance commercial demand.

4.1.3 Books and Journals

Printed books and journals are one of the most important sources of providing knowledgeable information about Assamese script. Many books have been written on Assamese script, language, and culture presenting valuable information including rare pictures of historical writing styles of Assamese script. Following are the resources and information collected from books (refer to Figure 4.7, 4.8, and 4.9).

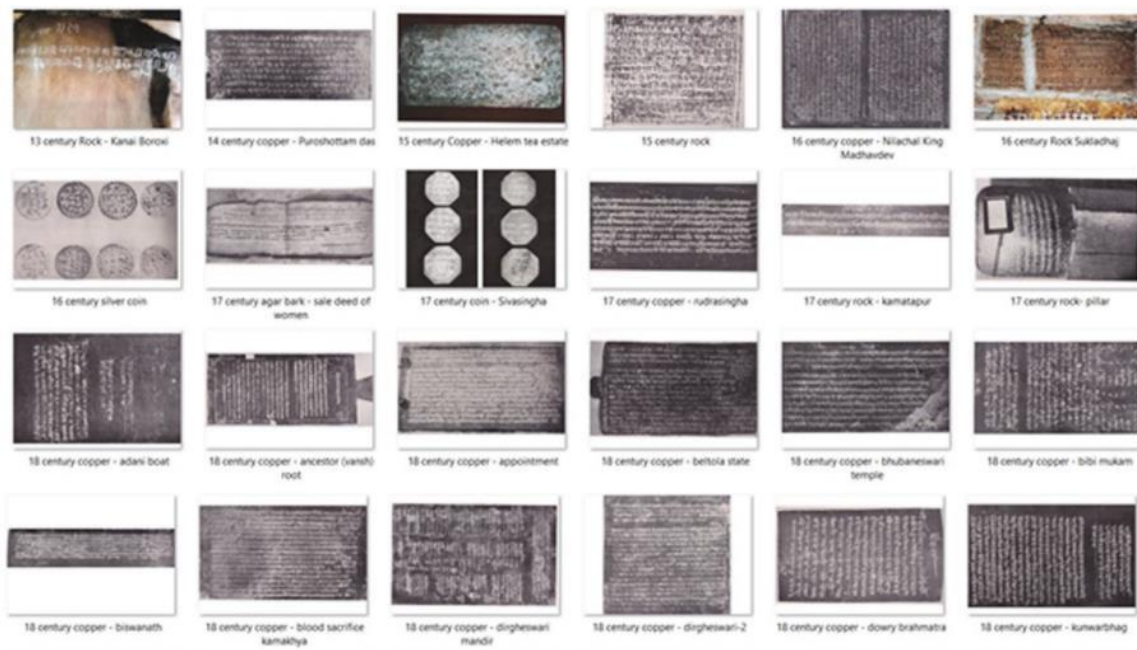


Figure 4.7: Images collected from various books written on Assamese script history



Figure 4.8: Printed sample of “ARUNUDOI”, Vol. 6, published in 1951, Place: Sibsagar

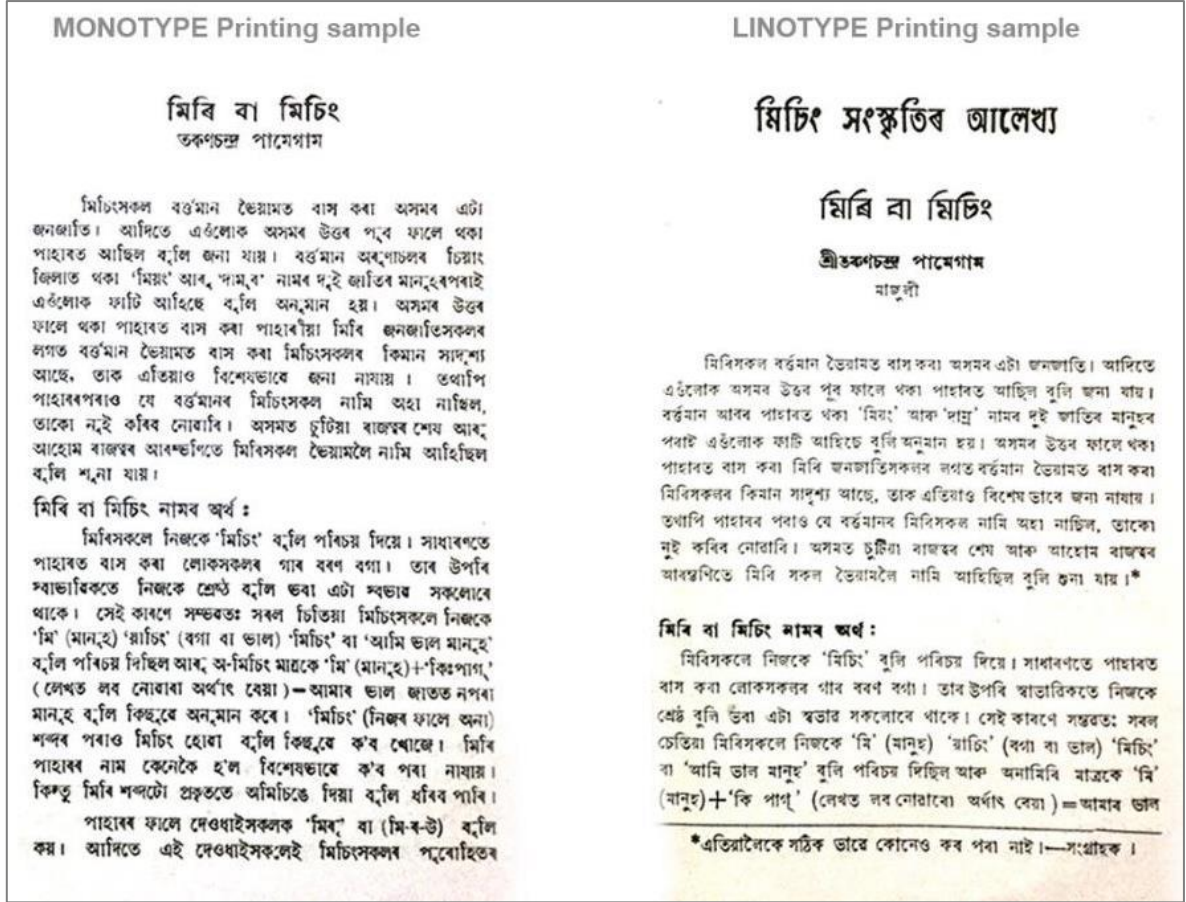


Figure 4.9: Printed samples of Assamese script: Monotype and Linotype technique
(Book – “*Mising Sanskritir Aalekhya*”)

Most of these relevant books and journals have been sourced either from library or book shops or from personal connections. Furthermore following excerpts could be summarized by extracting information from these books and journals about the Assamese script and its implications.

- A detailed historical description with evidence of the script to present the evolution and progress till the printing era.
- The historical writing styles, their descriptions, and significance on society during the medieval period have been discussed in the books written on Assamese script.
- Significance of Assamese script with language, culture, and society from the medieval period to the post-printing press era.
- Influence of Baptist Missionaries and British rulers on Assamese script and language.
- Different types of older printing techniques for Assamese script used in a few of the books have been examined.

- The first Assamese printed Journal “*Arunudoi*” showcases the preliminary version of letterpress printing samples available in Assam for printing Assamese script during the 1850s.
- Influence of printed Assamese books in publicizing Assamese script and language.

4.1.4 Printed information

Printed information on Assamese script and its relevant subjects have been sourced from the library, book shops, and publication offices. The objective of collecting printed information is to examine the progression of Assamese script in various print forms such as magazines, books, newspapers, advertising posters, and other such materials. How Assamese script has been presented in such printed media and how people accepted or reacted to it has been evaluated for further exploration. Few of the examples shown below in Figure 4.10, 4.11, 4.12, and 4.13.



Figure 4.10: Printed covers of famous Assamese novels – (1) *Ashimot Jar Heral Sima*, (2) *Miri Jiyori*, (3) *Dotal Hatir Uyen Khowa Haoda*



Figure 4.11: Printed covers of famous Assamese magazines – (1) *Bishmoy*, (2) *Prantik*, (3) *Saphura*



Figure 4.12: Printed advertising published in magazines



Figure 4.13: Printed samples of Assamese Newspapers

4.1.5 Digital information

Digital information on Assamese script has been explored in websites published in the Assamese language such as news websites and a few general information websites. These websites showcase Assamese script which renders properly on digital screens. Also, a few of the mobile apps which publish Assamese language contents have been explored as well for analyzing the growth of the script on the digital platform. Shown below are examples of digital information.

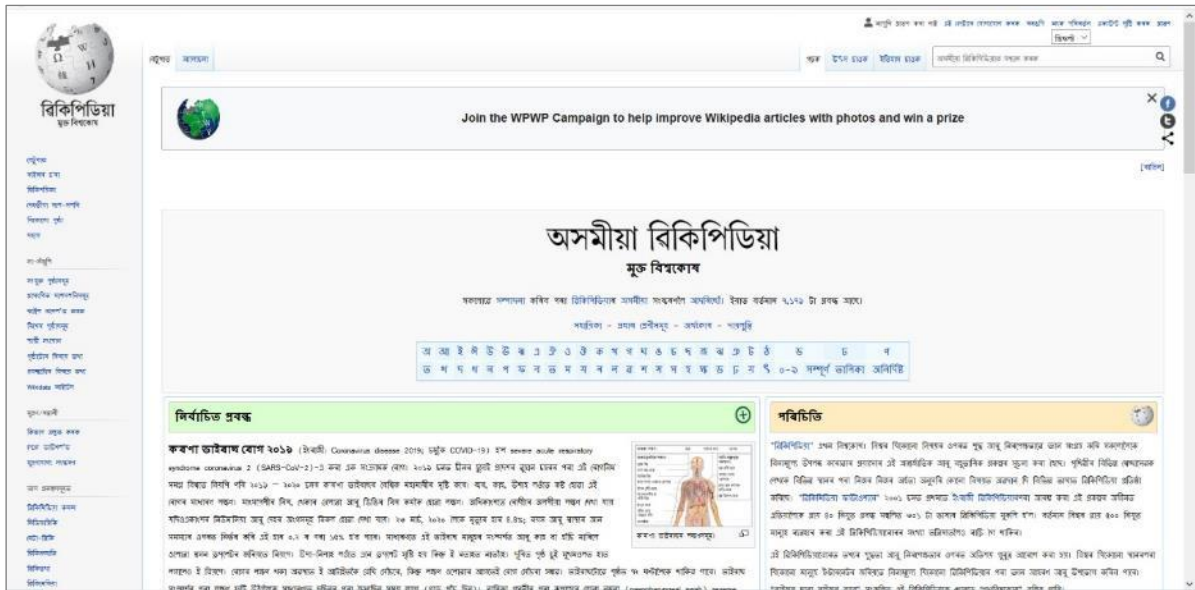


Figure 4.14: Website of Assamese Wikipedia published in the Assamese language

The website of Assamese Wikipedia (refer to Figure 4.14) is a voluntary initiation of few enthusiastic people of Assam to promote Assamese language and literature on the digital medium. A very good amount of articles covering different subject areas has been published online on Assamese Wikipedia. Many people have contributed to developing the contents in the Assamese language. The website uses conventional as well as a modern digital version of typefaces for web display.

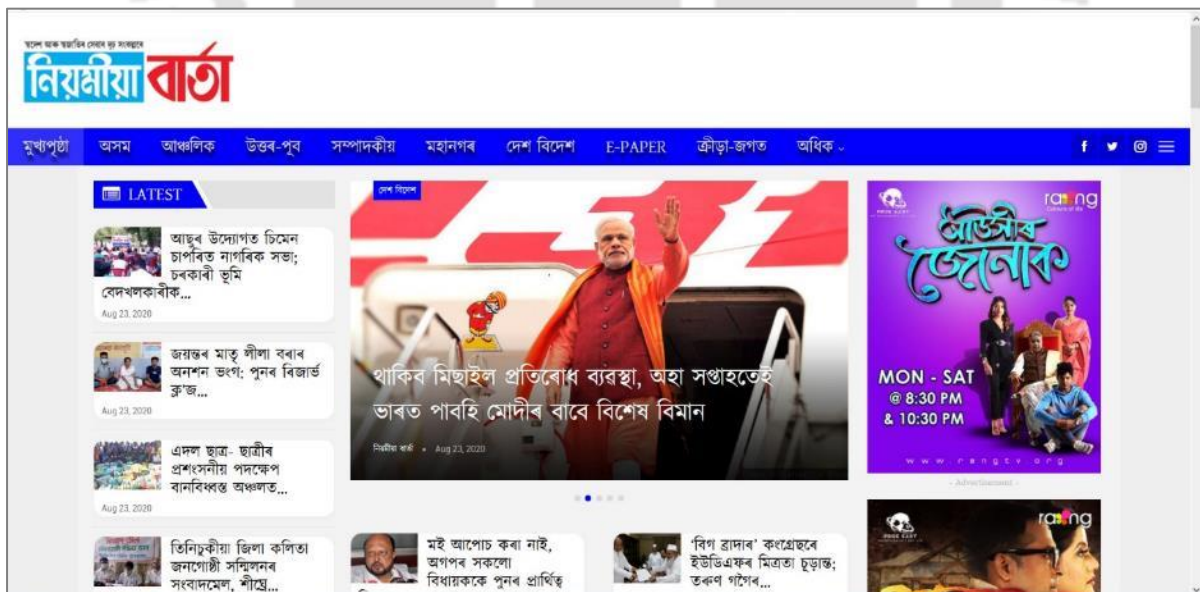


Figure 4.15: Website of “Niyomia Barta” a newspaper website published in the Assamese language

The website of “Niyomiya Barta” (refer to Figure 4.15) is a news website published in the Assamese language. It also has a newspaper by the same name for its printed version. The website uses a conventional typeface for web display as well as a print version.

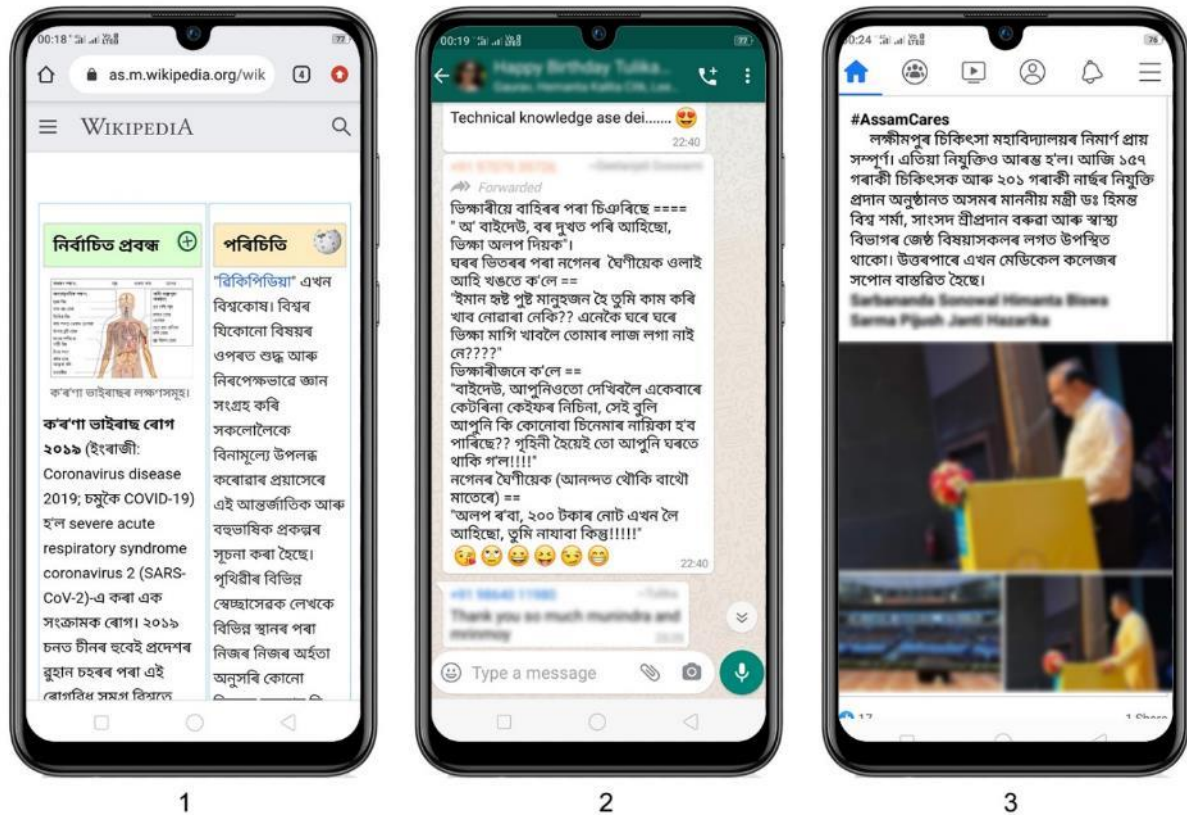


Figure 4.16: Assamese language applications for mobile phones. (1) Assamese Wikipedia app, (2) Assamese script on WhatsApp, and (3) Assamese script on Facebook app.

The mobile application for Assamese Wikipedia also displays the same font as that of their main website. Hence the website does not look different in both the version due to its typeface identity. Assamese script on WhatsApp application for mobile devices used to display modern digital typeface version which is also same for the Facebook app. Hence the typeface display for such apps look similar.

4.1.6 Researches and case studies

Although concentrated experiments with Assamese script considering design aspects could not be found, there were experiments related to Assamese script performed in other directions available with documentary evidence. Few important case studies and research work that include Assamese script studies as part of the research has been considered for references. Masih Saikia (Saikia 2009) in his Ph.D. research work mentioned many important facts about the Assamese script and its characteristics. Important extraction from the thesis that has put

forward some key elements on the properties of Assamese script have been discussed as follows:

The baseline identification: The script of the Assamese language is written from the left-hand side towards the right-hand side, similar to that of other languages, such as Latin/Roman script for English, *Devnagari* for Hindi, etc. Assamese script has a long horizontal run called a ‘*Matra*’ (Headline) and somewhat identifiable to the ‘Baseline’; in the case of the *Devnagari* script, it is called ‘*Sirorekha*’. The *Matra* represents the boundary of the upper and middle zone, and the baseline indicates the boundary of the middle and lower zone. In the case of the writings in English, people generally try to maintain the bottom vertical line i.e., they follow the ‘bottom’ justification, but in the case of Assamese language, people follow the ‘top’ justification, which means tries to maintain the bottom horizontal line (refer to Figure 4.17).

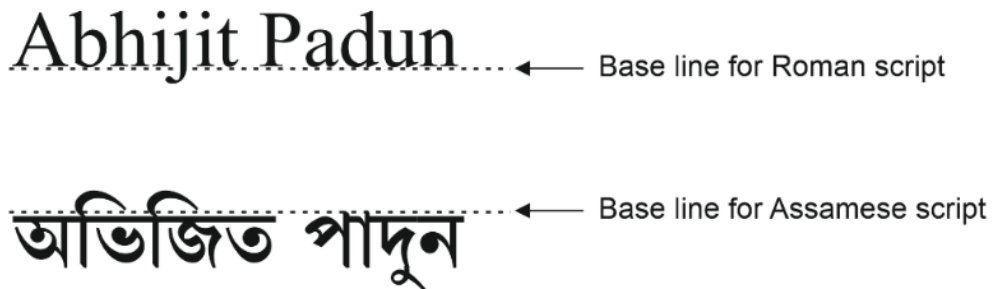


Figure 4.17: Description of baseline for Assamese and Roman script

Lower and upper baseline identification: Each text line is identified using two reference lines; the *upper line* and the *lower line*. They correspond to the minimum and maximum zero value positions adjoining a text line, respectively. Figure 4.18 (a) and 4.18 (b) below shows the description of baselines corresponding to the upper and lower line.

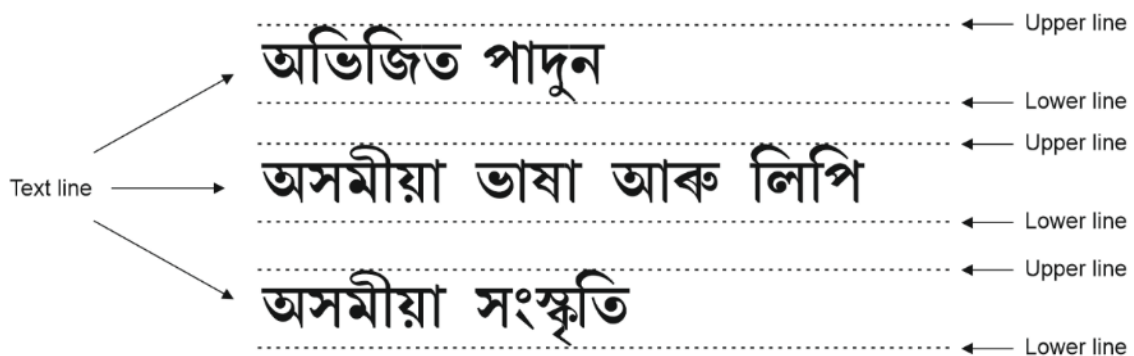


Figure 4.18 (a): describing upper line and lower line

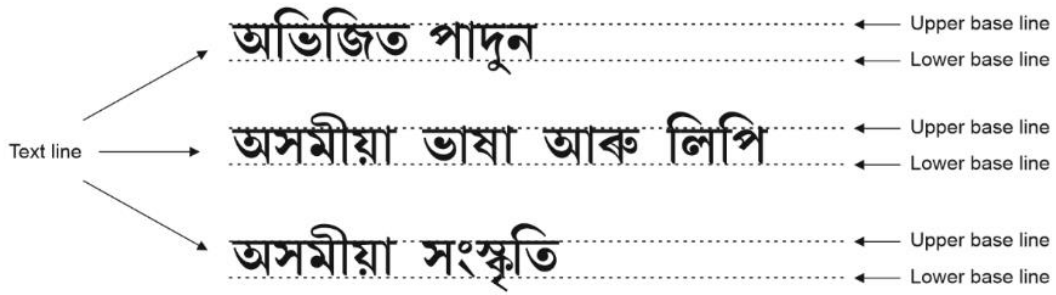


Figure 4.18 (b): describing upper baseline and lower baseline

Thus for each text line, there are four reference lines considering as upper and lower line and upper and lower baselines.

Grouping of characters: All the characters have been grouped in three primary zones namely (a) Core or middle zone, (b) Top or upper zone, and (c) Bottom or lower zone. These are non-overlapping groups (refer to Figure 4.19).

- (a) Core or middle zone: The middle zone covers the region in between the mean line and the baseline. The Core zone contains all the basic characters and the core (vowel) modifier symbol. Characters that lie within the two baselines are categorized into the *core characters* group.
- (b) Top or upper zone: The upper zone denotes the portion above the mean line. The top zone has some of the *ascending characters* and upper (or top) modifier symbols. These characters start in the core zone and extend towards the upper zone.
- (c) Bottom or lower zone: The lower zone denotes the region below the baseline. The bottom zone has some *descending characters* and lower (or bottom) modifier symbols. These characters start in the core zone and extend towards the lower zone.

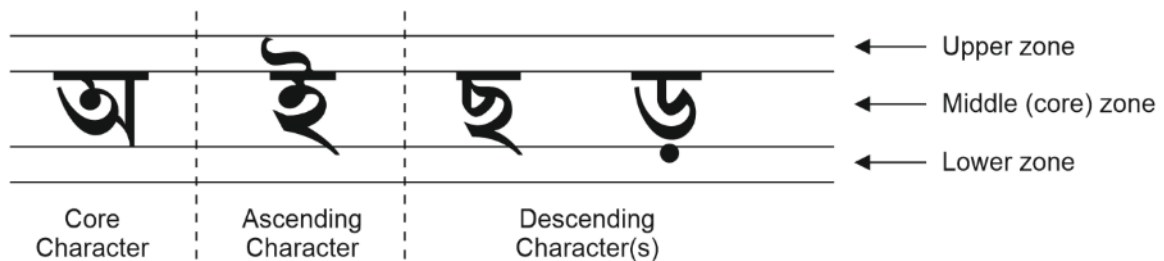


Figure 4.19: Three zones of Assamese character

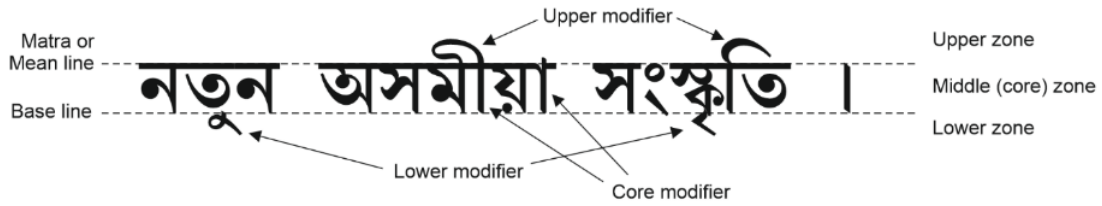


Figure 4.20: Three zones of an Assamese text line

In both the above figures (refer to Figure 4.19, and 4.20) the three zones have been clearly described with relevant characters that can explain the zone properties. As shown in figure 4.19, the character contains the middle or core zone only, which is called the core character. It does not cross or overlap the other two zones. Whereas the ascending character goes above the middle zone and descending character goes below the middle zone. In figure 4.20, a sentence written in the Assamese script is shown with zone descriptions. Here characters such as core modifier, upper modifier, and lower modifier are introduced. These are all vowel diacritics used to write Assamese words.

Text line detection and zone separation: As figure 4.19 shows, only the core character may also present to form a word or in combination with upper, lower, and core modifier. The upper zone is separated by a text line from the middle zone which is known as *Matra* or *Shirorekha* (as known in Devanagari script). The lower zone is separated from the middle zone by a baseline. We use the uppermost and lowermost points of the connected components in a text line to detect the mean line and baseline respectively. The horizontal line that passes through the maximum number of uppermost points is the mean line. Similarly, the horizontal line that passes through the maximum number of lowermost points is the baseline.

Detection of character boundary: A character boundary is the one that starts with where the first dot or mark of a character is present and ends where no blank space is found. Again two characters may also collide with their starting and ending boundary in case a core modifier is present. The below figure (refer to Figure 4.21, and 4.22) explains the character boundary.

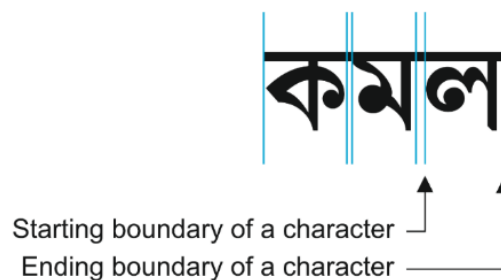


Figure 4.21: Shows character boundary formation

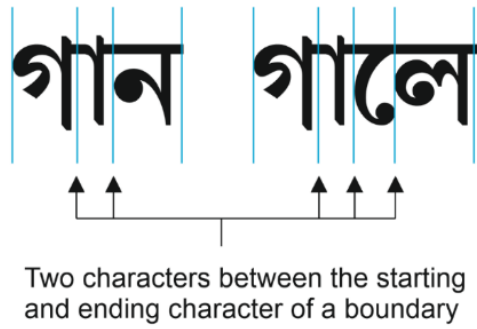


Figure 4.22: Shows common boundaries between two characters

Upper modifier and lower modifier symbols: The character(s) representing a vowel or a vowel diacritic which is situated in the upper zone is called the upper modifier symbol and situated in the lower zone is called lower modifier symbol. Figures 4.23 and 4.24 below shows the symbols.

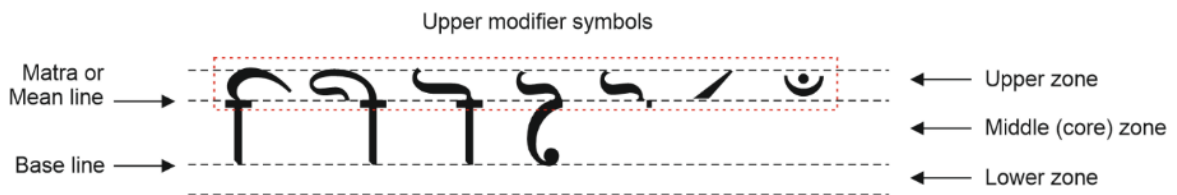


Figure 4.23: Shown is upper modifier symbols marked in red dotted line

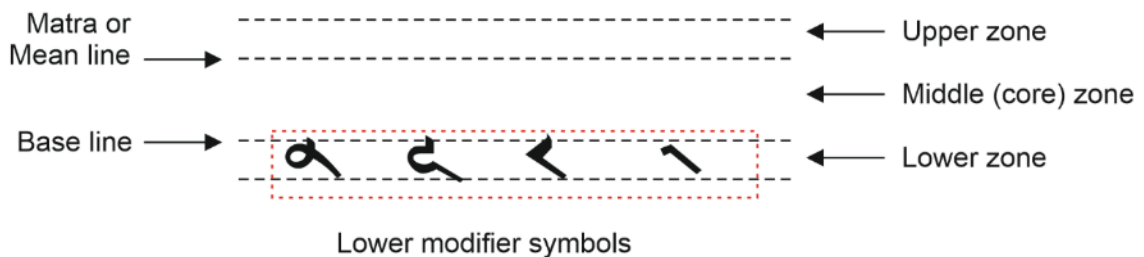


Figure 4.24: Shown is lower modifier symbols marked in red dotted line

Classification of characters based on structural features: All the basic Assamese Characters can be classified based on the visual/structural features. As mentioned earlier there are Core characters, Ascending characters, and Descending characters. Core characters can be further divided into three subgroups based on the coverage of the region of the core or middle zone. They are as follows:

- **Full box character:** These characters cover most of the middle zone (refer to Figure 4.25).

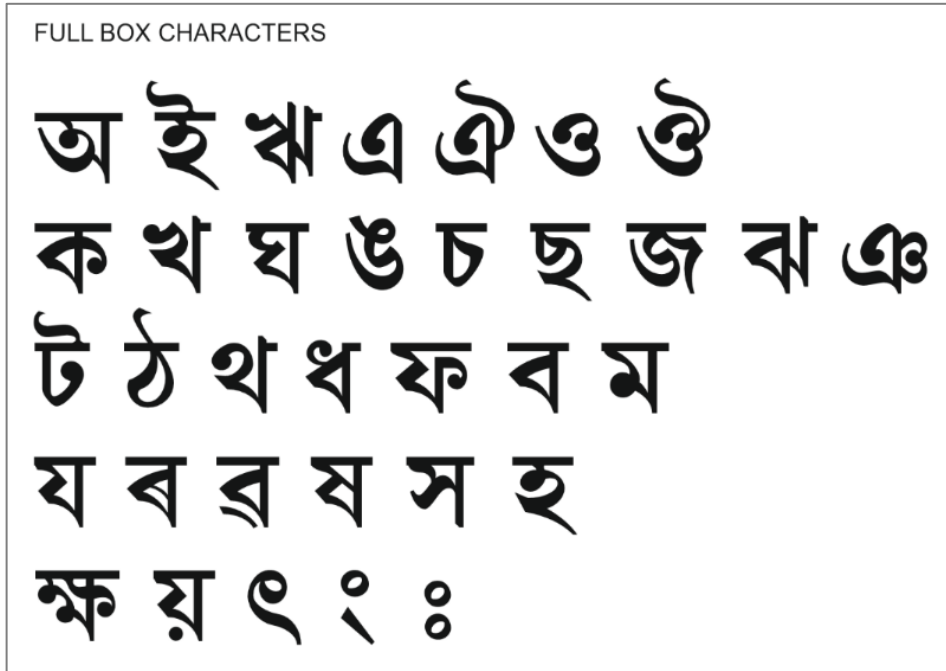


Figure 4.25: Full box characters

- **Upper half box characters:** These characters cover the upper region of the middle zone (refer to Figure 4.26).



Figure 4.26: Upper half box character

- **Lower half box characters:** These characters cover the lower region of the middle zone (refer to Figure 4.27).

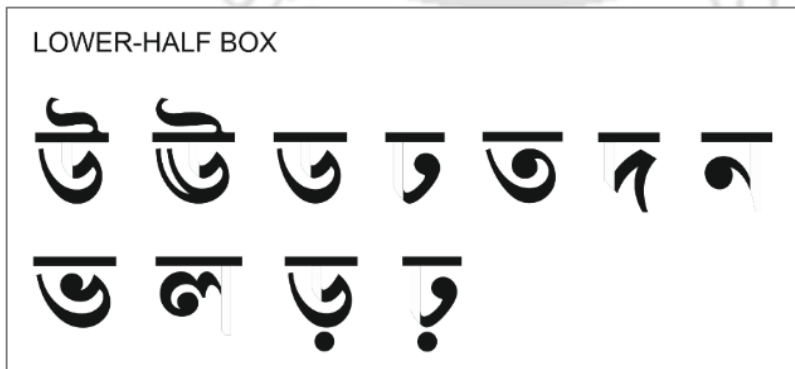


Figure: 4.27: Lower half box characters

The Full box characters can be further divided into four groups based on the presence and the position of the vertical bar. These groups are:

- i. **No bar characters:** Characters that do not have a bar (refer to Figure 4.28).



Figure 4.28: No bar characters

- ii. **Front bar characters:** Characters that have a bar at the front (left side) (refer to Figure 4.29).

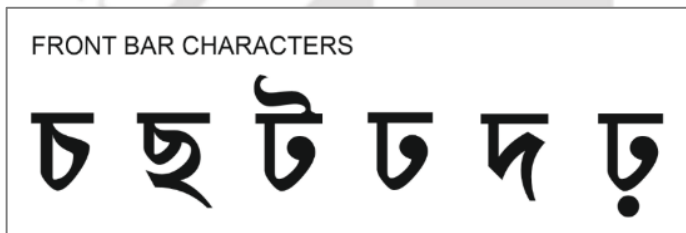


Figure 4.29: Front bar characters

- iii. **Middle bar characters:** Characters that have a bar in the middle (refer to Figure 4.30).

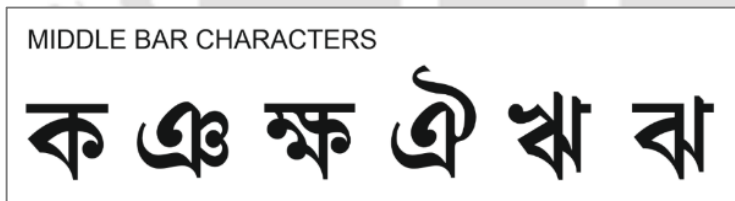


Figure 4.30: Middle bar characters

- iv. **End bar characters:** Characters that have a bar at the end (right side) (refer to Figure 4.31).

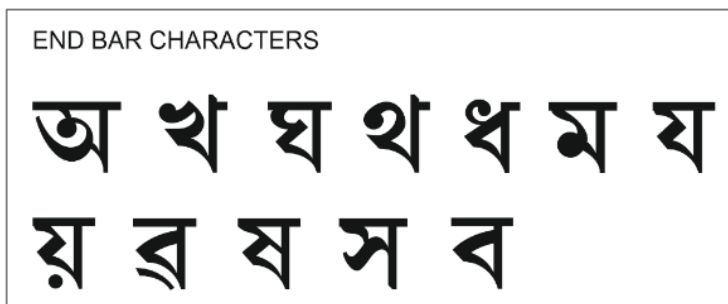


Figure 4.31: End bar characters

Since the End bar set of core characters is large, these characters are subdivided into two groups based on the joining pattern of the character with the *matra* (header line). These are:

- **End bar having single junction point:** These characters touch the header line only at one point (refer to Figure 4.32).



Figure 4.32: Single junction characters

- **End bar having multiple junction points:** These characters touch the header line at more than one junction point (refer to Figure 4.33).

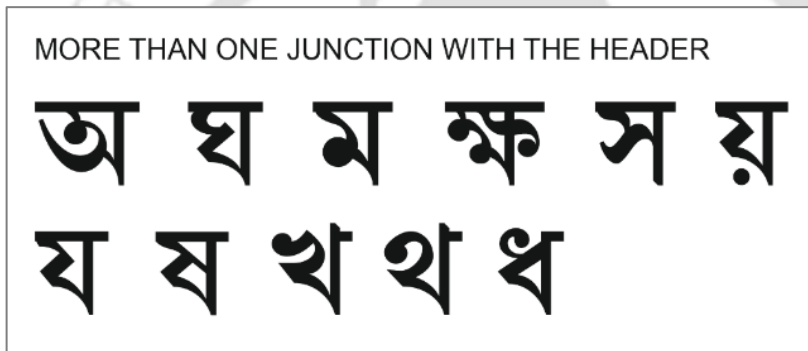


Figure 4.33: Multiple junction characters

The Classification based on these structural features is robust and remains consistent over a large number of fonts' styles and sizes.

Composite characters or conjunct characters: The composite or conjunct characters can be divided into two categories. Horizontal composite characters and vertical composite characters.

- **Horizontal composite characters:** Characters composed in a horizontal direction means one character is attached to the other on its right or left side in a horizontal position (refer to Figure 4.34). There may be up to three characters present in such kind of composition.

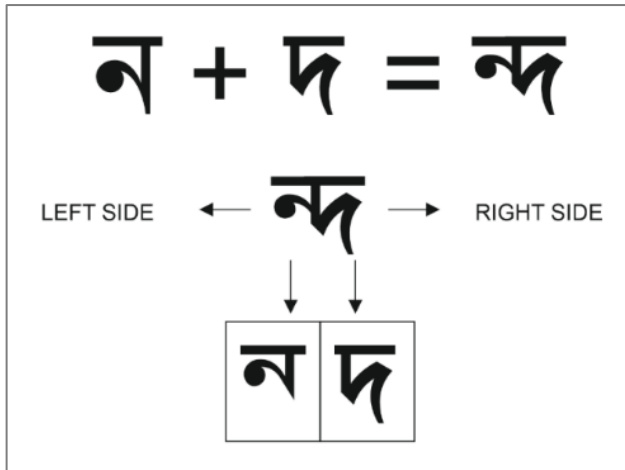


Figure 4.34: Horizontal composite character

- **Vertical composite characters:** Characters composed in a vertical direction means one character is attached to the other on the top or bottom side in a vertical manner (refer to Figure 4.35). There may be up to three characters present in such kind of composition.

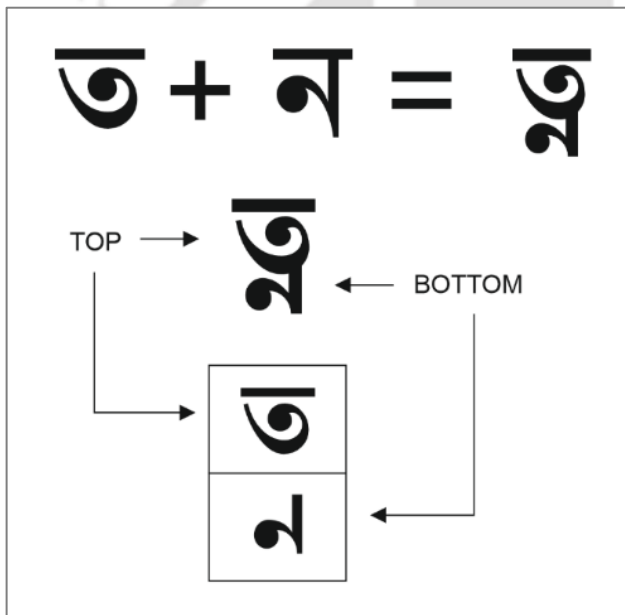


Figure 4.35: Vertical composite character

The thesis titled “*Analysis and recognition of handwritten text/documents of Assamese scripts*” by *Masih Saikia* of Gauhati University, Assam (Saikia 2009) put forward an extensive exercise on properties and classifications of the script which could be very insightful for designing Assamese typeface or analyzing current typefaces used for Assamese script. It elaborately describes the properties with in-depth technical angle and aesthetic considerations as well.

(*Typeface used for Assamese script in all the descriptive figures is “Assamese Sankar”.)

4.2 Data grouping

Grouping of data may help in analyzing the information collected in a structured format.

Based on the collected data, groupings can be done as follows –

- Field study data: It includes field study on collecting historical resources as well as field visit for taking interviews with various groups of people.
- Published data: It includes all types of published data in both print and digital format.
- Research data: It includes all the research, experiment, and case study based data.

Standardization in the structure of data types could be achieved through a grouping of data. Hence it could be easier to compile key factors for each grouping for further analysis and arrangement. Shown below in figure 4.36 is a schematic diagram to describe the grouping of data.

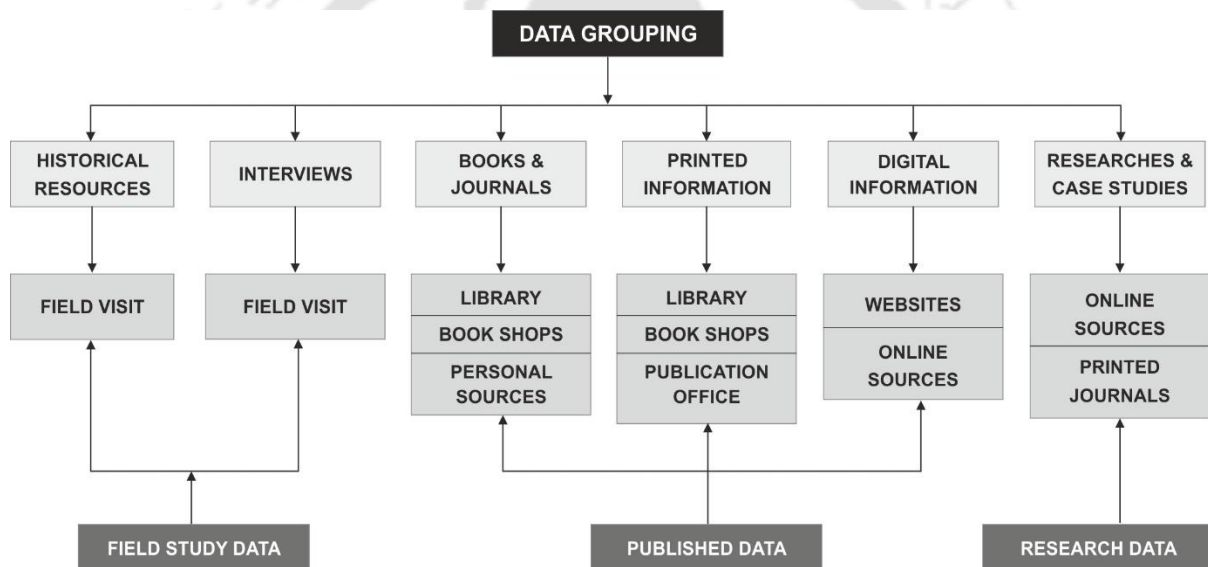


Figure 4.36: Schematic view of data grouping

4.3 Data analysis and arrangement

Study and analysis of data have been conducted on the three data groups. The following key factors could be summarised for each data group.

Field data:

- Historical data – To extract information about the originality and essence of the Assamese script from its early stage along with its uniqueness.
- Interview – To exam the viewpoint of people about the Assamese script, its uses, and emotional attachment with culture and tradition.

Published data:

- All types of print and digital information published – To extract the information about the progression of Assamese script from the post-printing era to the modern digital era. The analysis also examines the trends and traditions followed in the print industry for Assamese literature publications as well digital publications.

Research data:

- To extract information on experiments related to Assamese script, their results, and scopes. The study further examines the scopes of implementing the information on Assamese script design and application.

4.3.1 Analysis of Historical data: Xaansi bark manuscript**Observation in Xaansi bark manuscript:**

- *Xaansi* bark manuscripts are available from the medieval period to the 19th century which were written by many different groups of people.
- The writing styles differ based on period, region, writers, and castes.
- Writing styles of *Baminiyan*, *Gargayan*, and *Kaitheli*, etc. have their styles with different illustration techniques used.
- Writing styles for royal official documents, public documents, religious books, etc. have their styles developed by different expert writers/calligraphers appointed by the rulers and their governments at that time.
- Most of the religious-based books contain colorful illustrations.
- In almost all the manuscripts, writers/calligraphers used to follow text justification style with a gap at the center to tie with a knot to make the manuscripts fixed.
- Conjoint letters written on the manuscripts are not identical and vary in different manuscripts. This is due to different people involved in the job at different times.

4.3.2 Analysis of Historical data: Rock inscription**Observation in Rock Inscription:**

- The Assamese script found in the oldest Rock inscription of *Nagajari Khanikar Gaon* from 5th century AD is different from that of 18th century Rock inscription.
- Similar to the copper plate inscription, the letters were written individually rather than a word in combination.

- In the latter version of rock inscriptions found in the period of 15th to 18th century, the script was well crafted and easy to identify. This was due to the evolution of the script during that period.
- The evolution of script found in rock inscriptions and copperplate inscriptions are mostly similar.
- The letters are clear, the use of conjunct letters is well crafted and the composition of the entire inscription is very artistic.

4.3.3 Analysis of Historical data: Copperplate inscription

Observation in Copper Plate Inscription:

- Copperplate inscriptions of early age (around the 5th to 10th century) are different than the inscriptions found in medieval and later ages.
- The scripts written in older inscriptions are usually found in individual letter format. Whereas the later inscriptions are similar to the styles of *Xaansi* bark manuscripts.
- Inscriptions of the 13th to 18th century have a similarity in writing styles due to the evolution of script during that period.
- 15th to 18th-century inscriptions have more defined, well-articulated, and beautifully crafted letters than the previous inscriptions.
- Even the conjunct letters are also seen properly crafted in these inscriptions.

4.3.4 Analysis of Historical data: Historic coins

Observation in Historic Coins:

- In most of the coins, the name of the ruler was written.
- The structure of the writing style was one line one word type.
- The script was crafted and looks like the work of a goldsmith.
- The letters seen are bolder, bigger, and equal in size for all.
- Even the conjunct letters are also bigger and similar to the size of a single letter.

4.3.5 Analysis of Modern era data: Letterpress printing

Observations in Letterpress printing:

- In Letterpress printing all the letters are crafted from metal in tiny sizes. These are then fitted and put into printing machine block by block.
- Due to its complex development process of letters, conjunct letters have many issues while designing.

- In letterpress also there are 2 different types – *MONOTYPE* and *LINOTYPE* printing technique.
- In Monotype, conjunct letters were broke apart into single letters for independent use with other letters. Due to this words looked non-uniform and unbalanced.
- Later in the Linotype technique, this problem was addressed suitably. But Linotype also abandoned its production due to the entry of newer and advanced Offset printing technology.

4.3.5 Analysis of Published data (print): Offset printing

Offset printing:

- As the offset printing technology uses computer technology to set the texts hence it is more accurate than letterpress printing.
- Placements are well defined for every character.
- Clean printing for alphabets, characters, and symbols.
- Conjunct letters have been modified compared to letterpress printing but still many issues are left while formation with different letters. This may be due to improper designing of glyphs.
- In many places, conjunct letters create spacing problems between lines due to varied sizes.

4.3.6 Analysis of Published data (digital): Typing on digital devices

Observations in typing on Digital Device:

- In most touch-based digital devices, phonetic typing applications are used due to their simplicity in typing.
- Assamese script-based keyboards are available but yet to reach a satisfactory level.
- The common problem in typing in digital devices for both kinds of keyboards is for conjunct letters.
- In phonetic keyboards typing, conjunct letters are not properly detected by writing the phonetic spelling.
- In a script-based keyboard, conjunct letters do not properly fit while typing. This is due to improper application and design of the script.
- There are no common rules or methodology to follow while developing applications for a digital device. Different groups set different methods to make their application.
- Hence it is difficult to find the right typing application for the Assamese script.

Analysis of interview data and research data has been described previously in detail with key factors of the outcome.

An arrangement of data could be laid out based on its importance and application to the research experiments. As the historical data gives the most relevant sources about the origin and essence of the script hence historical data is of most primary importance. Similarly, other data could be arranged base on their necessity and importance. Therefore the arrangement could be shown as follows:

- Primary importance: Historical data
- Secondary importance: Field data (interview) and published information
- Tertiary importance: Research data and information

4.4 Data interpretation – Significance and importance of various data types

From all the data analysis discussed in the previous section, the most important is the historical data as they give the originality of the script as well as the actual progression phase. Modern era data which has been considered after the printing press came to India, is giving the information after commercialization of the script. This information does not portray the originality of the script. Even the data collected in the digital age of the script also goes in a similar direction. Hence for further exploration on the originality of the script, historical data may play a significant role to establish a unique identity.

As the objective is to design a typeface for digital media that could be established as a unique Assamese typeface with a connection to the historical letterform, hence the data collected from historical resources have been taken into consideration with primary importance.

Shown below in figure 4.37 is a comparative analysis of historical letterforms, machine printing based letterforms, and digital letterforms of Assamese script.


Historical Assamese letterforms	Letterpress printing based Assamese letterforms	Digital Assamese letterforms
	<p>বুলি বর্তমান গ্রন্থ আবশ্ৰণতে আৰু সাংস্কৃতিক ন-তাৎস্বিক 'মিৰি মিশ্বন' উল্লেখ</p> <p>বুলি বর্তমান 'দাম্বুক', স্বৰ্গৰ দুডালক (মাতৃ সূৰ্য্য) সম্প্ৰদায়ৰ</p>	<p>অ আ ই ঙ উ উ ঞ এ ঐ ও ঔ</p> <p>বুঢ়ী আইৰ সাধু</p> <p>কেগে উদঙাইছে বিৰোধীৰ অনিয়ম উত্তৰ কাম্বৰৰ সম্বন্ধিত বিয়োগেদি বিট্টীয় কেলেকাৰিব প্ৰদৰ্শনে ক'লে সুখাম্বী পৰিচয় ✓ পৰিচয়ৰ ক'লে উল্লেখ নাই মোৰ নাম ✓ বি পি এলৰে মিহৰা অস্বাভৱ ক'ৰিব ✓ মটিক মিশ্ৰেৰে আৰুগৈছে শাস্তি আলোচনা ✓ এইমাত্ৰ চম্ভৱ মোৰ নাই পট্টীয় নামকিনশ্ৰীৰ প্ৰ-পত্ৰ</p> <p>গুৱাহাটী চিকিৎসা মহাবিদ্যালয়ত নতুন সংযোজন ছূপাৰ স্পেচিয়েল হাস্পাতালৰ আধাৰশিলা স্থাপন মুখ্যমন্ত্ৰীৰ</p>

Figure 4.37: Samples of Assamese letterforms

Table 4.2: Analysis of Assamese letterforms

Historical Assamese letterforms	Letterpress printing based Assamese letterforms	Digital Assamese letterforms
<ol style="list-style-type: none"> 1. Historical letterforms follow the calligraphic style of writing. 2. All three styles – <i>Bamuniya</i>, <i>Kaitheli</i>, and <i>Garhayan</i> have their form and pattern. 3. The “Matra” or the median line continues without break from word to word. 4. Conjunct letter formations, size, and form have variations depend on characters involved from word to word. 5. An extended stretch has been noticed in most of the characters at the bottom or end which goes beyond the descender line due to the writing technique applied. 	<ol style="list-style-type: none"> 1. All the individual characters including vowel signs have been composed as an independent glyph. 2. The positioning of characters in letterpress printing always had issues. 3. The composition of conjunct letters does not properly represent the true form. 4. The “matra” or median line do not match in consecutive letters due to technical errors. 5. Letterforms were originally inspired by Bengali letterforms and writing styles. 	<ol style="list-style-type: none"> 1. Most of the technical errors have been rectified in digital form. 2. A bold and clear form of letter composition. 3. Most of the typeface designs got influenced by the Linotype Bengali letterform. 4. New typefaces used in digital devices also got influenced from Latin sans serif typeface with thin, clean and spacious in form. 5. No digital typefaces carry any design traces from historical Assamese letterforms.

4.4.1 Scanning and digitization of historical data

To extract the letter formation of historical writing styles, it was necessary to scan and digitize the collected historical data. To perform this process, the collected historical data have been chronologically arranged and analyzed initially before proceeding for digitization. Below is a detailed description of the digitization process.

Collecting historical resources

Table 4.3: Quantity of historical articles collected for digitization

Description of articles	Quantity explored
Rock inscriptions	12
Copperplate inscriptions	31
Xaansi bark manuscripts	23
Coins	8
Others	2

Images collected from Assam State Museum

An extensive number of images of various types of historical resources were taken from Assam State Museum to study and explore Assamese letterforms and their origination. Hi-quality photographs were taken for further digitization to analyze and extract information about scriptwriting style, shapes, forms, and compositions, etc. of on different types of mediums such as Xaansi bark, rock, copperplate, coins, terra-cotta, artilleries, and utensils. Shown below are some of the photographs of different types of historical articles.



Figure 4.38: Images of historical resources collected from Assam State Museum m

Images collected from various books published on Assamese script and history

A handful of books have been collected which were written on Assamese script and its history. A good amount of information has been gathered on Assamese script and history. Shown below are few important images of the application of Assamese script on various mediums extracted from those books.



Figure 4.39: Images collected from various books written on Assamese script history

Arranging resources chronologically

Table 4.4: Chronological arrangement of historical resources

Articles Period	Rock inscription	Copperplate inscription	Xaansi tree bark manuscript	Coins	Others
Early period (before 12 th century)	2	*	*	*	*
12 th to 16 th century (Era of Vaishnavism)	1	3	*	1	*
16 th to 18 th century (Influence of Ahom rules)	8	25	19	8	2
Early 19 th century (Pre- printing press era)	1	4	4	*	*

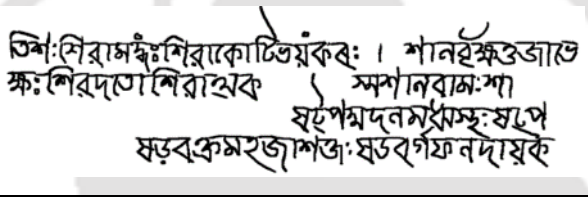
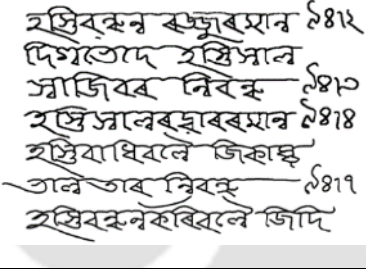
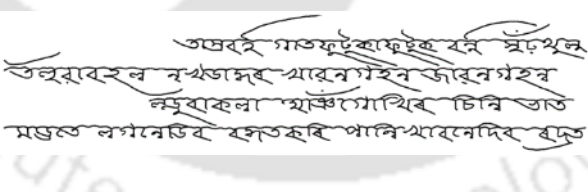
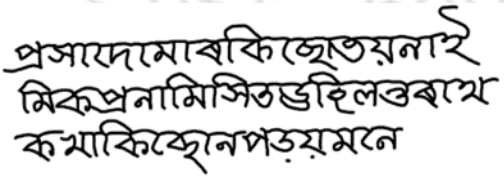
After taking the high-quality photographs and scanning images from books, the digitization process has been done by making a color correction, quality up-gradation, and noise reduction. Digitization makes the images suitable for further exploration for hi-quality tracing and image mapping to extract and evaluate letterform styles.

4.4.2 Digital tracing, observation, and analysis of historical data

After the chronological arrangement of historical data, the letterforms were then scanned and digitized for tracing the outlines.

4.4.2.1 Exploring writing styles: *Kaitheli* (Refer to Table 4.5)

Table 4.5: *Kaitheli* writing styles and their observations in different periods

Sl. no.	Period	<i>Kaitheli</i> style of writing (digitally traced from the image of the original article)	Observations
1	12 th to 16 th century (Era of Vaishnavism)		Words are written in continuous form without break.
2	16 th to 18 th century (Era of Ahom rules)		Emphasis on the calligraphic style of writing with a long stretch of characters beyond the baseline.
			Calligraphic style with decorative vowel signs and extended base in characters.
3	Early 19 th century (pre-printing press era)		Structured and formal handwritten style with compact vowel signs.

4.4.2.2 Exploring writing styles: *Bamuniya* (Refer to Table 4.6)

Table 4.6: *Bamuniya* writing styles and their observations in different periods

Sl. no.	Period	<i>Bamuniya</i> style of writing (digitally traced from the image of the original article)	Observations
1	12 th to 16 th century (Era of Vaishnava's)	মহাজ্যোয় যিঞ্জিত সন্দ্বীতিব অনু ষোড়জোনঘ শ্বেজিবহঙ্গী দ্বেদেবকন	Words have a clear identity. Presence of conjunct letters.
2	16 th to 18 th century (Era of Ahom rules)	কোসল্যাকপ্রনামিয়া সাৰমিৰমকডাকিলন্ত হিপৰিতদেগ্মিয়াবুলিলা মাগতশ্ৰুগালোবেচিৰবেঠানকৰি	Beautiful handwritten style. Vowel signs and conjunct forms are compact.
3	Early 19 th century (pre-printing press era)	বৰ্জনা গৃহিনিগ গোৰীচন্দ্র বক্ৰবক্ৰ মাৰ সৰুবা সাতকবিদি কয়নকৰিলে দণ্ডমাদ্ৰ ক প্রতিজা বামদাস। কলা। গ্নমৃতা। বাহৰ	Words are composed in straight lines. Character heights are regular.

4.4.2.3 Exploring writing styles: *Garhgayan* (Refer to Table 4.7)

Table 4.7: *Garhgayan* writing styles and their observations in different periods

Sl. no.	Period	<i>Garhgayan</i> style of writing (digitally traced from the image of the original article)	Observations
1	12 th to 16 th century (Era of Vaishnavism)	বোখাখুধপতম্লেধ কবায় ডত্ৰকোঞ্জি পত্তিমানৈবন্ধিদে	Each character appears in an individual form in a word.
2	16 th to 18 th century (Era of Ahom rules)	পৰমপ্রচণ্ডপ্রতা পতপনদলিতপ্রবলবিপ্ৰপটলন্তিহি সাগৰগুহীৰধীৰসকললোকমনোৰ্থপ্রবণকল্ম ণীৰদিন্দ্র স্তম্ভবকীত্তিকবৰ্ণীৰ্ণীস্বদ্বাৰায়	Well structured. An extended stretch of characters beyond the baseline.
3	Early 19 th century (pre-printing press era)	কামৰূপ দেসব বক্ৰবক্ৰবক্ৰায় হ উঁচৌযা দৰ মকৰিয়া সকলোসাব্বানেজনিব শ্রায়তপ্রগিপব বৰ্জনা গৃহিনিগ গোৰীচন্দ্র বক্ৰবক্ৰ	Follows a continuous line without a gap between words.

4.4.2.4 Comparing styles and patterns (Refer to Table 4.8)

Table 4.8: Classification table based on various characteristics

Styles	Form Regularity	Calligraphic Elements	Decorative Elements	Readability	Creative pattern
Kaitheli	Average	Good	Average to good	Average to good	Good
Bamuniya	Average	Good	Average	Average	Average
Garhayan	Best	Good	Average to good	Best	Average to good

4.4.2.5 Discussion on comparing styles

The comparison showed in Table 4.8 describes an overall observation on three different writing styles *Kaitheli*, *Bamuniya* and *Garhayan*. The comparison factors such as *Form Regularity*, *Calligraphic Elements*, *Decorative Elements*, *Readability*, and *Creative Pattern* have been decided based on the observation comments written in the exploration section of each writing styles. These comparison factors may help in observing a writing style of different periods with that of other writing styles. There are no prior reference to this comparing styles as no such document was found where historical script writing styles have been analysed from design or style point of view. Therefore, a tentative comparing style was adopted in a very simplistic form where instead of giving a distinct value a tentative opinion could be shown. Other alternative criteria that may be adopted is a value based analysis system where the factors considered may be evaluated by giving numerical value. But giving a numerical value may be difficult for these writing styles as they evolved in different time periods and numerical value may not able to justify the true essence of the writing styles.

4.4.3 Interpretation and analysis

To understand the forms, shapes, and styles of three types of writing historical writing styles, similar recreation has been tried out digitally to check the feasibility, applicability, and usefulness of the script styles. Based on the above observations, a set of characters including vowels and consonants were tried out by freehand digital letter writing styles. Below is a sample of letterforms based on Garhayan style (refer to figure 4.40).



Figure 4.40: Hand-drawn new characters for Assamese script based on *Garhgayan* style

The writing style has been tried to follow the historical Garhgayan style but with a slight modification to fit for screen visibility and appeal. From the experiment, it has been understood that recreating a historical writing style if approached with the right methodology could provide a progressive result for further research and adaptability to create a new typeface.

4.5 Observational outcome

After the exploration for uniqueness, a collective observation has been compiled to set the unique attributes and properties present in each character. Below are few key findings:

- The bottom area of many characters has extended bottom going beyond baseline due to its writing technique followed during that time.
- The vowel signs are written in a slightly longer, compressed, and calligraphic style.
- Conjunct letterforms are compact, yet well-composed. But they do not follow standard formation style and vary from writer to writer and writing mediums such as Copperplate, Rock, or *Xaansi* tree bark.
- The height to width ratio of many characters does not follow uniform size and form.

Based on the observations a hypothetical anatomical structure for the letterforms has been conceptualized to set up the character formation guideline. The guidelines of the anatomical structure have been taken based on the English alphabet system accepted universally.

Shown below (refer to figure 4.41) are images of three historical writing styles laid on the anatomical structure.

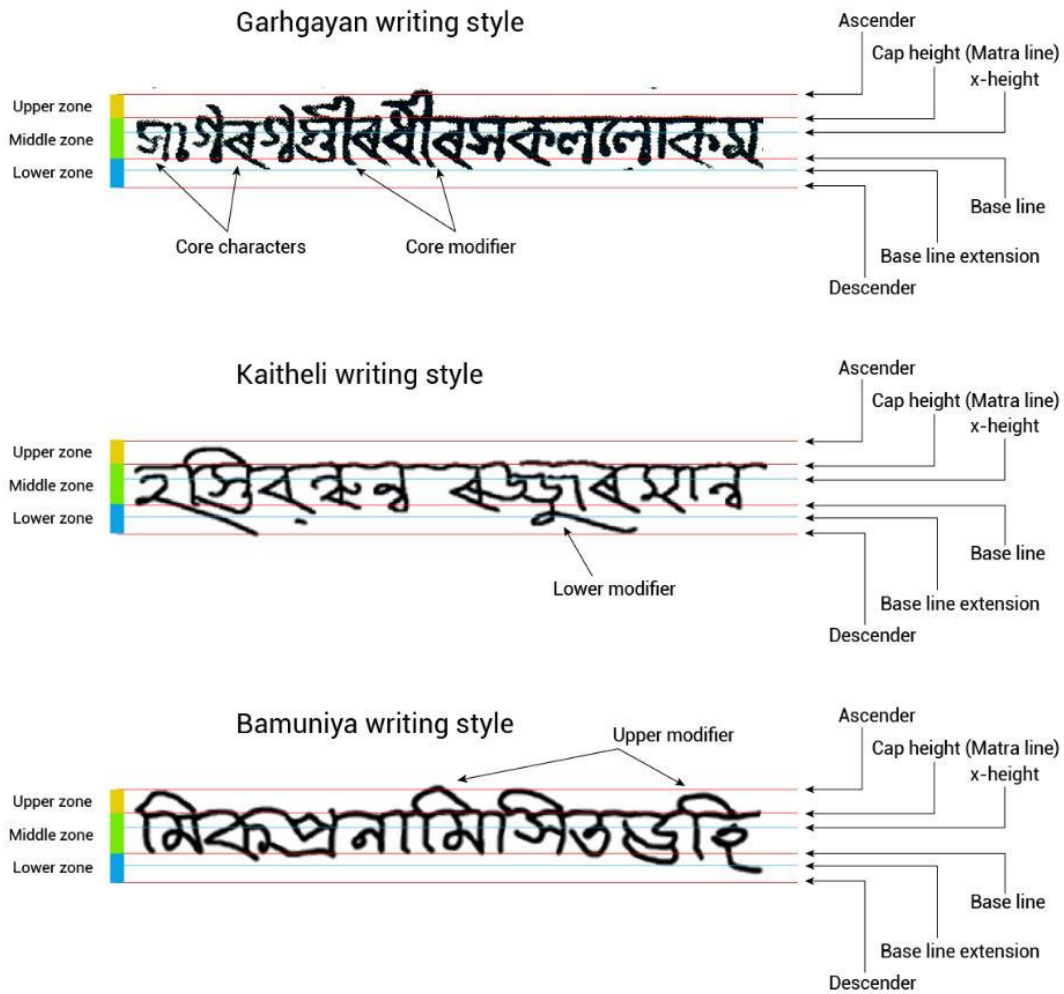


Figure 4.41: Anatomical structure of historical Assamese writing styles

4.6 Conclusion

From the analysis and interpretation of historical Assamese script, it has been observed that the letterform changed in its style, form, and identity over the centuries while progression. The letter writing and crafting style gradually progressed from a raw version to a highly defined and stylishly presented form. All the writing styles, be it Kaitheli or Bamuniya or Garhgayan, were written by skilled people and made a permanent mark in the history of Assamese letter writing.

Among all the three writing styles, *Kaitheli* was the popular one due to its mass acceptability. But *Garhgayan* was the most methodical and well-crafted due to its royal metropolitan essence and skilled craftsmanship.





CHAPTER 5

DESIGN EXPLORATION



Chapter 5: Design exploration

5.1 Experimenting with Assamese letterform design

After the observation and analysis of historical Assamese letterforms, exploration has been conducted with an experiment to produce a device applicable font for testing. *Garhayan* letterform has been considered for initial exploration due to its characteristics of simple form, methodical structure, and clear readability. A hand-illustrated draft character set (refer to figure 5.1) was drawn and converted into a test font for checking the applicability on screen. An online free application software provided by the website *Calligraphr.com* was used to quickly develop the test font (Calligraphr, 2018).



Figure 5.1: Draft letterform design in *Garhayan* style in a *Calligraphr.com* font template

5.2 Comparison and analysis with modern letterform

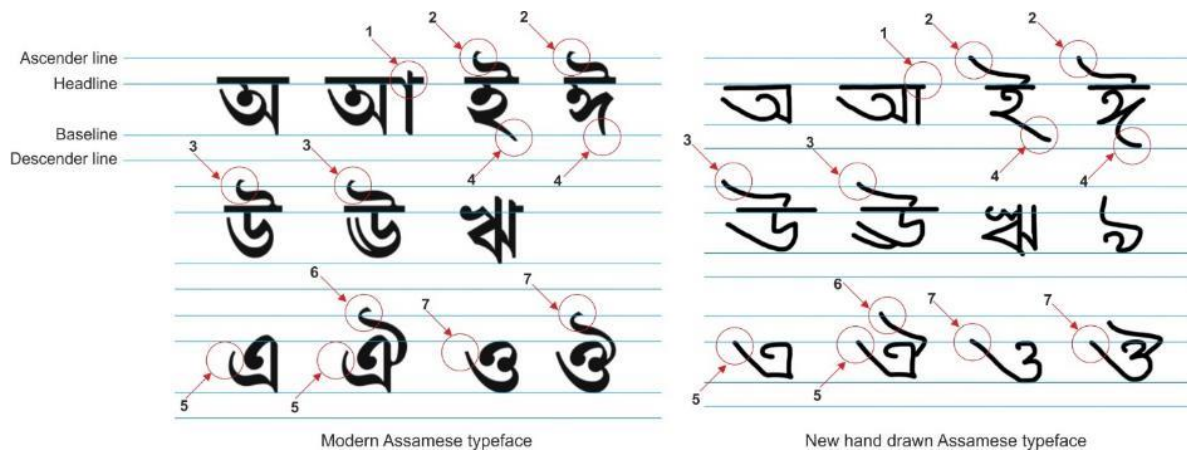


Figure 5.2: Comparison of draft *Garhgayan* letterform with modern Assamese letterform

The above figure 5.2 shows the comparison of modern Assamese typeface and new hand-drawn Assamese typeface (vowels only). Pointers marked over the characters on both sides show illustrative differences of modern Assamese typeface and the new proposed typeface. Below is the table showing the explanations.

Table 5.1: Comparison with the modern typeface.

Sl No.	Modern Assamese typeface	New hand-drawn Assamese typeface
1	Vowel sign for letter “AA” (আ) has a distinct junction point at the Headline	Here the junction is removed to match with the original script
2	The ascender part of the letter “E” (ই) and “EE” (ঐ) are curvy and short. Goes slightly above the Ascender line.	The ascender parts are kept longer in the form to maintain the illustrious style.
3	The ascender part of the letter “U” (উ) and “UU” (ঊ) are similar to “E” (ই).	A similar style followed as in letter “E”
4	The bottom part of the letter “E” (ই) extends a little lower than the baseline.	The bottom part goes beyond the baseline to the near descender line to follow a calligraphic style of the character.
5	For the letter “EE” (ঐ) the bottom extension reaches only to baseline.	Here the bottom extension goes beyond the baseline to touch the descender line.
6	For letters “EA” (এ) and “EAI” (ঐ), the bottom stroke is curvy and compressed.	The new design has a longer extension touching the headline.
7	In the letter “EAI” (ঐ) the top ascender part is curvy and goes little beyond the ascender line.	Here the ascender part is a straight stroke and touching the ascender line.
8	In the letters “O” (ও) and “OU” (ঔ) the ending finishes in the middle of the character height. The ascender matra of “OU” (ঔ) goes till the ascender line.	Here the ending for both “O” (ও) and “OU” (ঔ) touches the headline and ascender matra is a longer stroke and finishes before the headline.

5.3 Exploring variations in letterforms

Two variations of the letterform have been then experimented with based on *Bamuniya* and *Kaitheli* style. They were designed to check the difference in the application of the font series while being used on screen. Below is the sample letterform prepared based on *Bamuniya's* style of writing (refer to figure 5.3).



Figure 5.3: Draft letterform design in *Bamuniya* style in a *Calligraphr.com* font template

Below is the sample letterform based on *Kaitheli's* style of writing (refer to figure 5.4).



Figure 5.4: Draft letterform design in *Kaitheli* style in a Calligraphr.com font template

5.3.1 Comparison

Here are the final concept letterforms based on historical writing styles.

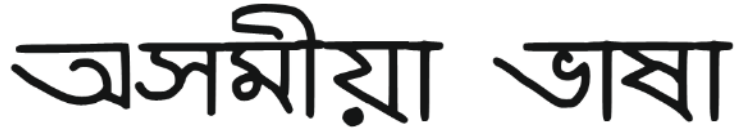


Figure 5.5: Letterform based on *Garhgayan* style



Figure 5.6: Letterform based on *Bamuniya* style

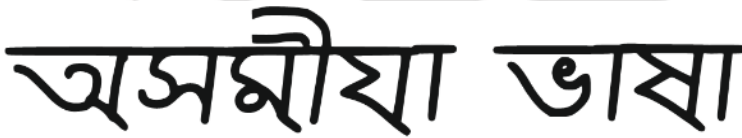


Figure 5.7: Letterform based on *Kaithehi* style

Due to some screen rendering issues of the online software for the Assamese script, the characters of the Assamese script could not be displayed properly. But for a basic visualization of the letterforms, the design exploration could provide enough information.

5.4 Exploring conjunct letter formation

Conjunct letters are formed by joining a vowel and a consonant together or a vowel and two consonants in combination to shorten the length of a word. Many conjunct letters after formation appear as if they have been overlapped. In few cases, the size proportion of 2 letters or 3 letters in conjunct formation are complicated, and looks like some error happened. Glyph sizes for conjunct letters do not have any proper explanation in traditional print letterforms. Appropriate anatomical structures of the Assamese script are not available anywhere, so whatever explanation available for Bengali letters has also been followed by Assamese as well. In historical manuscripts, the conjunct letters were handwritten by different people. Hence for a particular conjunct letter/letters, they may not be found identical in style in different historical manuscripts.

Below are a few of the conjunct letter examples (refer to figure 5.8).

ক ক্ক ঙ্গ ঙ্গ্গ ক্ক ক্ক ক্ক ক্ক ক্ক ক্ক ক্ক
ক্ষ ক্ষ ক্ষ ক্ষ ক্ষ ক্ষ ক্ষ ক্ষ
খ খ্য খ
গ গগ গ্গ গ্গ গ্গ গ্গ গ্গ গ্গ গ্গ গ্গ
ঘ ঘ ঘ ঘ
ঙ ঙ্গ ঙ্গ্গ ঙ্গ্গ ঙ্গ্গ ঙ্গ্গ ঙ্গ্গ ঙ্গ্গ ঙ্গ্গ

Figure 5.8: Assamese conjunct letter samples

In the conventional font types for printing technology, conjunct letters have been composed with broken or half or parts of the letters which took part in conjunct formation. So those broken parts used to be designed separately. Below are samples of the breaking of conjunct letter parts (refer to figure 5.9).

ঁ ঙ্গ ঙ্গ্গ ঙ্গ্গ ঙ্গ্গ
টৈ ঠ ঠৈ ঠৈ ঠৈ
ত ল প হ ন ঙ্গ ঙ্গ
ফ ব ক ভ ষ ঞ

Figure 5.9: Part or half letters for the conjunct formation

Due to the part composition of conjunct letters, the final letter formation may not render the desired form while display or print. This used to be a major problem while composing conjunct letters in many of the conventional font system available for printing.

5.4.1 Addressing conjunct letter issues

Experiment – 1. Looking for original references of the script from historical articles used before the printing era and find out the formation style.



Figure 5.10: Conjunct letter samples on Xaansi bark, rock, and copperplate in medieval times.

Key points observed:

- i. The letter formation in all three samples is similar. All the characters or letters follow a single horizontal line similar to Devanagari script called “matra”.
- ii. In the case of conjunct letters, the overall size of the formation goes a little below the other letters.
- iii. As the letters were handwritten or manually crafted hence they did not follow any specific size. So the same type of conjunct letters written in different articles looked different in size and proportion.
- iv. Hence it will be difficult to formulate any specific criteria from the historical references.

Experiment – 2. Exploring the possibilities of making a formulation to join different letters combined in the conjunct letter formation.

Formulation – 1: Taking reference from Monotype and Linotype foundry design for metal typesetting of Assamese and Bengali script.

In Monotype and Linotype technique, the conjunct letters were recomposed as single letters joined individually one after another rather than broken parts in combination. For example:

1. $\text{ব} + \text{ও} (\text{়}) = \text{ব্}$ used to be written in Monotype as “ব ্ব”. Hence there was no need of a separate conjunct letter formation for ব্ . It will just be “ব ্ব”. Example: আব্ could be আব্ব

2. Similarly, all the vowels could be designed in such a way that they can be used with any consonant independently. This will minimize the extra characters for conjunct formation in the character list.

NOTE: This exploration has already been tried by many font designers and developers. It minimizes the total characters in the character list of the script while forming conjunct with vowels. But while dealing with a consonant with another consonant this formulation could not proceed.

Formulation – 2: Creating a size proportion formula for letters combined in conjunct formation depending on the order of combination.

Case 1: Conjunct formation with two consonants only (refer to figure 5.11)

Figure 5.11: Example of size and proportion of conventional Assamese conjunct formation in printing

If we arranged the characters in such a way that the size of the first character will be $\frac{2}{3}$ of the second character as the second character is a primary member of the conjunct formation. The new formation could be shown as below (refer to figure 5.12):

Figure 5.12: Example of conjunct formation with a 2:3 ratio of participating letters

Comparison of size and proportion with a ratio of the conjunct letter is shown below (refer to figure 5.13).

Figure 5.13: Size distribution of participating letters

Case 2: Conjunct formation is with three consonants only (refer to figure 5.14).



Figure 5.14: Example of conjunct letters with three participating consonants

Here we can have a proportion ratio of 2/3 and 1/3 for the first and third characters keeping the middle one in full proportion. This means the middle character will be treated as the primary character. The new formation could be shown as below (refer to figure 5.15):

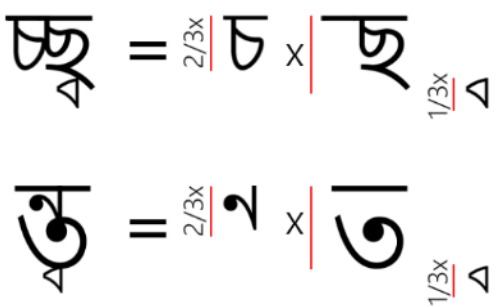


Figure 5.15: Three letter conjunct composition in 2/3 and 1/3 ratio

Conclusion: Though the formulation may work, the number of combinations of conjunct formation with varied ratios could be too large to fit into the character list of the script, which may lead to technical as well as application errors while creating the font programming.

Experiment – 3: Creating all possible conjunct letters individually to treat each conjunct formation as a single entity instead of joining half letters which have been a conventional practice.

Key factors:

- It has been mentioned in the previous researches that there are more than 300 conjunct formations available in Assamese script, out of which only around 150 conjunct letters are used which fulfills all the needs.
- As the digital format of typefaces is not restricted to the number of characters in the script character list, hence all the frequently used conjunct letters could be designed as a new character instead of joining broken part letters.
- This will solve the problem of character size mismatch in conjunct letter formation as well as produce an appropriate design of conjunct letters.

Shown below few independent characters for the conjunct letter list that could be applied in a new font (refer to figure 5.16).

ক	খ	গ	ঘ	ঙ	চ	ছ	জ
ট	ঠ	ড	ঢ	ণ	ত	থ	দ
ন	দ	ধ	দ	ব	ঝ	ব্য	ন
ক	খ	গ	ঘ	ঙ	চ	ছ	জ

Figure 5.16: A tentative character list of independent conjunct letters

5.5 Proposing a design direction

After an initial experiment with different writing styles that existed earlier in the medieval Assam, the writing style *Garhgayan* has been considered for the next level of exploration. This was because the *Garhgayan* style has been observed as simple, legible, and follow symmetry as well as methodical in the style of writing. Moreover, it used to portray royal metropolitan essence with historic Assamese culture. Following are the reasons for choosing the *Garhgayan* style for design exploration (refer to figure 5.17):

- *Garhgayan* style was created by the people appointed by Ahom rulers in writing chronicles, official documents, declarations, etc. for the Ahom dynasty. Those people used *Xaansi* tree bark to write chronicles, books, and documents. For official declarations and treaties, they used copper plates and rocks.
- This style was also applied to the artilleries of the royal army.
- Besides these, all types of coins issued by the *Ahom* dynasty found in medieval times have the presence of the *Garhgayan* style of scriptwriting.
- As this style contains the essence of royal metropolitan touch which used to portray Assamese culture during that period as well as having the characteristics of simplicity, legibility, and symmetry, hence it has been preferred for further exploration to design a new typeface with uniqueness and have a clear connection with the writing style.

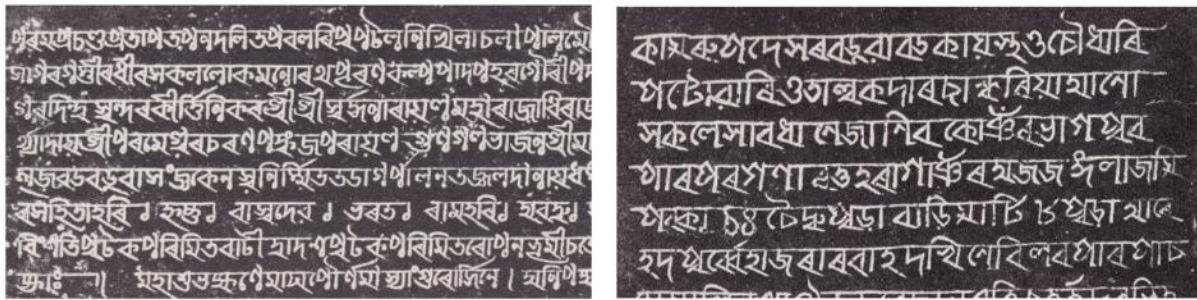


Figure 5.17: Copperplate inscription showing *Garhgyayan* writing styles of two different periods

5.6 Designing a concept typeface

As per considerations in the design direction, designing of concept typeface has been focused based on the medieval *Garhgyayan* writing style of Assamese script. Before designing, collected historical data has been analyzed for extracting unique elements that could establish an identity of the script while designing for modern-day digital use.

5.6.1 Scanning and digitization of historical resources

Samples of historical resources collected from many centuries were initially scanned and treated for digitization. Shown below are four samples from different centuries (refer to figure 5.18).



Figure 5.18: Copperplate inscriptions showing *Garhgyayan* writing style created between 16th to 19th centuries.

5.6.2 Analysis of writing styles

Writing styles of historical articles have been studied and analyzed by digitally tracing the letterforms so that the characteristics of each letter could be extracted to find out unique identities hidden in them (refer to figure 5.19, 5.20, and 5.21).

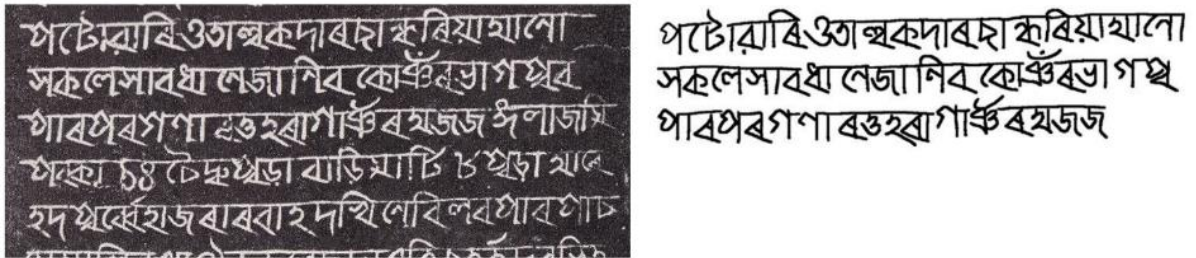


Figure 5.19: Digitally traced sample of 17th-century Garhgayan writing style

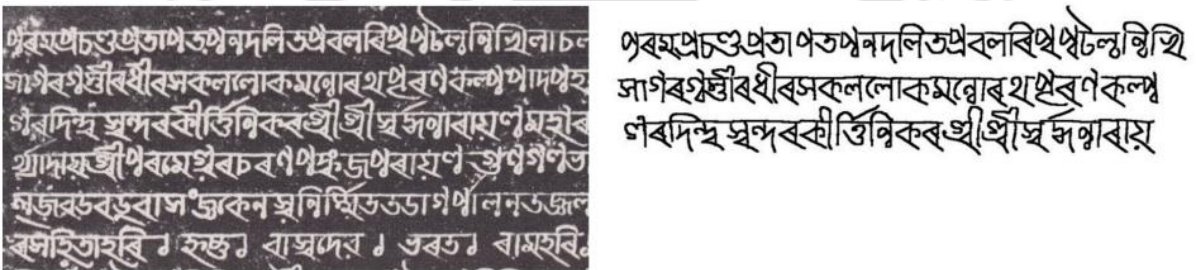


Figure 5.20: Digitally traced sample of 18th-century Garhgayan writing style

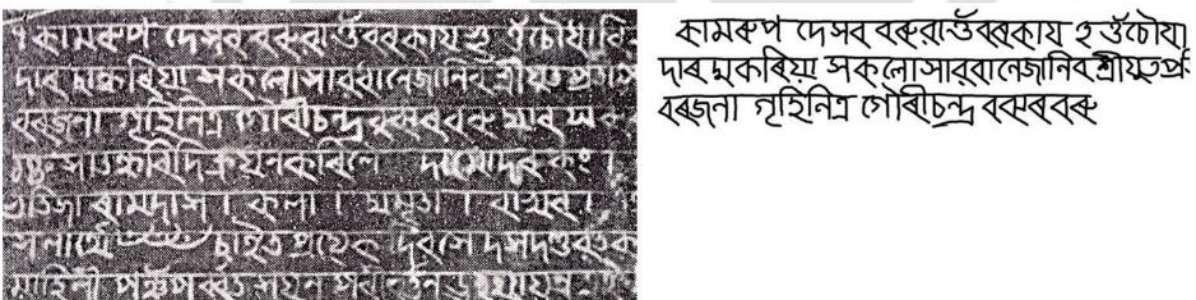


Figure 5.21: Digitally traced sample of 19th-century Garhgayan writing style

Above are the three historical writing styles of the 17th, 18th, and 19th centuries where letterforms were digitally traced and recreated to check the characteristics and specific identities hidden in them.

5.6.3 Finding unique characteristics

Based on the analysis of historical letterforms following observations have been noticed (refer to figure 5.22).

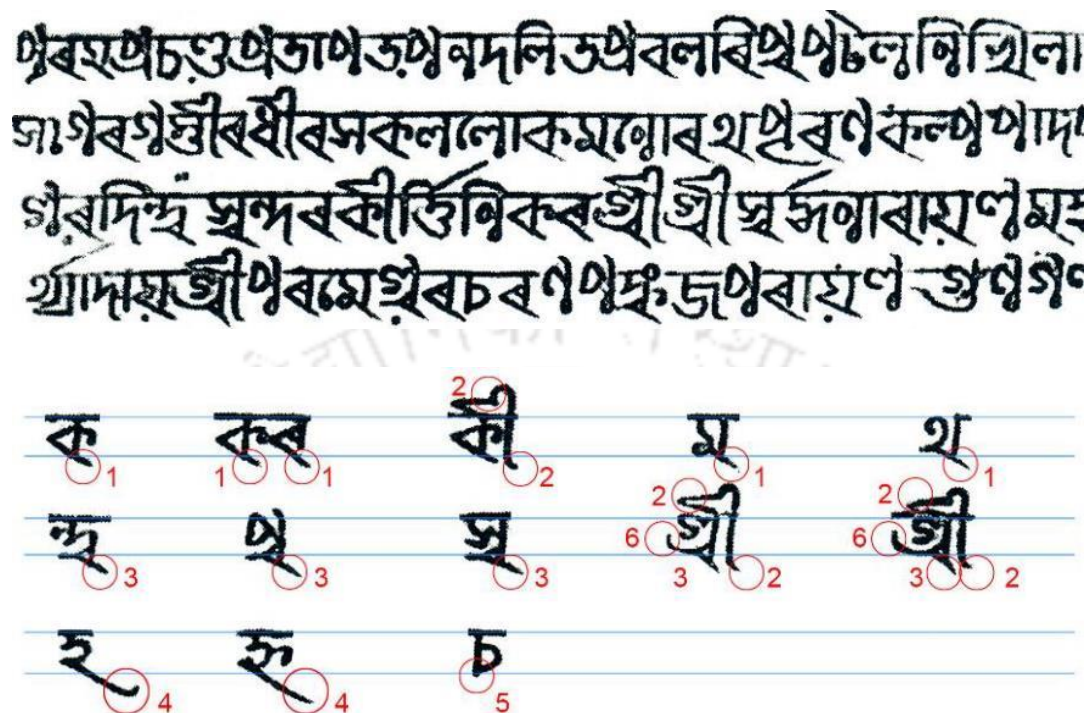


Figure 5.22: Observation of unique characteristics of Garhgan writing style of 18th century

Observation table: Below table 5.2 describing the uniqueness as marked in the above figure 5.22.

Table 5.2: Description of unique observation

Sl. No.	Unique characteristics observed	Marking	Period
1	Letters have a sharp and long stretch at the end where two strokes intersect.	1	Observed from the 17 th centuries onwards
2	The vowel diacritics have a decorative contour at the top and forms a tendril at the bottom.	2	Observed from the middle of 17 th centuries
3	In the formation of conjunct characters where bottom letters used to be “BA” (ब), “KA” (क), etc., ends with sharp and long stretch as in marking 1.	3	Observed from the middle of 17 th centuries
4	Letters “HA” (ह), “E” (ई), and “EE” (ई) used to have a stretched ending at the bottom.	4	Observed from the middle of 17 th centuries
5	Letters “CHA” (च), “CCHA” (छ) “TA” (ट) and “DHA” (ढ) develop a sharp angle at the bottom.	5	Observed from the middle of 17 th centuries
6	Letters “AI” (ऐ), “OI” (औ), and conjunct of “RA” (र) have a curvy flow at the end.	6	Observed from the middle of 17 th centuries

5.6.4 Conceptualizing a new Assamese typeface based on Garhgayan style of writing.



Figure 5.23: Handmade digital illustration sample of Assamese letterforms based on Garhgayan style.

Initially, based on the digitally traced historical letterforms of Garhgayan style, a digitally illustrated draft letterform (refer to fig. 5.23) have been tried out to check the letter style formation (also shown in the previous chapter). As the result was not satisfactory, hence again hand-drawn illustrations were tried on graph paper. This gave a fruitful result as the form exploration came out satisfactory. At the first step, a rough drawing of the letterforms has been drafted on graph paper for checking the shape, form, size, etc., and point out the unique features observed in the actual historical writing sample. Then refined illustrations of the letterforms were done using custom-designed graph sheets. Below are the illustration samples (refer to figure 5.24 and 5.25 (a), (b), (c)) explored.

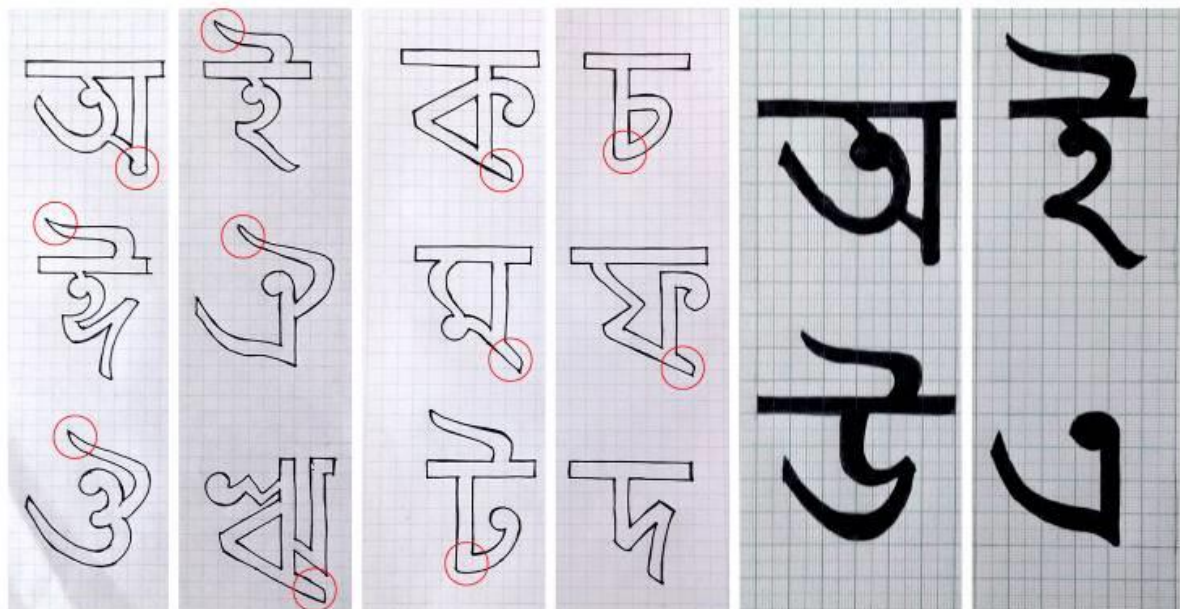
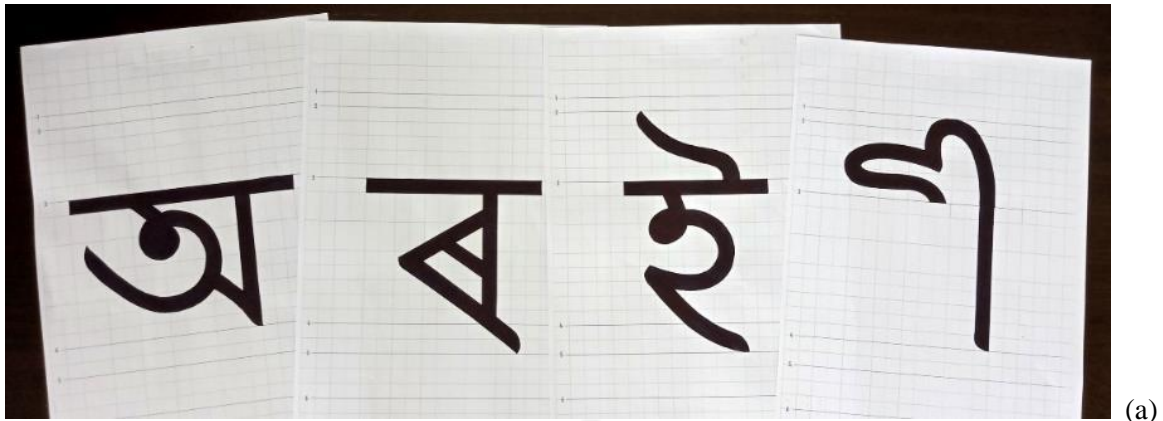
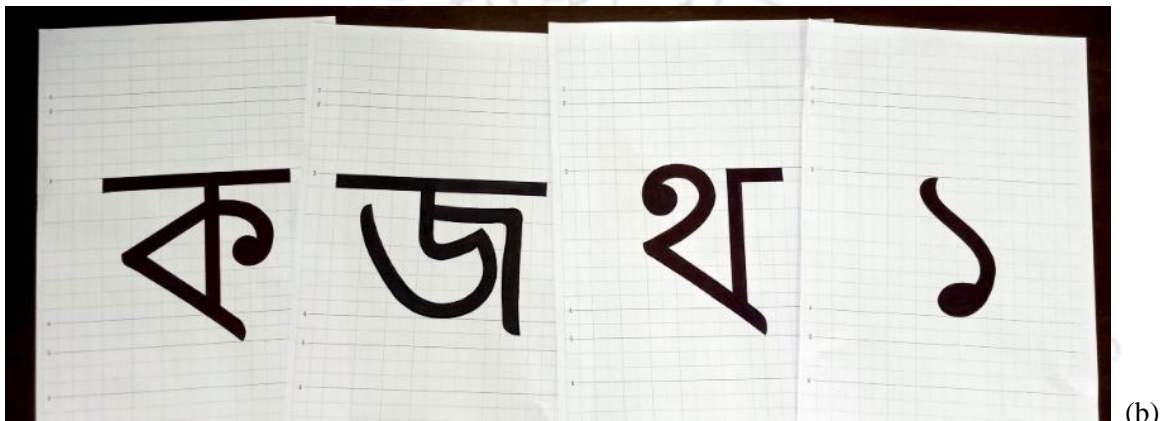


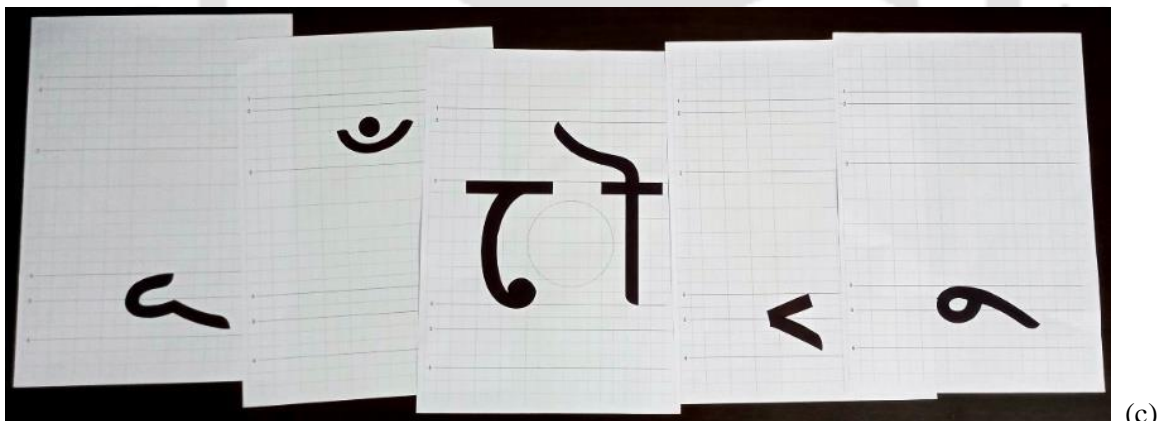
Figure 5.24: Handmade draft illustration of modified concept characters with distinct features marked.



(a)



(b)



(c)

Figure 5.25: Refined handmade illustrations of letterforms based on draft illustrations. Picture (a), (b), and (c) shows the refined characters of vowels, consonants, and vowel diacritics

5.7 Digitization of concept typeface

The final handmade illustration of the concept typeface has been then scanned and digitally traced using computer software for making the first set of the digital version. The initial version has been looked modern as well as conventional. Shown below in figure 5.26

the initial stage of the digitally traced version of a few of the consonants and vowels of the script.

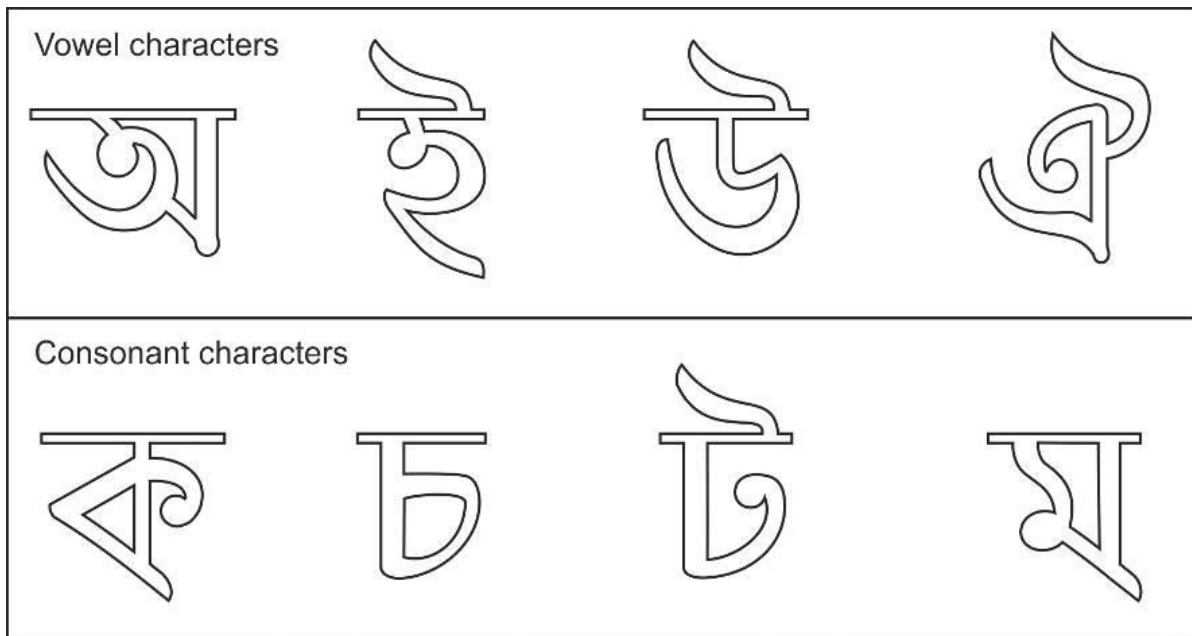


Figure 5.26: Digitized version of modified characters created from tracing

5.8 General user review

A random user review was conducted on the digitally traced characters (refer to figure 5.26). Below are the key factors summarized (refer to Table 5.3).

Table 5.3: User review of the initial level of digitally traced characters

Sl. No.	Key suggestions
1	Look wise the letters are interesting but the thickness of strokes is not uniform.
2	Letter styles may fit more into print documents because of their classic form.
3	Letters may be suitable on digital screens if the stroke thickness, spacing, etc. could be improved.
4	The extended edge created at the junction of two lines in some of the characters reminds of historical writing styles which have been appreciated.
5	Conjunct letter formation should be clearly defined instead of conventional form.

5.9 Modification of concept typeface

Based on the random user review and feedback, the concept typeface has been modified into a monolinear thickness. This was done to make the typeface highly visible, legible and readable on digital screens. The below example shows a few of the characters of consonants and vowels (refer to figure 5.27).

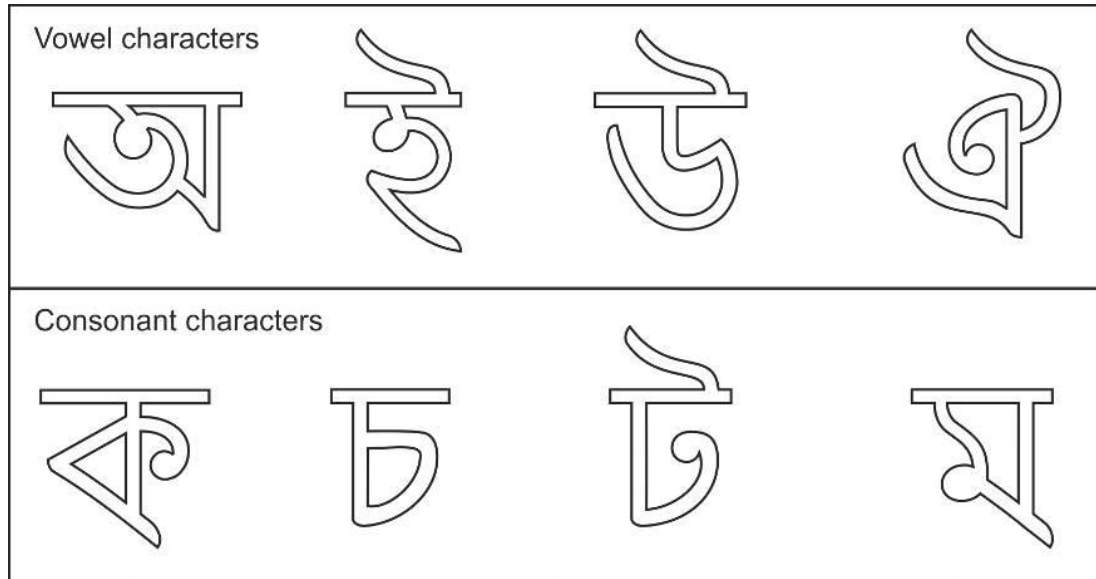


Figure 5.27: New character samples after modification considering the key suggestions

5.10 Converting concept typeface into final type design

After modification of the concept typeface into monolinear thickness, a brief review was conducted and suggestions were taken to proceed with the final type design. Initially, each character was placed on a graph sheet to standardize the size, shape, and form before digital illustration of the final design (refer to figure 5.28).

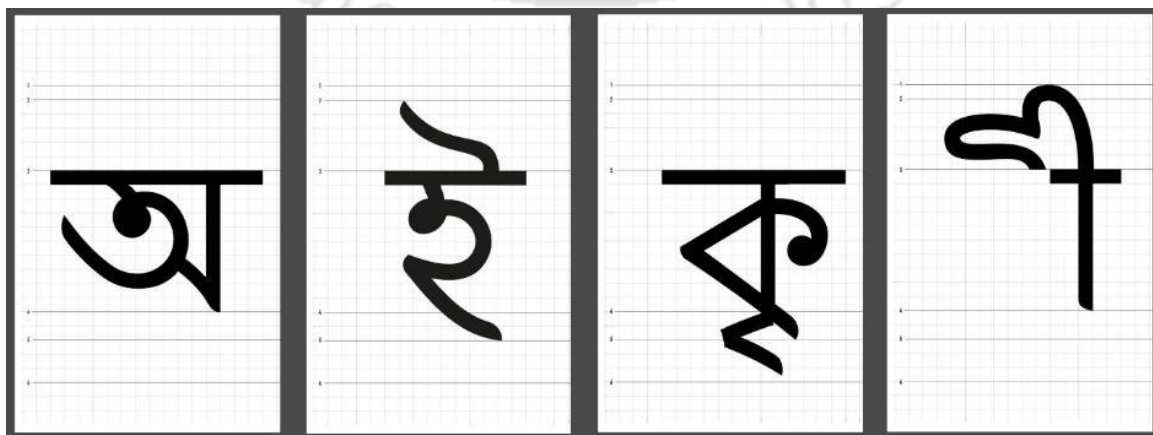


Figure 5.28: Standardising structures of the modified characters

After structural verification, the final set of new characters have been designed. Below is the layout of the final design with all the characters including vowels, vowel diacritics, consonants, number system, and symbols (refer to figure 5.29).

VOWELS & DIACRITICS													
অ	আ	ই	ঈ	উ	ঊ	ঋ	এ	ঐ	ও	ঔ			
	।	ি	ী	ু	ূ	্	ে	ৈ	ো	ৌ			
CONSONANTS AND EXTRAS													
ক	খ	গ	ঘ	ঙ	য	ৰ	ল	ৱ					
চ	ছ	জ	ঝ	ঞ	শ	স	ষ	হ					
ট	ঠ	ড	ঢ	ণ	ক্ষ	য়	ড়	ঢ়					
ত	থ	দ	ধ	ন	ৎ	ং	:	ং					
প	ফ	ব	ভ	ম	্	।	—	—					
NUMBERS													
০	১	২	৩	৪	৫	৬	৭	৮	৯				
SYMBOLS													
!	?	"	"	'	,	()	#	*	:	;	.	{ }	[]
-	-	/	\	<	>	=	×	÷	+	-			

Figure 5.29: Final version of new Assamese character set

Words composition, sentence composition, and short paragraph composition have been tested to check the basic legibility, readability, and composition for screen display (refer to figure 5.30 and 5.31).

নতুন অসমীয়া লিপি

Figure 5.30: Testing of letters, words, and sentence composition with new Assamese character set

নতুন অসমীয়া লিপি
 ॥ গড়গঞা ॥
 সুপ্ৰভাত
 আপোনালোক সকলোকে নতুন অসমীয়া
 লিপিলৈ আদৰ্শী জনাইছো। আশা কৰো
 আপোনালোকে লিখি আৰু পঢ়ি ভাল পাব।

Figure 5.31: Paragraph composition testing with new Assamese typeface character set

In this new character set, one of the important addition apart from other key characteristics is the Spacer or “Elongated matra”. The Spacer has two parts: (a) start-spacer, and (b) end-spacer. Spacers can be used as indenting of the first word and last word in a paragraph. This character used to be present in many medieval copperplate inscriptions.

(1) start-spacer	(2) end-spacer
—	—

Figure 5.32: Example and use of spacer characters

5.10.1 Testing the new typeface on digital devices

The new typeface has been tested with different types and sizes of text compositions to check the visibility and legibility issues on digital devices. The outcome observed has been promising and the new typeface could be the new choice if converted into an applicable font. Following are the screenshots of a mobile phone and a tablet displaying a text paragraph using the new typeface *Garhgayan Assamese* (refer to figure 5.33).

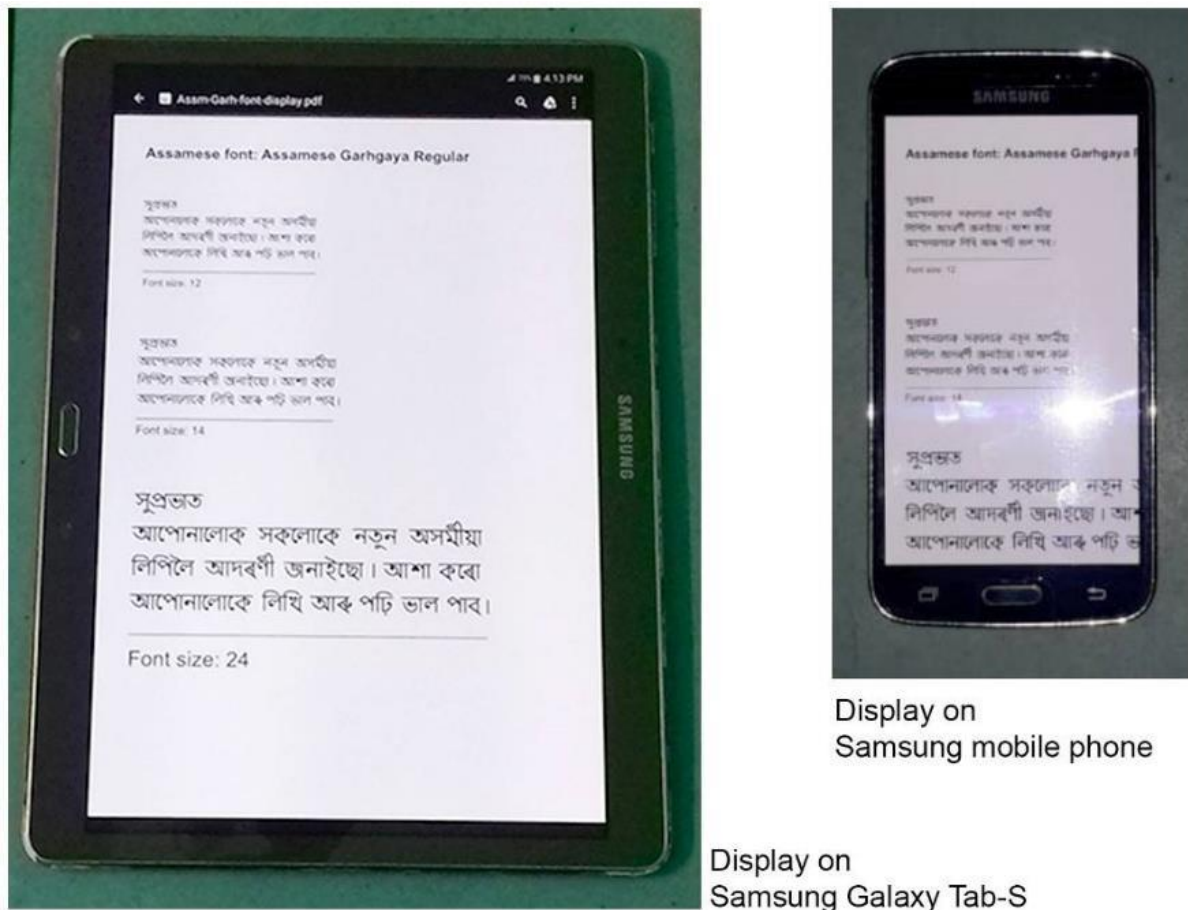


Figure 5.33: Screenshots of a tablet and a mobile phone with the new typeface on display

5.10.2 Designing of conjunct letters

In Assamese script, there are around 250 conjunct letters. But only around 150 conjunct letters have been in regular use. Therefore while designing the conjunct letters, the widely used ones have been initially considered for exploration. The conjunct letters have been composed as a single character unit instead of broken pieces as conventionally practiced. Below are a few newly designed conjunct letter examples (refer to figure 5.34 and 5.35).

ক + ব = ক্ৰ প + ব = প্ৰ
 গ + ব = গ্ৰ শ + ব = শ্ৰ
 ঘ + ব = ঘ্ৰ হ + ব = হ্ৰ

Figure 5.34: Designing of two-letter conjunct formation example – A Consonant with “Ra”.

ক + ক = ক্ক গ + ব + ধ = গ্ৰধ
 ক + ম = ক্ৰম দ + ব + ধ = দ্ৰধ
 ক + ট = ক্ৰট চ + ছ + ব = চ্ৰছ

Figure 5.35: Designing of two-letter and three-letter conjunct formation example of consonants

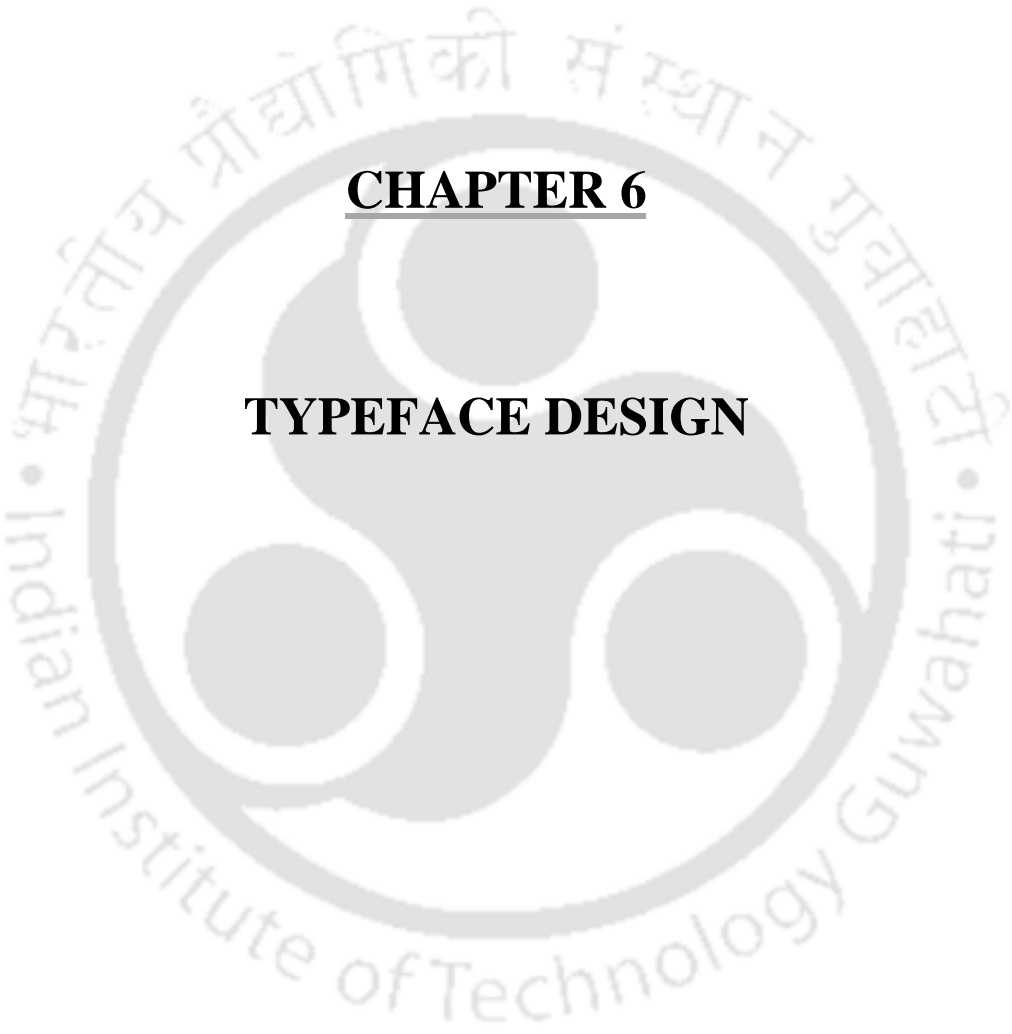
5.11 Observation and discussion

In this chapter, exploration, and analysis were done on historical Assamese letterforms to design a new Assamese typeface provided a very constructive outcome. The justification for choosing *Garhayan* writing style for further exploration of typeface design proves to be appropriate at this initial stage due to the unique characteristics that the style contains. The conceptual typeface that has been designed renders affirmative results which could be further experimented with for developing a full-scale device font applicable for all kinds of digital devices such as computers, mobile phones, tablets, websites, etc.

A user survey was conducted to validate the design and usability of this new typeface for further application. For this purpose, a set of research questionnaires has been presented (see Appendix – 1b) to the selective group of users invited for the survey. Based on the outcome of the research questionnaire, further directions for the next level of research experiments have been set up to achieve constructive results.

The next chapters will describe further experiments on the new typeface design.





CHAPTER 6

TYPEFACE DESIGN



Chapter 6: Typeface design

As the design exploration based on historical letterform Garhgayan proved to be effective and rendering an appealing look with appropriate legibility, readability, and symmetry, further analysis on the new character set needs to be experimented with. The following sections described the detailed explorations.

6.1 Technical consideration – Proposing anatomical structure

Anatomical structure in typography explains various types of strokes and their behavior of a letterform. In the explanation of the anatomical structure of the newly designed Garhgayan Assamese typeface, the primary reference for making the guidelines have been set up based on the Roman script which has been practiced as the international standard. Since there has been no evidence of structural composition or technical guidelines developed for Assamese script in history as well as modern printing era, hence hypothetical guidelines have been set up to understand the behavior of the strokes of the newly designed letterform. A detailed description has been presented as follows.

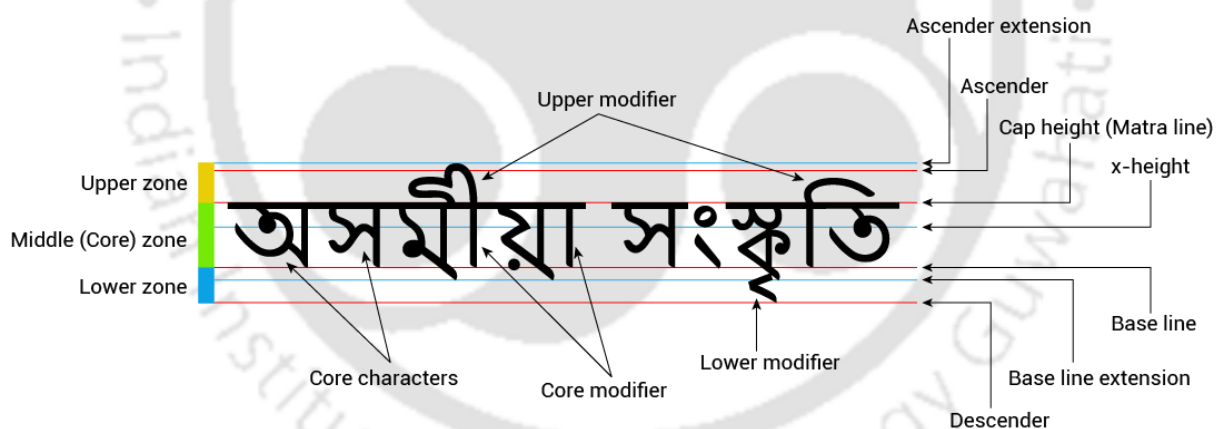


Figure 6.1: Description of Anatomical structure of *Garhgayan Assamese* typeface

The anatomical structure has been divided into three distinct zones namely:

1. Upper zone: Contains upper modifier characters.
2. Middle or Core zone: Contains core characters as well as core modifiers.
3. Lower zone: Contains lower modifier characters

The entire character structure has been fixed with specific guidelines laid out based on the Roman script with a little modification needed for this new typeface. The description of guidelines are as follows:

1. **Baseline:** It is the imaginary line where core characters rest. In figure 6.1 the baseline is the line where the bottom part of all the core characters touches.
2. **X-height:** It is the imaginary line that shows the height of lower case “x” in Roman script. Here it is taken at an approximately 2/3 height of a full core character. Technically it defines the junction point for vertical conjunct formation.
3. **Cap height (Matra line):** It is the imaginary line that defines the height of a core character from its baseline. This is the line where the matra of all core characters placed.
4. **Ascender:** It is the imaginary line that is placed above cap height or “matra line”. Almost all the upper modifiers are within the ascender line.
5. **Ascender extension:** It is the imaginary line taken above the ascender line. Few of the upper modifiers which cross the ascender line are fixed at the ascender extension line.
6. **Baseline extension:** It is the imaginary line taken below the baseline. Many of the core characters which have an extended edge beyond their end-joining point are fixed in this line. The extended edges will go till the baseline extension.
7. **Descender:** Descender is the last line below baseline extension. All lower modifier characters are placed within this line.

6.1.1 Scale and size reference

The scale factor for a character of a letterform is very important as it defines the size of a letter in comparison to other letters or characters of that typeface. The size of a letter or scale factor in the *Garhayan Assamese* typeface has been defined as follows (refer to figure 6.2).

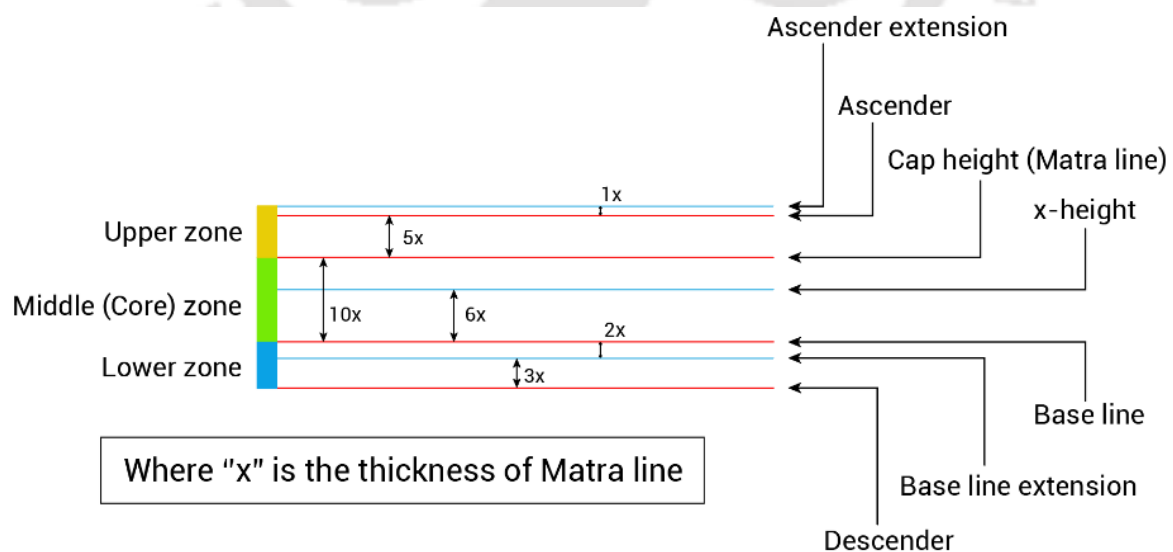


Figure 6.2: Scale and size reference of guideline for anatomical structure of *Garhayan Assamese*

To understand the size and scale factor, a detailed illustrative description has been shown below in figure 6.3.

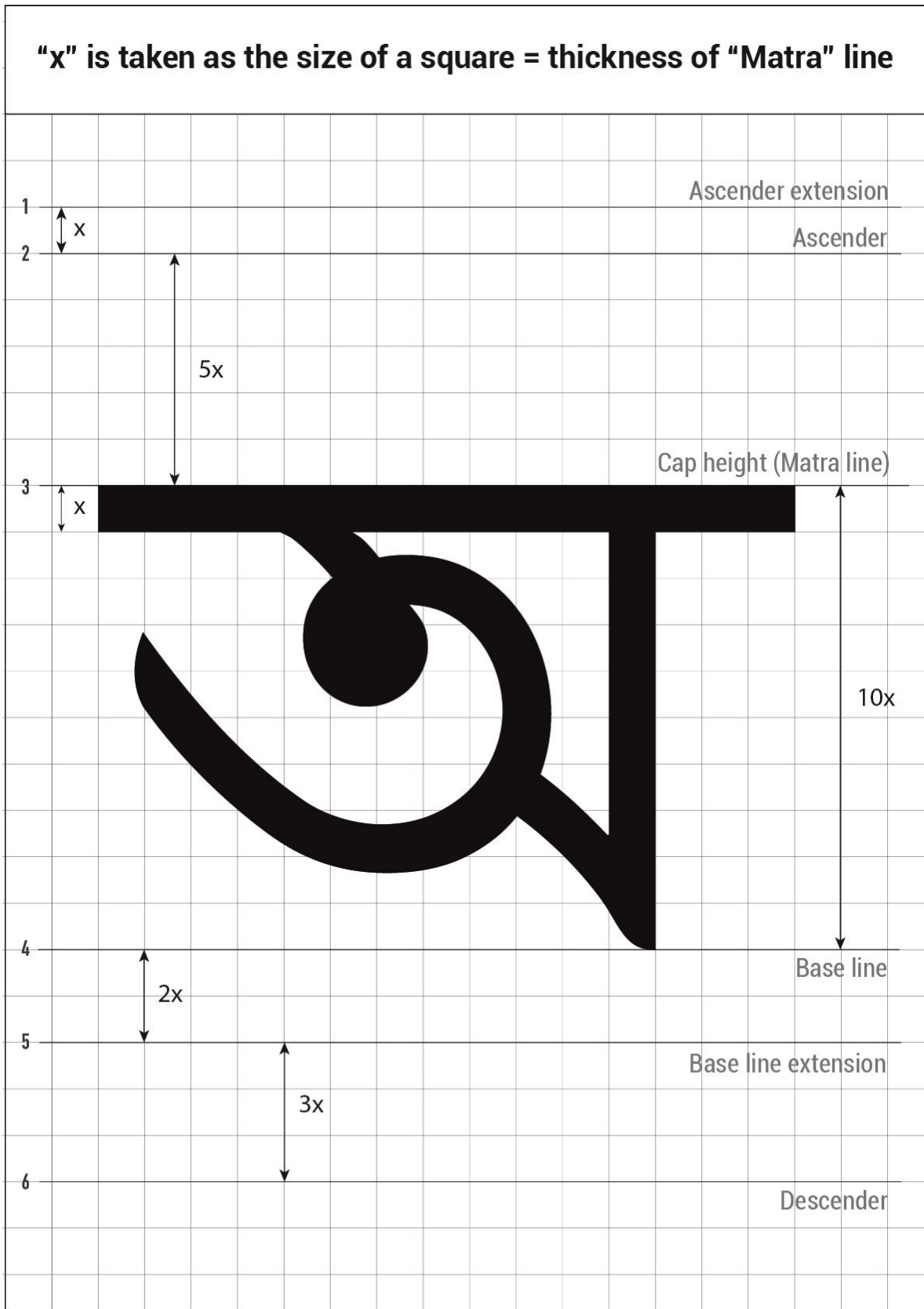


Figure 6.3: Description of scale factor and size reference of a character with guidelines.

6.2 Technical layout – Glyph layout and design composition (AI & Font Lab)

Based on the anatomical structure, a vector layout has been set up for the complete character set of the new typeface *Garhgayan Assamese* using Adobe Illustrator. Based on the layout setup, each character has been placed on the guideline and resized to exactly satisfy the condition of the anatomical structure proposed. The layout with guidelines, grids, and measurement system that contains a particular character consists of the various glyph. Initially, all the characters have been composed in Adobe Illustrator with specified guidelines and directions then exported to Font Lab Studio software for refinement and final production.

6.2.1 Character layout in Adobe Illustrator (AI)

Vector layout for all the characters including numbers and symbols has been composed in Adobe Illustrator with a scaling set-up based on anatomical structure. Lines, terminals, curve corrections, etc. have been modified based on the grid system and guidelines. Shown below are a few of the layout examples composed in Adobe Illustrator with solid filled illustration for output and outline illustration for verification (refer to figure 6.4, 6.5, 6.6, 6.7, 6.8, and 6.9)

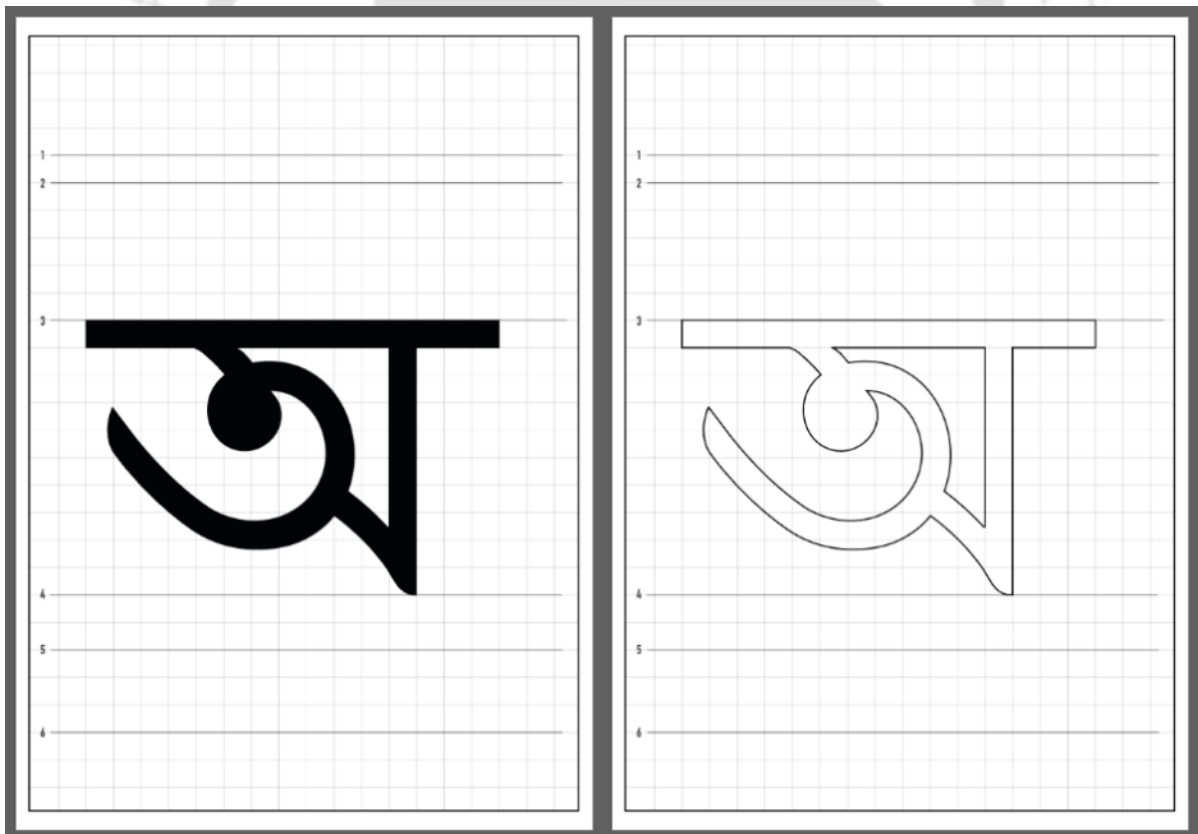


Figure 6.4: Vector layout in Adobe Illustrator for letter “A” with solid and outline illustration

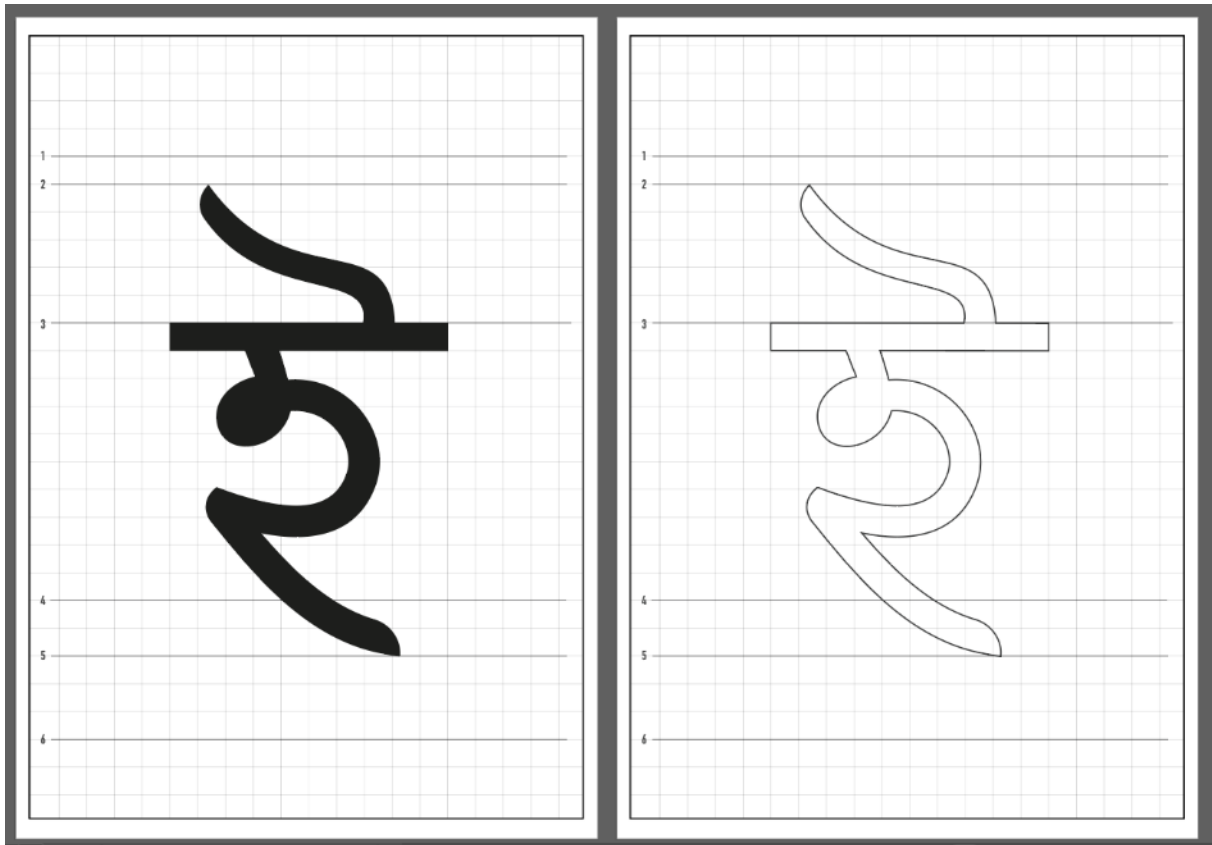


Figure 6.5: Vector layout in Adobe Illustrator for letter “Harsha Ie” with solid and outline illustration

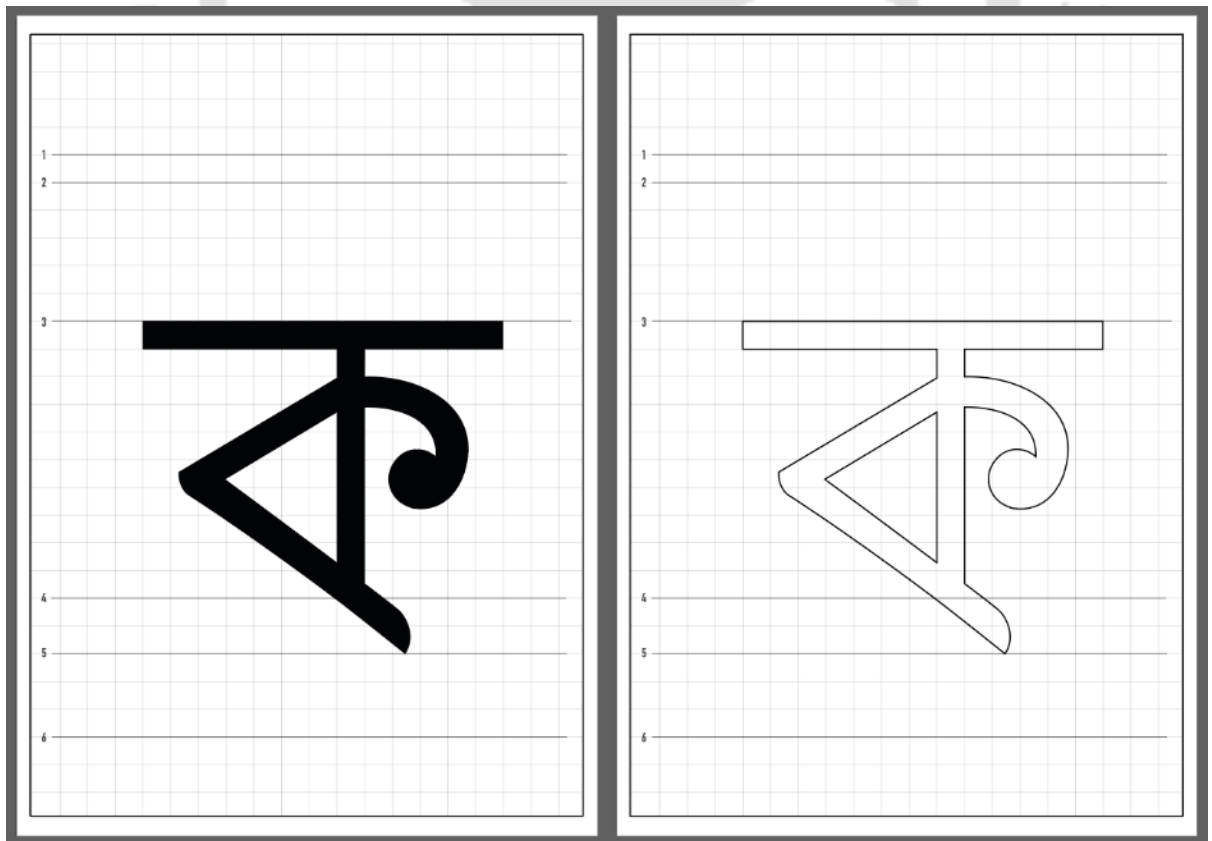


Figure 6.6: Vector layout in Adobe Illustrator for letter “Ka” with solid and outline illustration

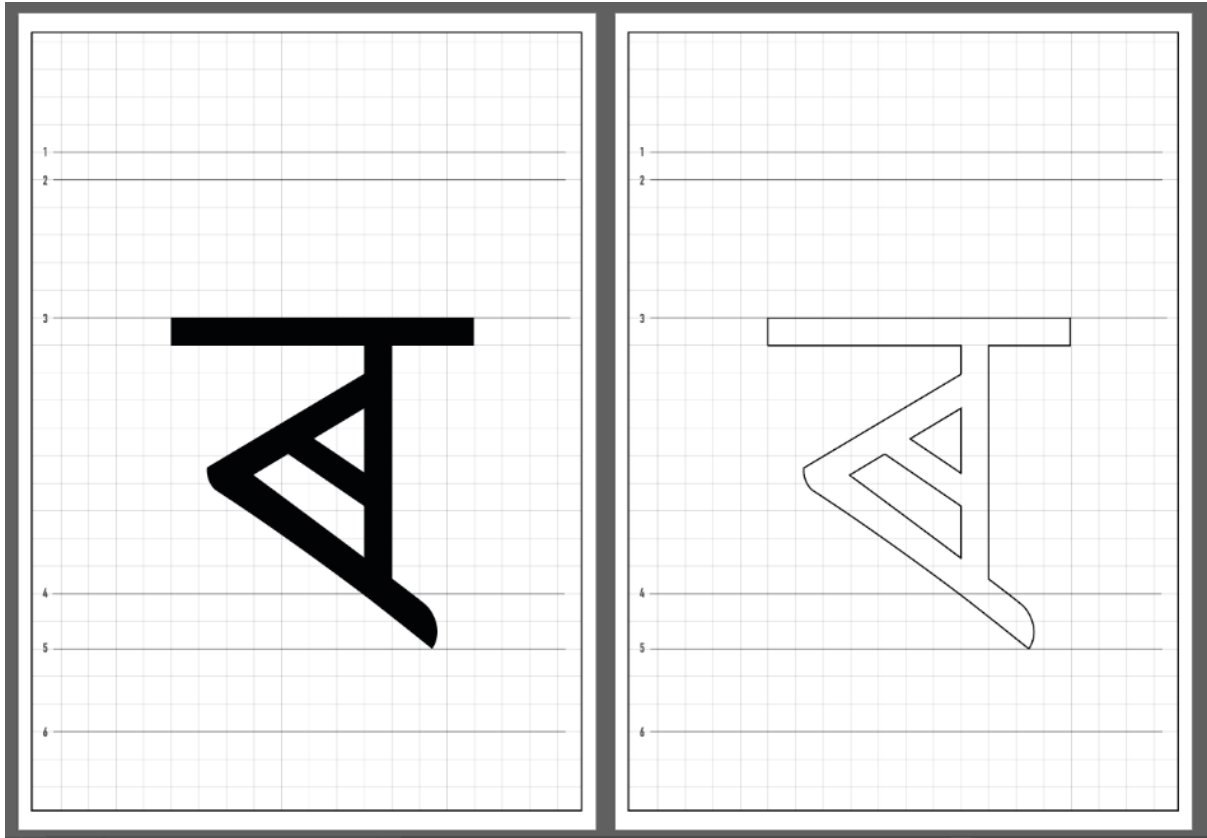


Figure 6.7: Vector layout in Adobe Illustrator for letter “Ra” with solid and outline illustration

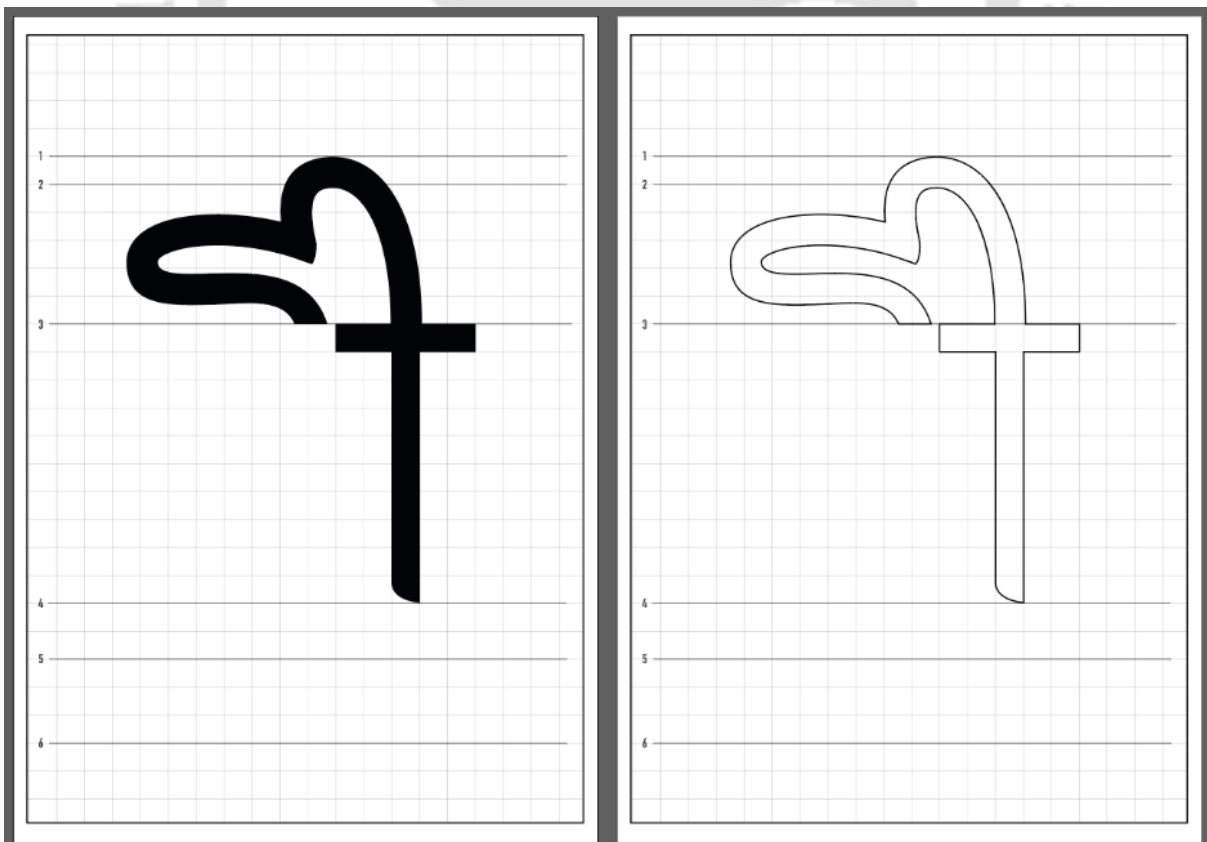


Figure 6.8: Vector layout in Adobe Illustrator for vowel symbol “Dirgho Ie”

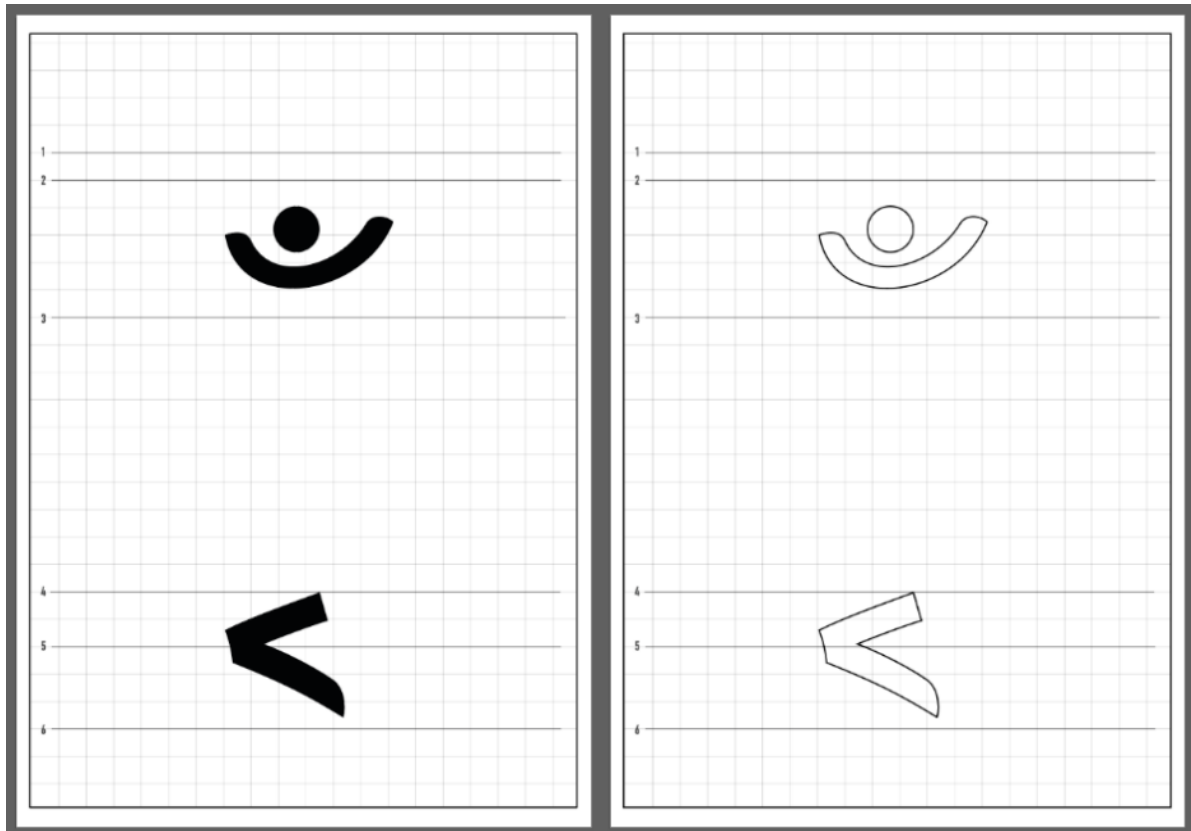


Figure 6.9: Vector layout in Adobe Illustrator for vowel symbol “Hri” and “Chandrabindu”

The full character layout composed in Adobe Illustrator has been shown in Appendix – 2 for reference.

6.2.2 Character layout in Font Lab Studio

Font Lab Studio software was tried for the design and development of typeface and variations with all kinds of technical feasibility and features that can enable a font applicable for any media be it print, digital, motion, and more. Hence Font Lab Studio has been chosen for further design, develop and produce a device applicable font for the new typeface *Garhayan Assamese*. The final vector illustrations created in Adobe Illustrator have been exported to Font Lab for further processing. In the Font Lab Studio, all characters of the new typeface have been processed as follows (Font Lab VI User Guide, 2019).

- Set up font dimension – Ascender, descender, line spacing, line gap, top and bottom space, etc.
- Leading, kerning, character and word spacing, etc.
- Vertex and curvature correction, line thickness correction, etc.
- Conjunct letter composition and set up.

Shown below are a few of the screenshots of the layout setup done in Font Lab Studio (version - 6).

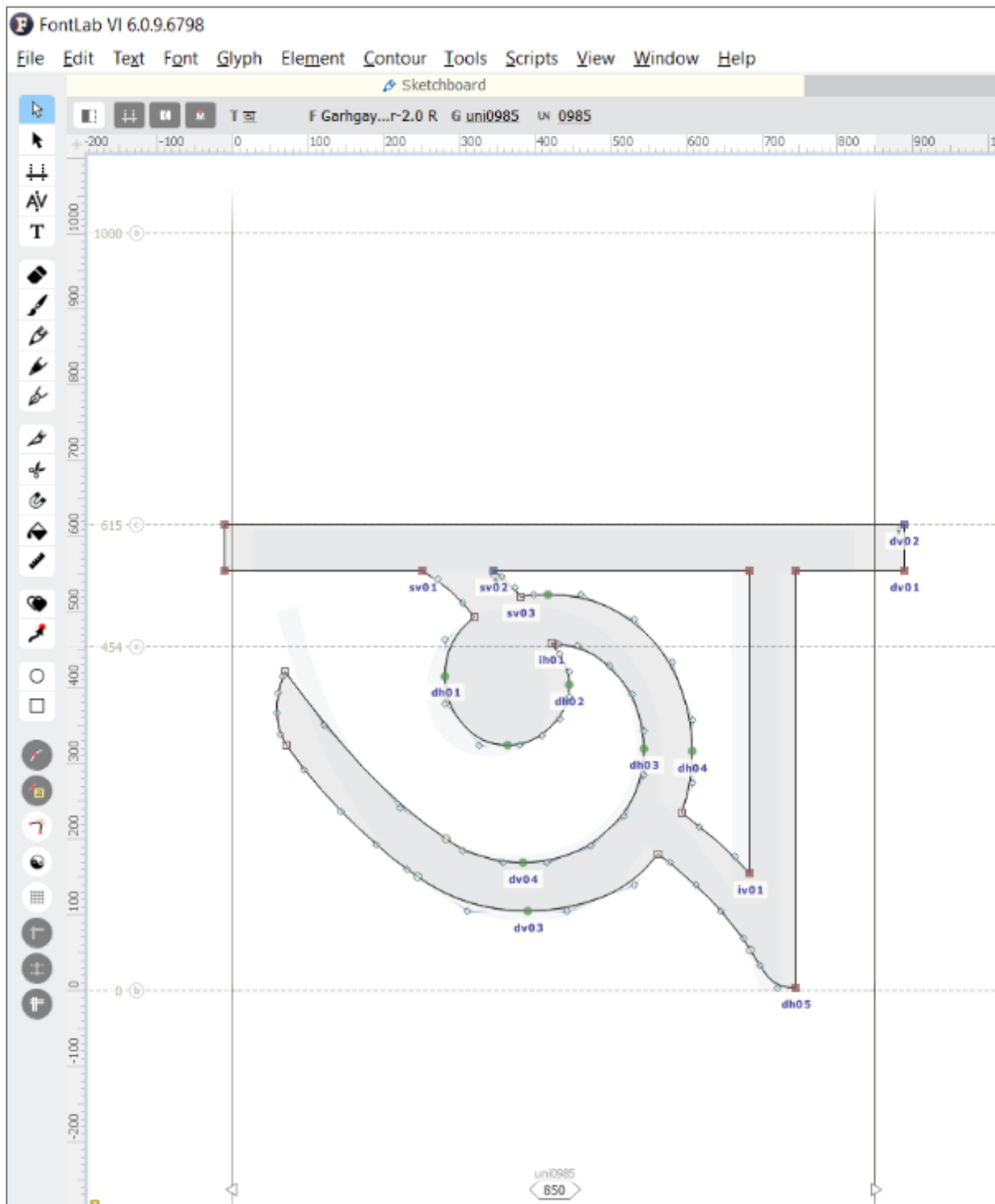


Figure 6.10: Technical layout of letter “A” in Font Lab Studio

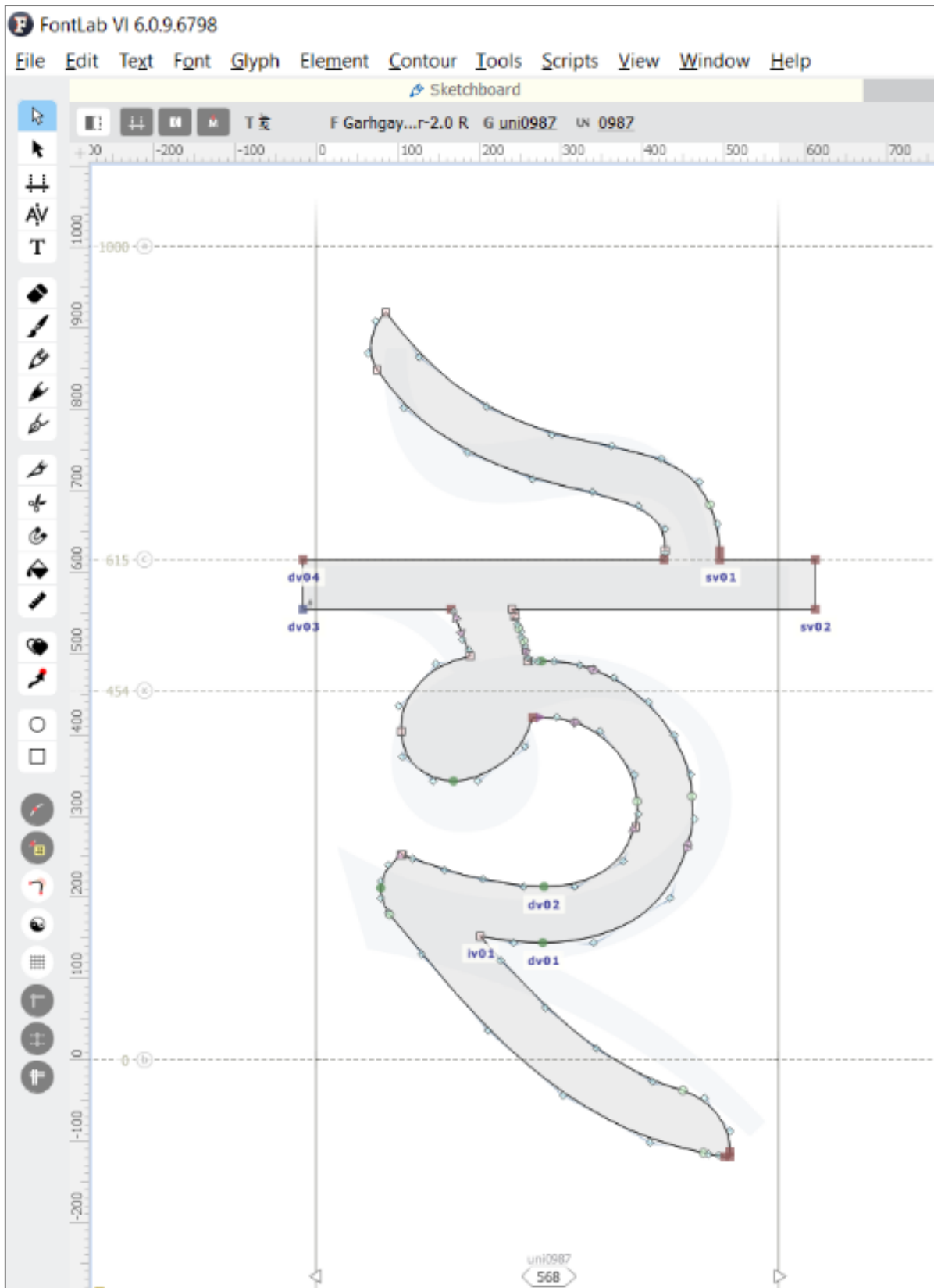


Figure 6.11: Technical layout of letter “Harsha Ie” in Font Lab Studio

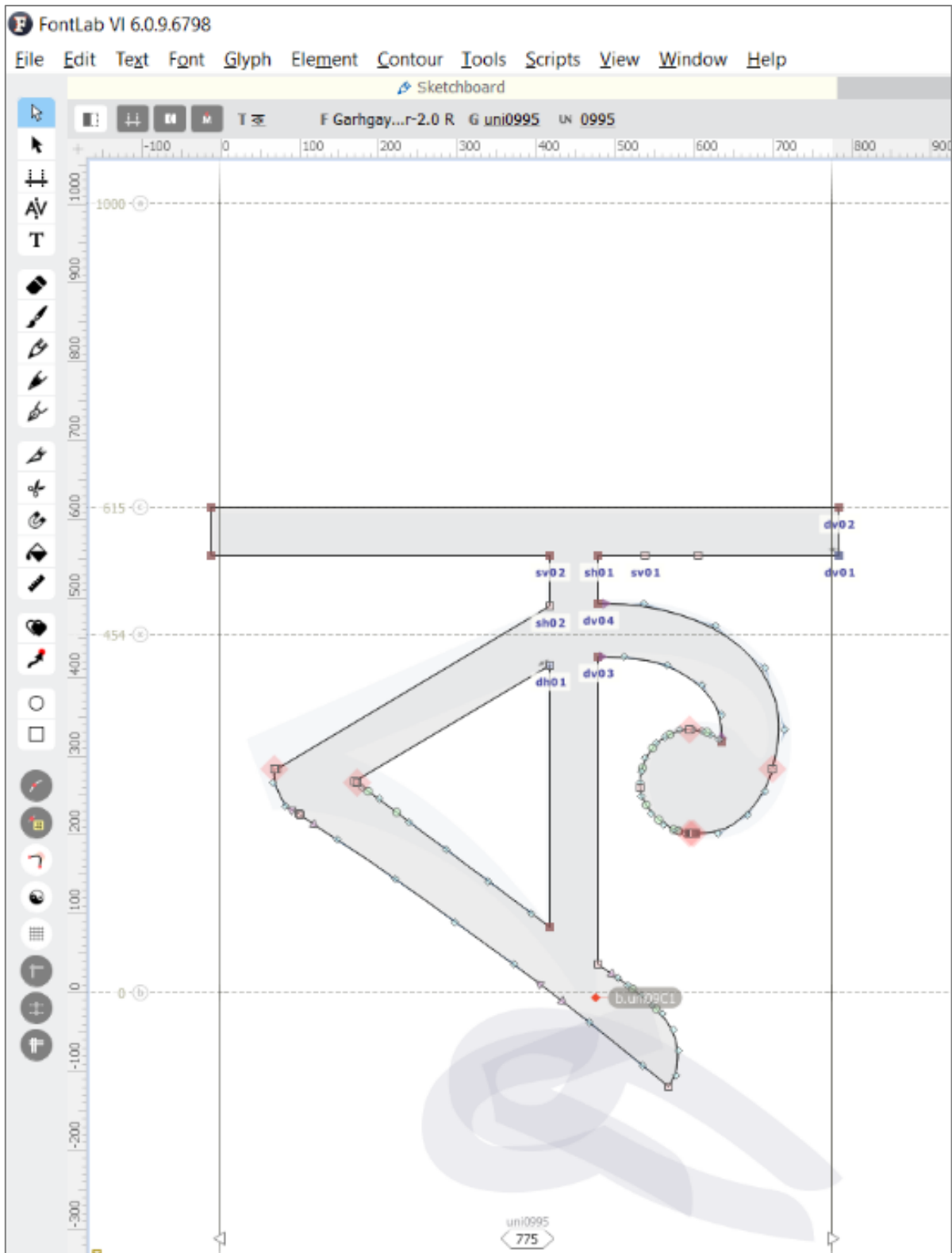


Figure 6.12: Technical layout of letter “Ka” in Font Lab Studio

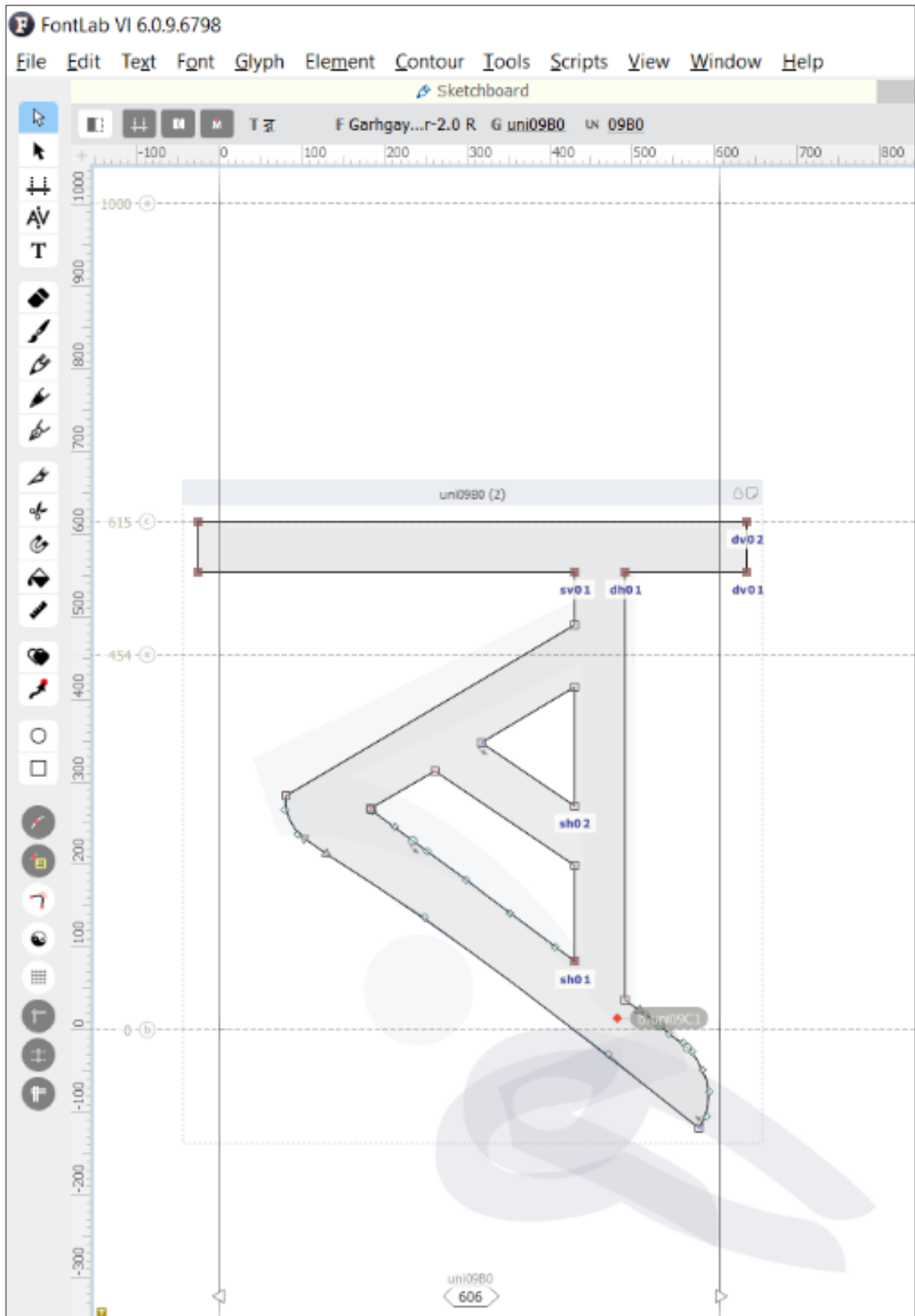


Figure 6.13: Technical layout of letter “Ra” in Font Lab Studio

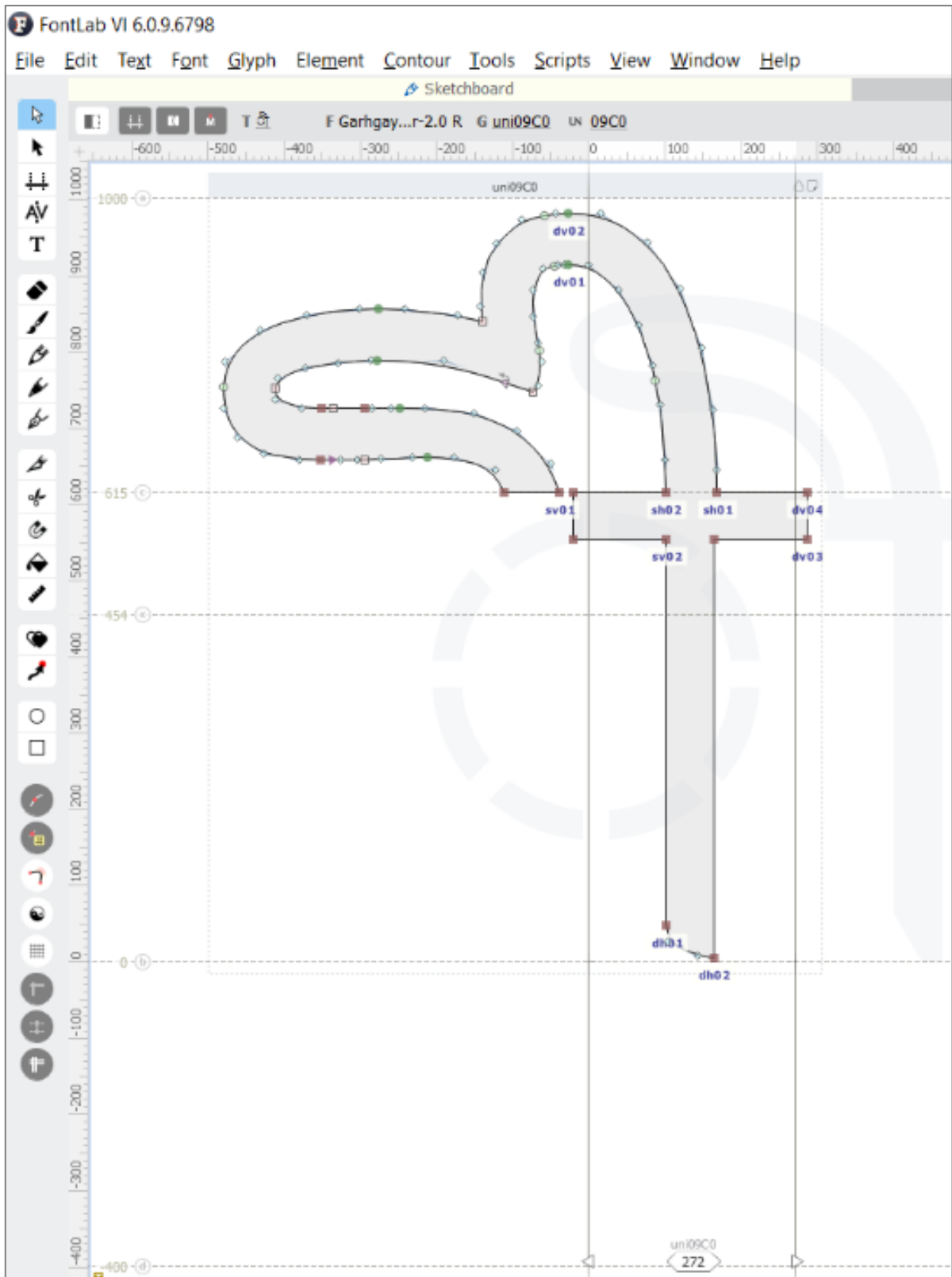


Figure 6.14: Technical layout of vowel symbol “Dirgho Ie” in Font Lab Studio

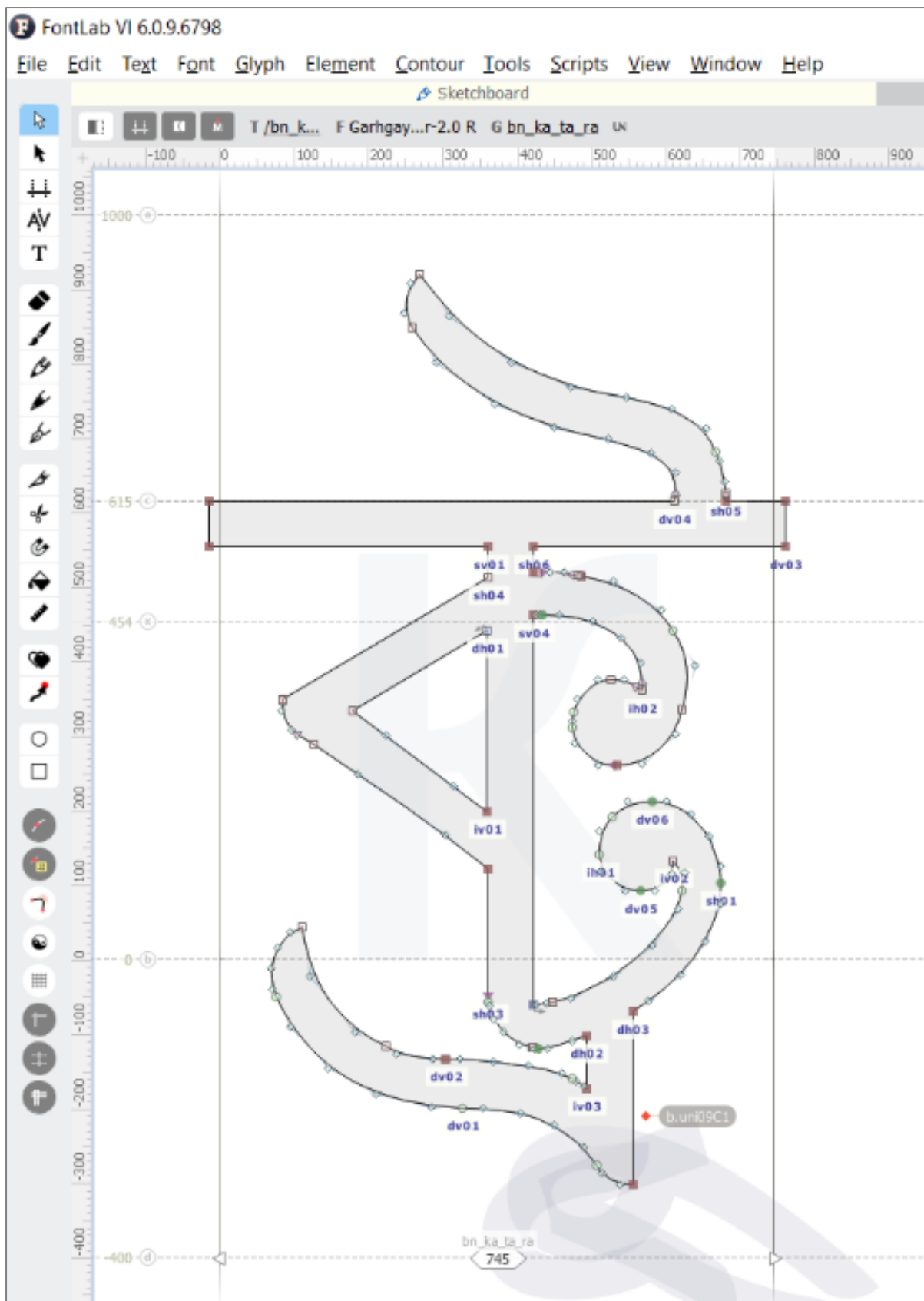


Figure 6.15: Technical layout of conjunct letter “Oktra” in Font Lab Studio

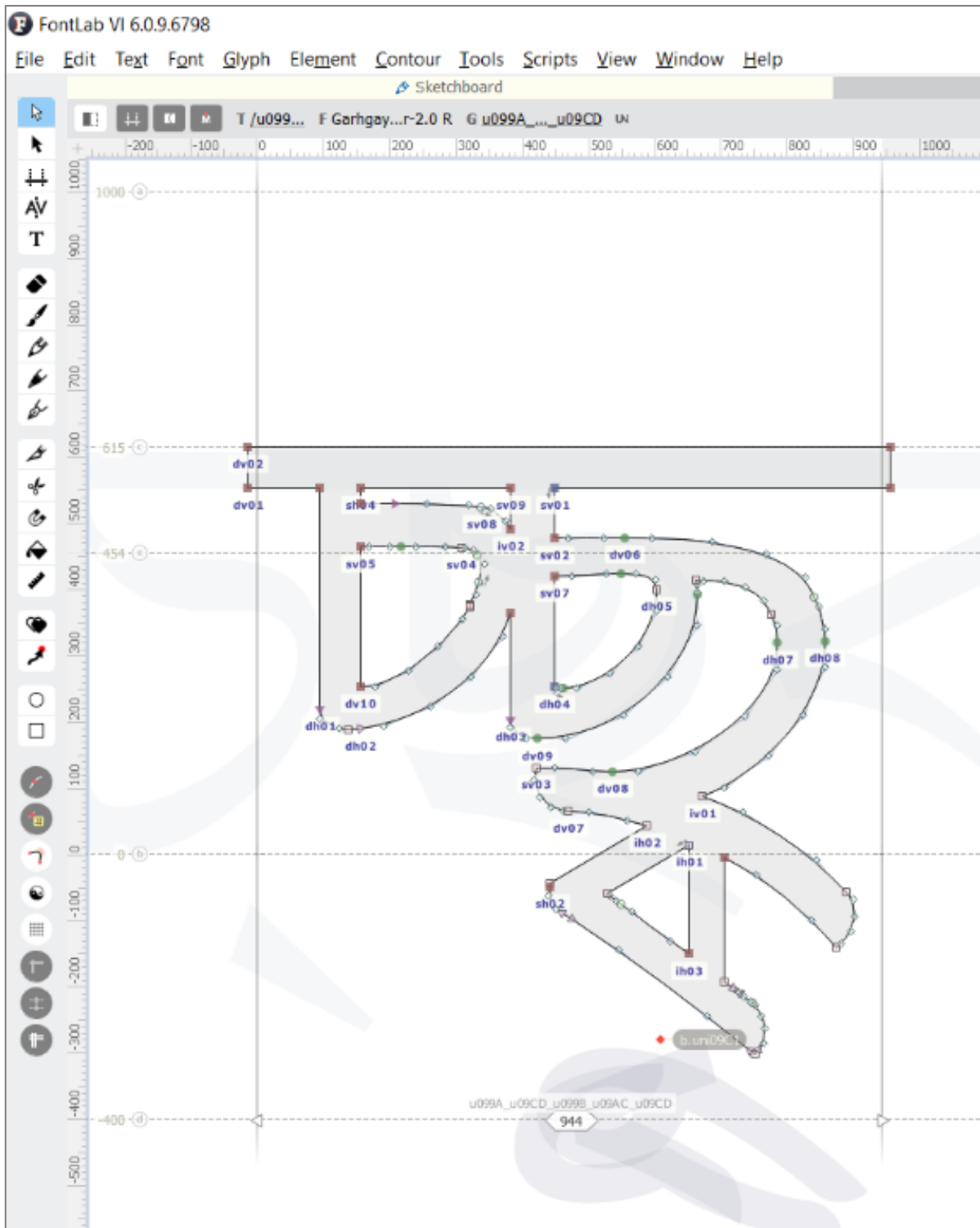


Figure 6.16: Technical layout of the conjunct letter “Chhba” in Font Lab Studio

A complete list of all the characters including vowels, vowel diacritics, consonants, numbers, symbols, conjunct letters, and additional characters have been described in Annexure – 2.

6.2.3 Hinting of Font characters

Font hinting or known as instructing is the use of mathematical instructions to adjust the display of an outline font so that it lines up with a rasterized grid. At low screen resolutions, hinting is critical for producing clear, legible text.

Hinting of all the characters of the new typeface *Garhgayan Assamese* has been done with the TrueType hinting technique. Hinting in TrueType invokes tables of font data used to render fonts properly on the screen. One aspect of TrueType hinting is grid-fitting, which modifies the height and width of font characters to line up to the set pixel grid of screen display.

This exercise is necessary to make the typeface render properly in digital media especially for websites and digital devices. The software's automatic hinting application to apply TrueType hinting on characters shows very satisfactory results while testing. As shown below in figures 6.17, 6.18, and 6.19 are some samples.

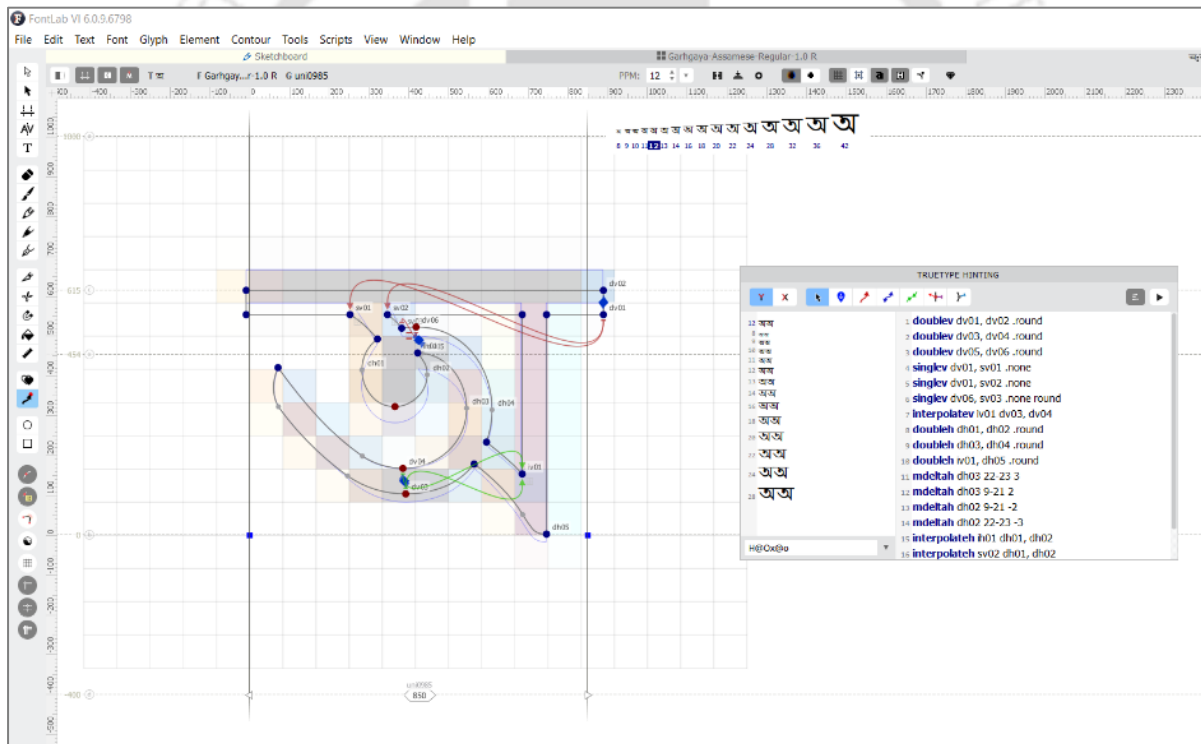


Figure 6.17: Application of true type hinting to letter “A”

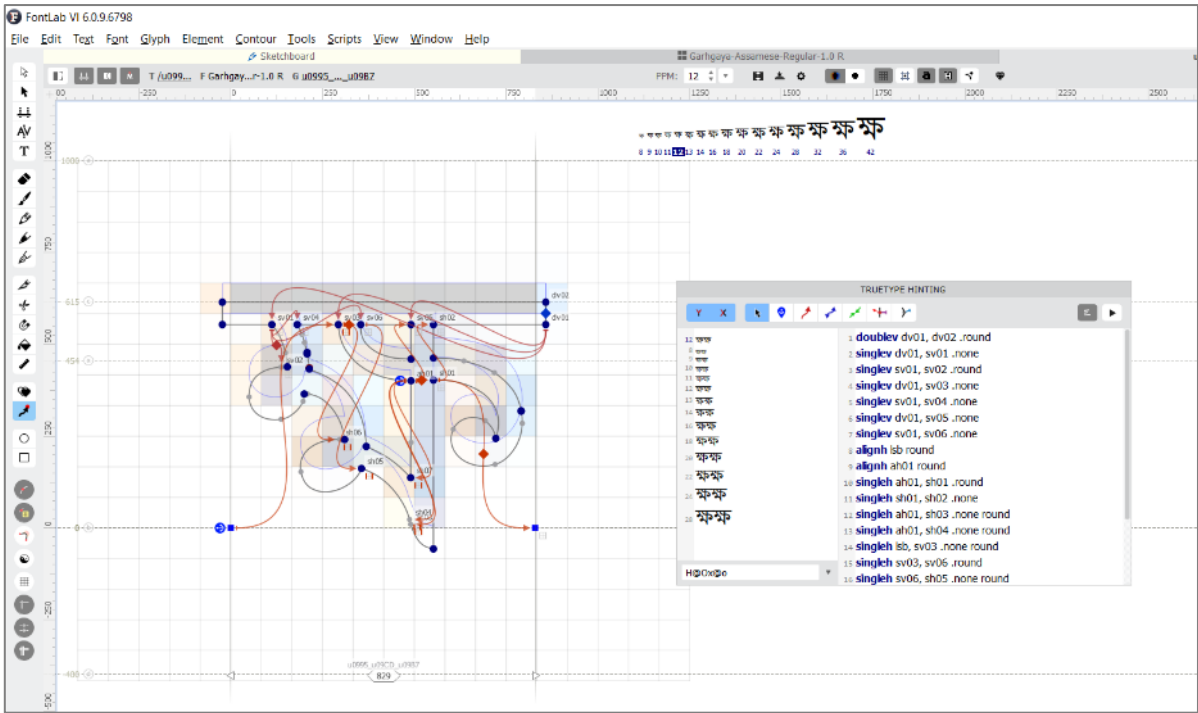


Figure 6.18: Application of true type hinting to letter “Khya”

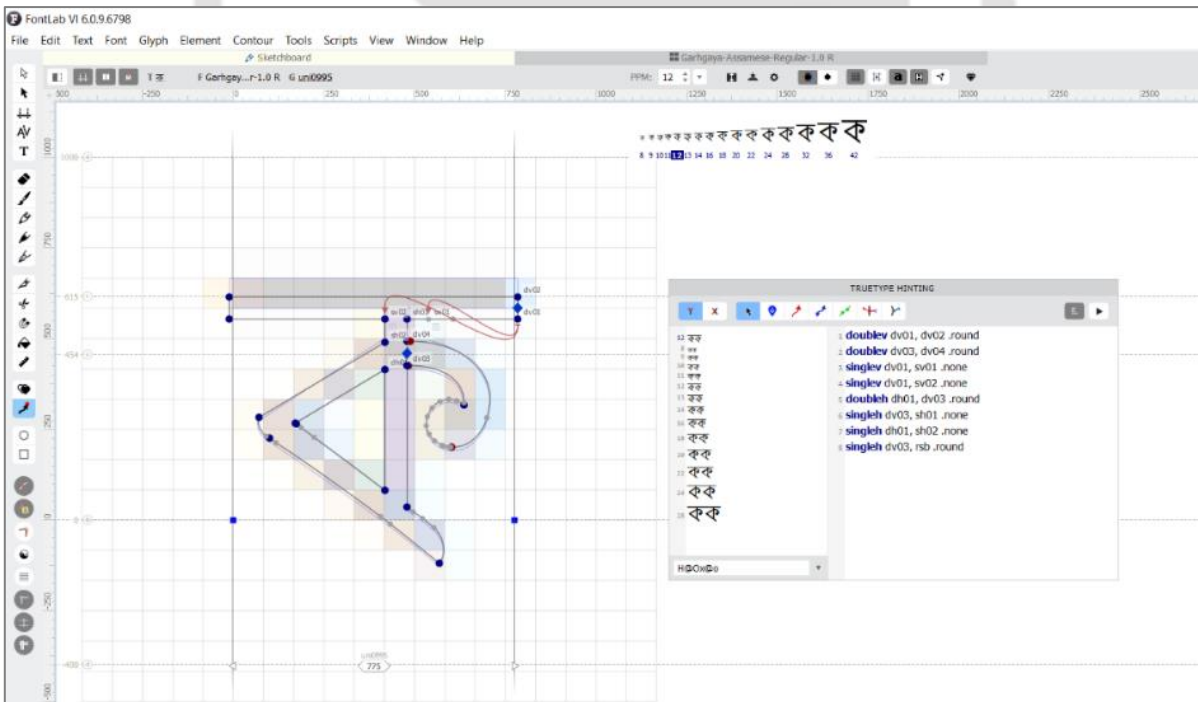


Figure 6.19: Application of true type hinting to letter “Ka”

6.2.4 Unicode characterization – Assigning Unicode numbers

All Indian scripts were assigned a Unicode identification number by the Unicode consortium to be universally displayed in multiple mediums accepted worldwide irrespective of any devices. Since Assamese script has been considered as a subset of Bengali script due to its similarity in characteristics, hence Unicode identification has been as assigned as Bengali-Assamese in its list. Below is the chart provided by the Unicode consortium for Unicode numbering of Bengali-Assamese characters that have been applied to the *Garhayan Assamese* typeface also (refer to figure 6.20).

	098	099	09A	09B	09C	09D	09E	09F
0	৭ 0980	ঈ 0990	ঊ 09A0	ৱ 09B0	ী 09C0		ঋ 09E0	ঔ 09F0
1	ঁ 0981		ড 09A1		ঢ 09C1		ণ 09E1	শ 09F1
2	ং 0982		ঢ 09A2	ল 09B2	ণ 09C2		ত 09E2	থ 09F2
3	ঃ 0983	ও 0993	এ 09A3		ো 09C3		ৌ 09E3	র্ 09F3
4		ঙ 0994	ত 09A4		খ 09C4			ঢ 09F4
5	অ 0985	ক 0995	খ 09A5					ণ 09F5
6	আ 0986	খ 0996	দ 09A6	শ 09B6			০ 09E6	৩ 09F6
7	ঙ 0987	গ 0997	ঘ 09A7	ষ 09B7	ৌ 09C7	ৌ 09D7	১ 09E7	২ 09F7
8	ঐ 0988	য 0998	ম 09A8	স 09B8	ৈ 09C8		২ 09E8	৩ 09F8
9	ঋ 0989	ঙ 0999		হ 09B9			৩ 09E9	০ 09F9
A	ঊ 098A	চ 099A	প 09AA				৪ 09EA	১ 09FA
B	ঋ 098B	ছ 099B	ফ 09AB		ৌ 09CB		৫ 09EB	২ 09FB
C	ঐ 098C	জ 099C	ব 09AC	় 09BC	ৌ 09CC	ড় 09DC	৬ 09EC	৩ 09FC
D		ঝ 099D	ভ 09AD	হ 09BD	় 09CD	ঢ 09DD	৭ 09ED	০ 09FD
E		ঞ 099E	ম 09AE	া 09BE	ৎ 09CE		৮ 09EE	১ 09FE
F	এ 098F	ট 099F	য 09AF	ি 09BF		য় 09DF	৯ 09EF	

Figure 6.20: Bangla-Assamese character chart with Unicode numbering

Based on the Unicode character chart, the new typeface *Garhayan Assamese* has been assigned Unicode numbering including custom-designed characters present only in this typeface. Shown below are the images of the Unicode chart prepared for the *Garhayan Assamese* typeface (refer to figures 6.21, 6.22, 6.23, 6.24, 6.25, and 6.26).

GARHGAYAN ASSAMESE REGULAR						
UNICODE NUMBERING WITH PHONETIC NOTE						
VOWELS AND VOWEL DIACRITICS						
অ	আ	ই	ঈ	উ	ঊ	ঋ
"O"	"Aa"	"Harsha-le"	"Dirgho-le"	"Harsha-U"	"Dirgho-Uu"	"Ri"
U-0985	U-0986	U-0987	U-0988	U-0989	U-098A	U-098B
এ	ঐ	ও	ঔ			
"E"	"Oi"	"U"	"Ou"			
U-098F	U-0990	U-0993	U-0994			
া	ি	ী	ু	ূ	্ৰ	ে
"Aa-kar"	"I-kar"	"le-kar"	"U-kar"	"Uu-kar"	"Ri-kar"	"E-kar"
U-09BE	U-09BF	U-09C0	U-09C1	U-09C2	U-09C3	U-09C7
ে	ো	ৌ				
"Oi-kar"	"U-kar"	"Ou-kar"				
U-09C8	U-09CB	U-09CC				

Figure 6.21: Unicode chart for vowels and vowel diacritics

UNICODE NUMBERING WITH PHONETIC NOTE
CONSONANTS AND EXTRAS

ক	খ	গ	ঘ	ঙ	চ	ছ
"Ka"	"Kha"	"Ga"	"Gha"	"Ngo"	"Pratham So"	"Dwitiyo So"
U-0995	U-0996	U-0997	U-0998	U-0999	U-099A	U-099B
জ	ঝ	ঞ	ট	ঠ	ড	ঢ
"Bargia-Ja"	"Jha"	"Nyo"	"Murdhanya-Ta"	"Murdhanya-Tha"	"Murdhanya-Da"	"Murdhanya-Dha"
U-099C	U-099D	U-099E	U-099F	U-09A0	U-09A1	U-09A2
ণ	ত	থ	দ	ধ	ন	প
"Murdhanya-Na"	"Dantya-Ta"	"Dantya-Tha"	"Dantya-Da"	"Dantya-Dha"	"Dantya-Na"	"Pa"
U-09A3	U-09A4	U-09A5	U-09A6	U-09A7	U-09A8	U-09AA
ফ	ব	ভ	ম	য	ৰ	ল
"Pha"	"Ba"	"Bha"	"Ma"	"Antasta-Ja"	"Ra"	"La"
U-09AB	U-09AC	U-09AD	U-09AE	U-09AF	U-09B0	U-09B2

Figure 6.22: Unicode chart for consonants and consonant extra (part – 1)

UNICODE NUMBERING WITH PHONETIC NOTE
CONSONANTS AND EXTRAS

ৱ	শ	স	ষ	হ	ক্ষ	য়
"Wa"	"Talabya - Xa"	"Dantya - Xa"	"Murdhanya - Xa"	"Ha"	"Khya"	"Ya"
U-09F1	U-09B6	U-09B8	U-09B7	U-09B9	u0995+u09CD +u09B7	U-09DF
ড়	ঢ়	ৎ	ং	:	ঁ	্
"Da-Rha"	"Dha-Rha"	"Harsnta-Ta"	"Anusar"	"Bisarga"	"Chandrabindu"	"Halant"
U-09DC	U-09DD	U-09CE	U-0982	U-0983	U-0981	U-09CD
।	্	্	ৰ	্		
"Dahri"	"Em-dash" (start-matra)	"En-dash" (end-matra)	"Ra"	"Reph"		
U-0964	U-2014	U-2013	U-09F0	U-09B0_09CD		

Figure 6.23: Unicode chart for consonants and consonant extra (part – 2)

UNICODE NUMBERING WITH PHONETIC NOTE
NUMBER SYSTEM & SYMBOLS

০	১	২	৩	৪	৫	৬
"Shunya"	"Ek"	"Dui"	"Tini"	"Sari"	"Pans"	"Soi"
U-09E6	U-09E7	U-09E8	U-09E9	U-09EA	U-09EB	U-09EC
৭	৮	৯				
"Haat"	"Aanth"	"Nou"				
U-09ED	U-09EE	U-09EF				
!	?	"	"	'	'	,
"Exclam"	"Question"	"quotedblleft"	"quotedblright"	"quoteleft"	"quoteright"	"Comma"
U-0021	U-003F	U-201C	U-201D	U-2018	U-2019	U-002C
:	;	.	{	}	[]
"Colon"	"Semicolon"	"Period"	"Braceleft"	"Braceright"	"Bracketleft"	"Bracketright"
U-003A	U-003B	U-002E	U-007B	U-007D	U-005B	U-005D

Figure 6.24: Unicode chart for number system and symbols (part – 1)

UNICODE NUMBERING WITH PHONETIC NOTE
SYMBOLS

-	_	/	\	#	<	>
"Hyphen"	"Underscore"	"Slash"	"Backslash"	"Numbersign"	"Less"	"Greater"
U-002D	U-005F	U-002F	U-005C	U-0023	U-003C	U-003E
=	×	÷	+	-	()
"Equal"	"Multiply"	"Devide"	"Plus"	"Minus"	"Parenleft"	"Parenright"
U-003D	U-00D7	U-00F7	U-002B	U-2212	U-0028	U-0029
*						
"Asterisk"						
U-002A						

Figure 6.25: Unicode chart for number system and symbols (part – 2)

CONJUNCT LETTER FORMATION SYSTEM
UNICODE NAMING OF CONJUNCT LETTER SYSTEM

DIFFERENT TYPES OF CONJUNCT LETTER FORMATION AND UNICODE NAME	
Conjunct letter formation	Unicode name
ক + া = কা	U-0995 _ U-09BE
ক + ি = কি	U-0995 _ U-09BF
ক + ী = কী	U-0995 _ U-09C0
ক + ্ + ক = ক্ক	U-0995 _U-09CD_ U-0995
ক্ক + ী = ক্কী	U-0995 _U-09CD_ U-0995_U-09C0
গ + ্ + ব + ্ + ধ = গ্ৰ্ধ	U-0997 _U-09CD_ U-09AC_U-09CD_U-09A7
গ্ৰ্ধ + ি = গ্ৰ্ধি	U-0997 _U-09CD_ U-09AC_U-09CD_U-09A7 _U-09BF
ক + ্ + ষ = ক্ক্ৰ	U-0995 _U-09CD_ U-09B7
গ + ্ৰ = গ্ৰ	U-0997_U-09C1
ব + ্ + ক = ব্ক	U-09F0_U-09CD_U-0995

Figure 6.26: Unicode numbering system for conjunct letters

6.2.5 Font production for testing

After assigning Unicode numbers for all the characters in Font Lab, a font output has been produced to check the feasibility and applicability for typing and display. Shown below is the full character window ready for font production (refer to figure 6.27).

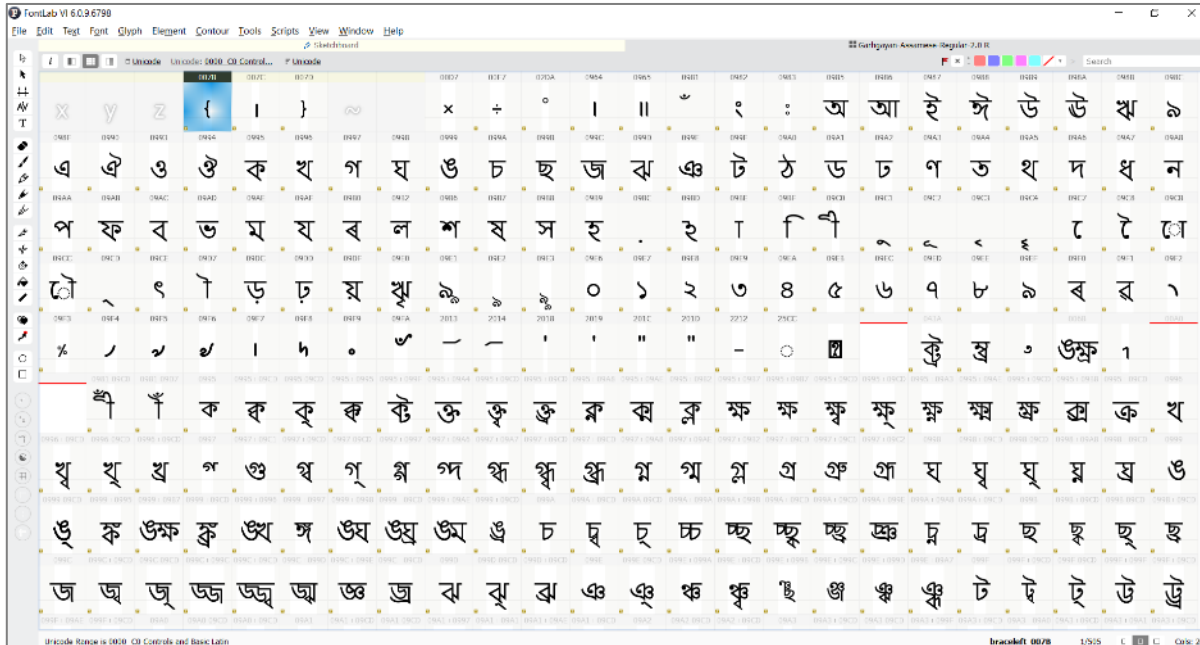


Figure 6.27: Complete character set of Garhgayan Assamese typeface for production

After producing a TrueType font (.ttf) the font has been installed on a computer and tested on Microsoft Word for typing and display. Below is the screenshot to describe the testing (refer to figure 6.28).

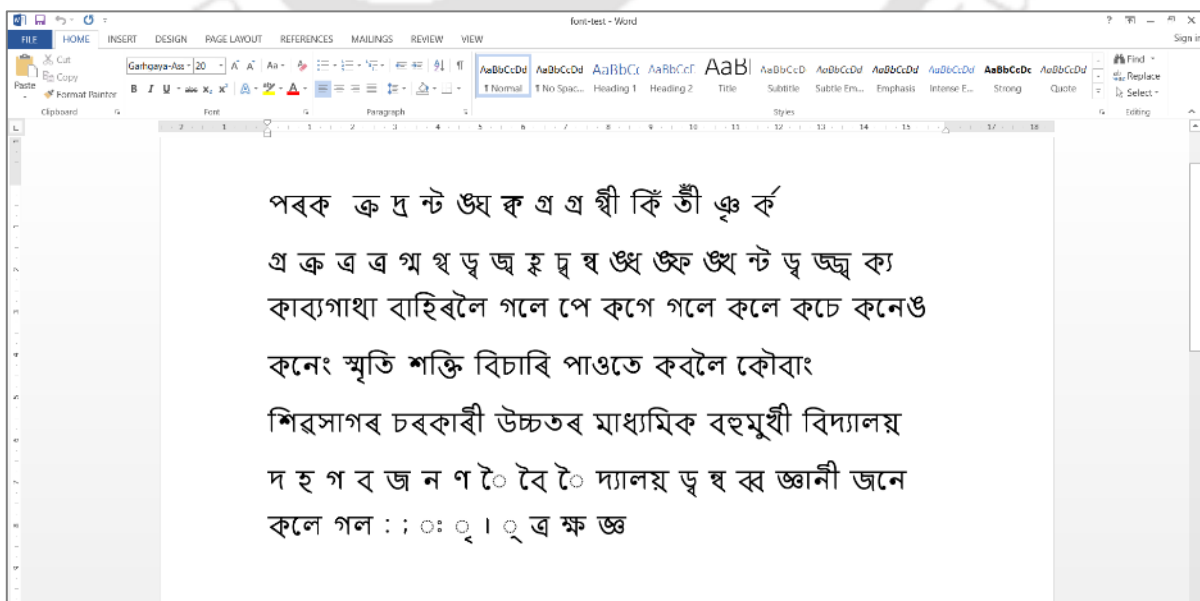


Figure 6.28: Testing of typing and display of TrueType font output on MS Word

After the testing for typing and display on a computer it has been observed that few of the conjunct letters, vowel diacritics, and symbols have some issues due to font rendering and character arrangement technique. To overcome these issues the final output version of the font has been exported to Microsoft Volt for the final correction regarding arrangement and display.

6.3 Font proofing and correction

Due to few issues left in the final output font produced from Font Lab Studio, further proofing for typing and display has been conducted to find out the error areas. It has been noticed that while typing some of the conjunct letters the output shows some different result which was due to error in the character arrangement process and Unicode numbering mismatch. Also in some of the characters of the upper modifier zone and lower modifier zone displayed in an overlapping visual. To overcome these issues the output font has been re-arranged and corrected using Microsoft Volt software.

6.3.1 Verification and correction using Microsoft Volt

This is the most important stage where the typeface has been configured for the device applicable True Type Font (.ttf) to be used in any digital device. To implement this stage, a software named ‘Microsoft Volt’ developed by Microsoft was used to configure the typeface. The most important role played by this software is to configure all upper modifier and lower modifier characters to be joined with core characters and conjunct letter formation and joining. Below are image samples of the MS Volt work in progress (Using VOLT: Tutorial, 2020).

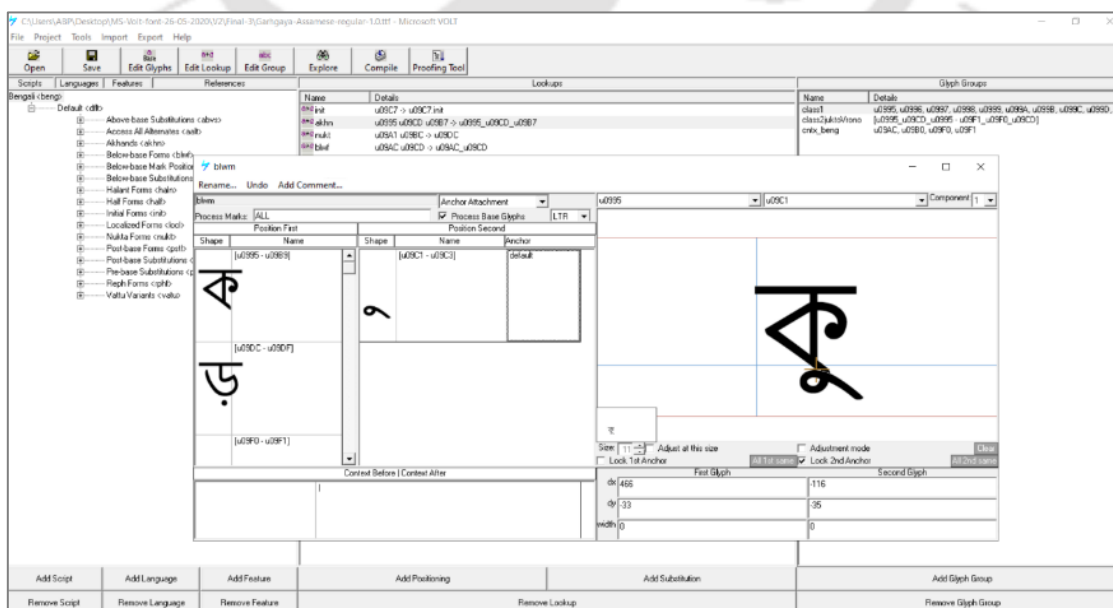


Figure 6.29: Configuration of lower modifier character (vowel symbol “U”) in MS Volt

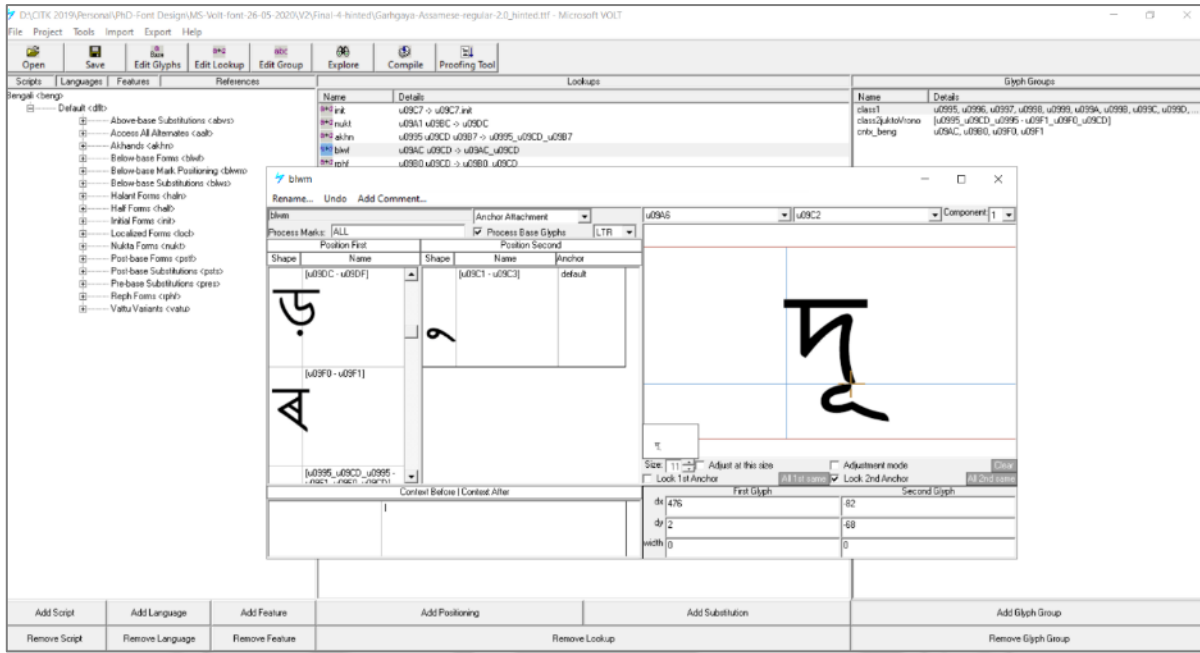


Figure 6.30: Configuration of lower modifier character (vowel symbol “Hri”) in MS Volt

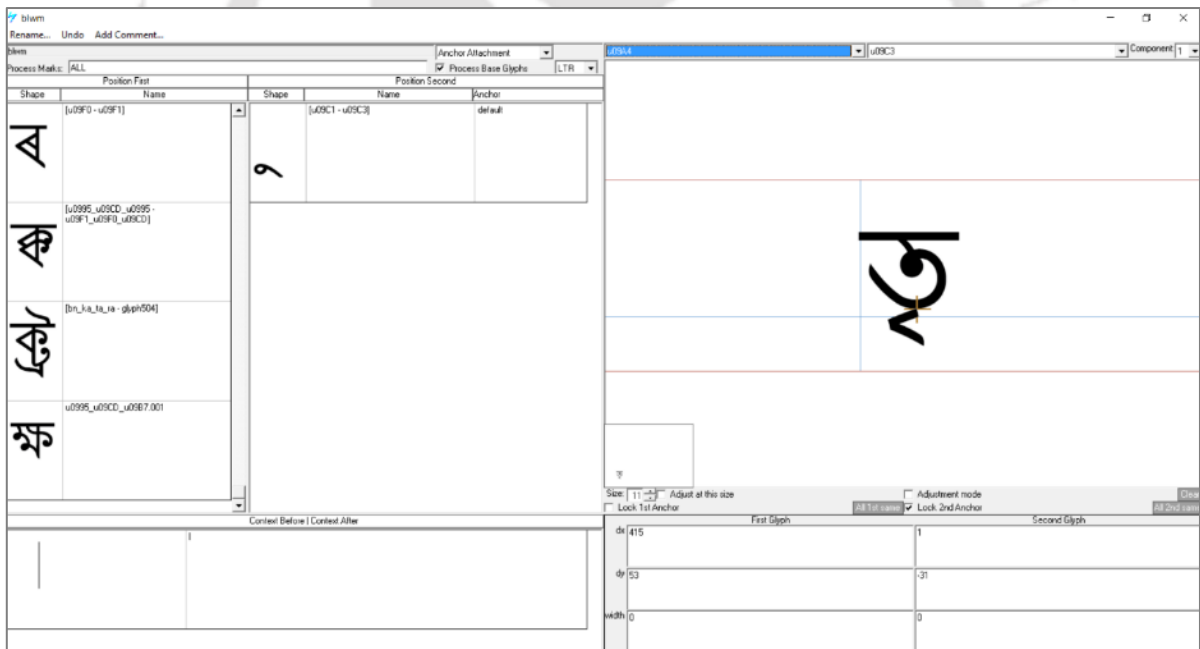


Figure 6.31: Configuration of lower modifier character (vowel symbol “Hri”) in MS Volt

In the above three figures (refer to figure 6.29, figure 6.30, and figure 6.31) are called “Below-base Mark Positioning”. Here the arrangement of vowel symbols that will attach with a consonant can be modified by re-positioning the characters appropriately. The same process could be applied to all the lower modifier characters whether it is a vowel symbol or a “raph” or “halant”. The characters need to be re-positioned appropriately for screen display because

many times while rendering from a particular software output may not work properly for Indian scripts due to complex compositions.

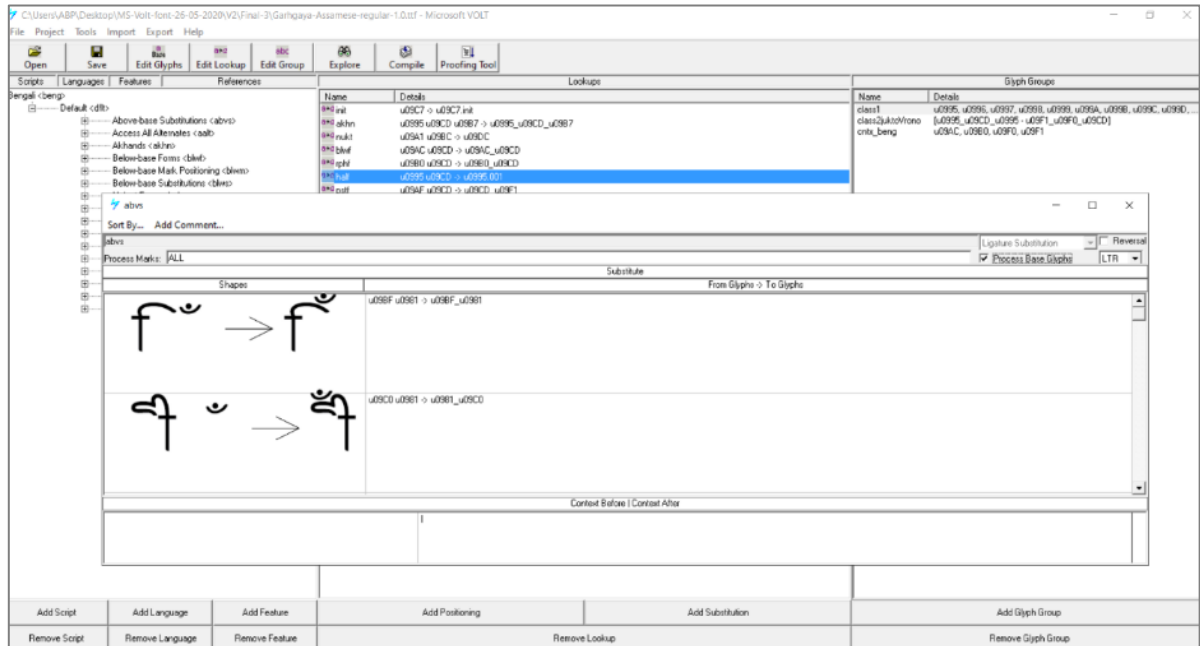


Figure 6.32: Configuration and arrangement of upper modifier characters (vowel symbols and Chandrabindu) in MS Volt

The above figure (refer to figure 6.32) shows the arrangement of “Above-base Substitution” which is the arrangement between vowel symbols in the upper modifier zone with the upper zone character “Chandrabindu”.



Figure 6.33: Configuration of the combination of core and upper modifier characters in MS Volt

The above arrangement (refer to figure 6.33) is called “Post-base Substitution” where a full form of conjunct characters could be made one unit comprising of vowel symbols and consonant symbols.

6.3.2 Font production for device use

After checking and verifying every character arrangement be it conjunct or vowel modifier or consonant modifier, the final character set has been compiled and set for production output. Showing below (refer to figure 6.34) a sample image of characters after the final compilation.

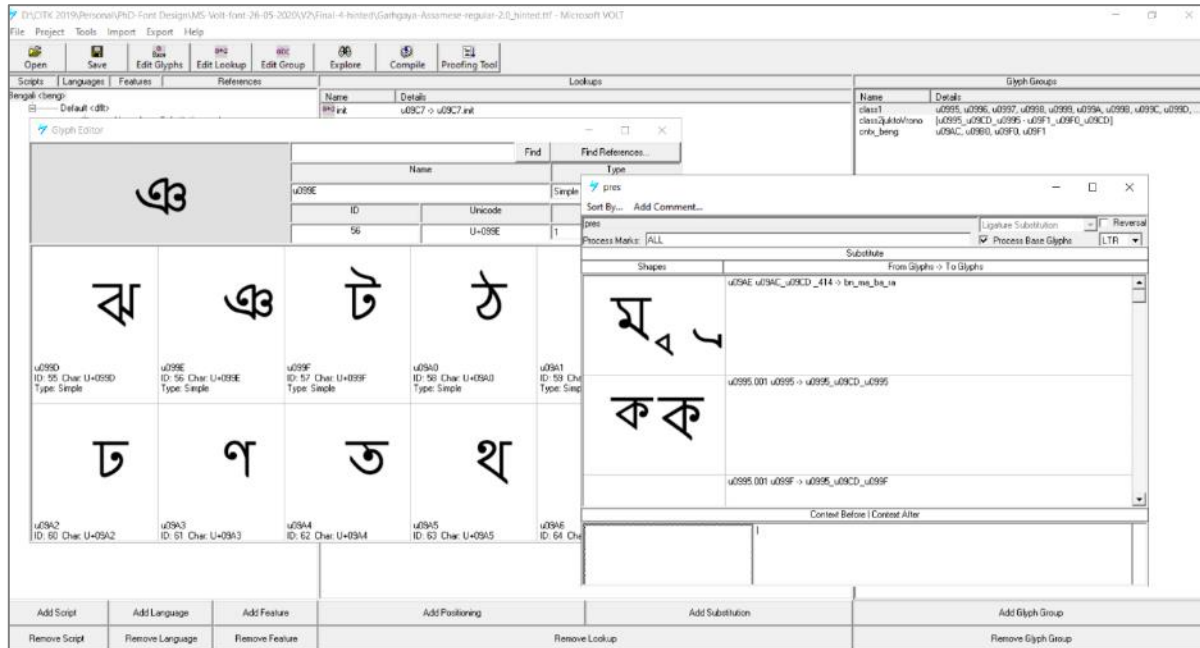


Figure 6.34: Character set after final compilation in MS Volt

The output font is a TrueType Font (.ttf) with true type characteristics applicable for any digital device.

6.4 Usability check for screen and print display

The production output font has been then sent for checking screen and print display for various media such as websites, digital devices, printing software, etc. A paragraph has been composed and written on MS Word software with the newly designed font “Assamese Garhmayan” using an in-script Assamese keyboard. The paragraph has been then compiled in different font sizes and compositions for general screen display as well as printing of that document for quality verification. The newly designed font “Assamese Garhmayan” has been then tested for display on the website by placing it as a dummy text for an online news website. The font also has been tested for digital devices such as mobile phones and tablets by placing it on social media sites such as Facebook and WhatsApp. Shown below are the reference images of each of the experiments conducted for display testing.

6.4.1 Screen and print display testing using MS Word and Adobe Acrobat

A paragraph has been composed and typed in MS Word using an in-script virtual keyboard for Assamese typing. It has been then set in various font sizes and alignment to check readability display testing. The file has been then converted to PDF using Adobe Acrobat for printing check of the formatting and character display. The result comes out to be very encouraging. Shown below (refer to figure 6.35) is the reference image of paragraph formatting.

Font Size: Heading – 12, Body – 10, Align: Justify	Font Size: Heading – 14, Body – 12, Align: Centre	Font Size: Heading – 20, Body – 16, Align: Left
<p>ঈশ্বৰহীনতা</p> <p>অসহজ সময়ৰ ধাৰাবাহিকতা চলি আছে। আগেয়ে কাহানিও নোপোৱা এক অভিজ্ঞতাৰ মাজেৰে দেশৰ মানুহে দিন কটাবলগীয়া হৈছে। কেৱল দেশেই নহয়, পৃথিৱীৰ ১৩০ কোটি মানুহৰ ঘৰৰ ভিতৰতে কেইবা সপ্তাহ সোমাই থাকিবলগীয়া এই বাধ্যবাধকতা মানৱ সভ্যতাত প্ৰথম। জীৱন ৰক্ষাৰ বাবে 'স্কন্ধতাৰ' এই সম্পৰীক্ষাত পক্ষ আৰু প্ৰতিপক্ষ এচাম মানুহ বনাম আন এচাম মানুহ নহয়। সমগ্ৰ মানৱ জাতি এফালে আৰু দানৱ অৰ্থাৎ ভাইৰাছবিধ আন এফালে।</p> <p>অসহজ সময়ৰ ধাৰাবাহিকতা চলি আছে। আগেয়ে কাহানিও নোপোৱা এক অভিজ্ঞতাৰ মাজেৰে দেশৰ মানুহে দিন কটাবলগীয়া হৈছে। কেৱল দেশেই নহয়, পৃথিৱীৰ ১৩০ কোটি মানুহৰ ঘৰৰ ভিতৰতে কেইবা সপ্তাহ সোমাই থাকিবলগীয়া এই বাধ্যবাধকতা মানৱ সভ্যতাত প্ৰথম। জীৱন ৰক্ষাৰ বাবে 'স্কন্ধতাৰ' এই সম্পৰীক্ষাত পক্ষ আৰু প্ৰতিপক্ষ এচাম মানুহ বনাম আন এচাম মানুহ নহয়। সমগ্ৰ মানৱ জাতি এফালে আৰু দানৱ অৰ্থাৎ ভাইৰাছবিধ আন এফালে।</p>	<p>॥ ঈশ্বৰহীনতা ॥</p> <p>অসহজ সময়ৰ ধাৰাবাহিকতা চলি আছে। আগেয়ে কাহানিও নোপোৱা এক অভিজ্ঞতাৰ মাজেৰে দেশৰ মানুহে দিন কটাবলগীয়া হৈছে। কেৱল দেশেই নহয়, পৃথিৱীৰ ১৩০ কোটি মানুহৰ ঘৰৰ ভিতৰতে কেইবা সপ্তাহ সোমাই থাকিবলগীয়া এই বাধ্যবাধকতা মানৱ সভ্যতাত প্ৰথম। জীৱন ৰক্ষাৰ বাবে 'স্কন্ধতাৰ' এই সম্পৰীক্ষাত পক্ষ আৰু প্ৰতিপক্ষ এচাম মানুহ বনাম আন এচাম মানুহ নহয়। আগেয়ে কাহানিও নোপোৱা এক অভিজ্ঞতাৰ মাজেৰে দেশৰ মানুহে দিন কটাবলগীয়া হৈছে। জীৱন ৰক্ষাৰ বাবে 'স্কন্ধতাৰ' এই সম্পৰীক্ষাত পক্ষ আৰু প্ৰতিপক্ষ এচাম মানুহ বনাম আন এচাম মানুহ নহয়। সমগ্ৰ মানৱ জাতি এফালে আৰু দানৱ অৰ্থাৎ ভাইৰাছবিধ আন এফালে।</p>	<p>ঈশ্বৰহীনতা</p> <p>অসহজ সময়ৰ ধাৰাবাহিকতা চলি আছে। আগেয়ে কাহানিও নোপোৱা এক অভিজ্ঞতাৰ মাজেৰে দেশৰ মানুহে দিন কটাবলগীয়া হৈছে। কেৱল দেশেই নহয়, পৃথিৱীৰ ১৩০ কোটি মানুহৰ ঘৰৰ ভিতৰতে কেইবা সপ্তাহ সোমাই থাকিবলগীয়া এই বাধ্যবাধকতা মানৱ সভ্যতাত প্ৰথম। জীৱন ৰক্ষাৰ বাবে 'স্কন্ধতাৰ' এই সম্পৰীক্ষাত পক্ষ আৰু প্ৰতিপক্ষ এচাম মানুহ বনাম আন এচাম মানুহ নহয়। সমগ্ৰ মানৱ জাতি এফালে আৰু দানৱ অৰ্থাৎ ভাইৰাছবিধ আন এফালে।</p>

Figure 6.35: Testing for screen and print display MS Word and Adobe Acrobat (PDF).

6.4.2 Testing for web and online display

The font has been applied on a dummy website created for an Assamese news channel “Asomiya Pratidin” to check the display on the website and online media platform. The software used to create the web pages is Adobe Photoshop and Illustrator. The dummy pages were designed by replacing the actual text from the news clips with Garhgayan Assamese. The readability, legibility, appeal, and functionality have been analyzed for the font. Shown below (refer to figure 6.36) is the full page view of an inside page of the website as well as an enlarged view to see the font application on the webpage for readability, functionality, and appeal.



Figure 6.36: Application of Garhayan Assamese font on Asomiya Pratidin website (full page view)



Figure 6.37: Enlarged view of heading section



Figure 6.38: Enlarged view of main news coverage text.



Figure 6.39: Enlarged view of featured news section text.

6.4.3 Testing for screen display on digital devices (mobile phone)

The font has been tested on demo application of WhatsApp and Google search by making a dummy app with Photoshop to check the usability issues. Below are two testing images (refer to figure 6.40).



Figure 6.40: Testing of the font for screen display on mobile devices

Also, a new android typing app for Garhayan Assamese font typing with an in-script keyboard has been designed and developed to check the applicability on mobile devices which will be discussed in the next chapter.

6.5 Observation and discussion

From the experimental analysis, it has been observed that on-screen display and print output the newly designed font *Garhayan Assamese* performed a quite satisfactory result. Be it the use of font as a document text tested on MS Word application or application on webpages as a web font or device font on mobile phones the new font works well with all kinds of applications. The standard input or typing of the font has been processed using Unicode standard keyboard available for computer and mobile devices. But since the new font contains few unique characters that have been designed based on the historic *Garhayan* writing style, therefore, the standard Unicode keyboard available for computers and other digital devices could not able to offer the special character input keys. Hence there is a need to design a separate keyboard for both computer and digital devices such as mobile phones or tablets which could offer the option for the application of specially designed unique characters.

The next chapter discusses the experiment on input method analysis and design of a new keyboard for *Garhayan Assamese* font to be applicable on the computer and digital devices.



CHAPTER 7

TYPEFACE APPLICATION



Chapter 7: Typeface application

As discussed in the previous chapter the new typeface *Garhgayan Assamese* has been successfully tested for display on computer screens and mobile devices. The testing was done on Windows 10 operating system for computers and android based digital devices. But it will be incomplete if the typeface application has not been tested for other operating systems and digital devices. Therefore an experiment has been conducted on other operating systems for computer and digital devices to check the applicability of the new typeface or font.

7.1 Application on a computer display

As the typeface has been primarily designed for documentation purposes, therefore the important part of testing is rendering and display on computer screens. In the initial stage of testing and typing on the computer, the typeface gave satisfactory results with Windows 10 operating system. But it is necessary to examine whether the same result could also be found for computers with an older or newer version of operating systems.

7.1.1 Check for operating system compatibility

As the typeface has been designed with TrueType Font (.ttf) properties, hence it can be easily applied on windows computers running on Windows XP onwards. The same has been tested by installing on different computers running on different Windows operating systems. It can also be applied on Linux OS as well as Mac OS as the True Type format is the most common font format applicable on any type of computer operating system.

7.1.2 Check for keyboard compatibility

The new typeface *Garhgayan Assamese* has been designed with Unicode compatibility. Therefore any in-script keyboard which supports Unicode character typing for Indian scripts can be used. But since the Assamese characters are similar to Bengali characters as well as share the same Unicode number system hence an in-script keyboard with Bengali or Assamese characters could be most suitable for typing the new font. In the latest Windows operating systems such as Windows 7 onwards, virtual Assamese or Bengali keyboard could be downloaded from the internet easily. These keyboards used to work fine with windows operating systems for typing in Assamese or Bengali scripts based on Unicode system. *Garhgayan Assamese* typeface has also been tested with such a virtual keyboard. But one issue with such keyboards is that the special characters of the typeface could not be typed. For that

one has to use the character map of the typeface to insert the special characters. Shown below is the in-script virtual keyboard that has been used to test the *Garhgayan Assamese* typeface (refer to figure 7.1, 7.2, and 7.3).

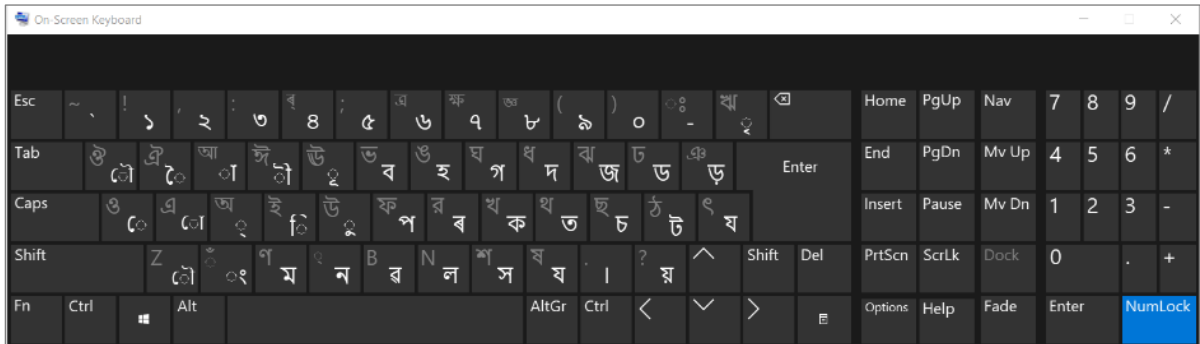


Figure 7.1: In-script virtual keyboard for Assamese Unicode typing (normal mode)

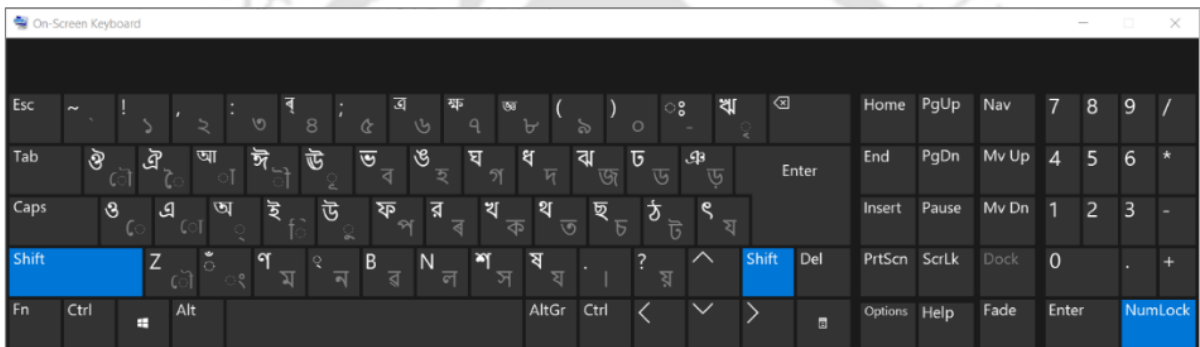


Figure 7.2: In-script virtual keyboard for Assamese Unicode typing (shift mode)

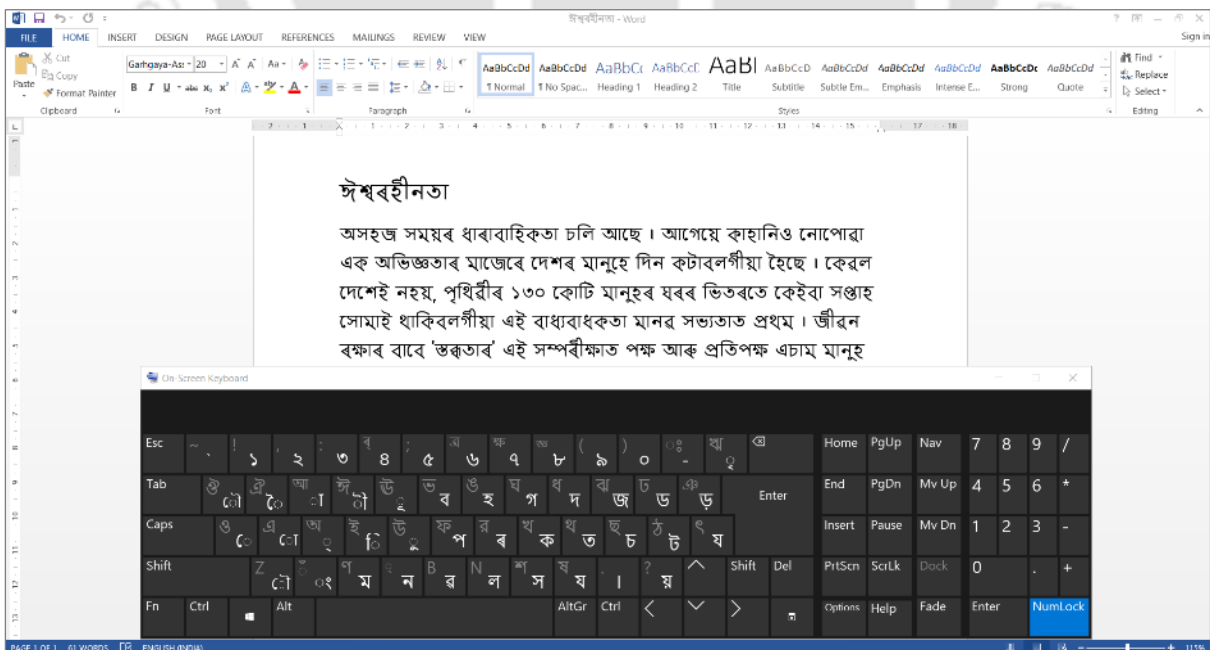


Figure 7.3: Typing test with Garhgayan Assamese font using the in-script virtual keyboard

The keyboard can be used in two modes displaying different character range for smooth typing. A normal mode and a shift mode. A third mode with “Alt + Ctrl” keys pressed is also available but it is hardly been used as it does not display any important characters.

7.2 Custom keyboard design and application

Garhayan Assamese typeface has been designed with unique Assamese characteristics based on the historical *Garhayan* writing style of Assam. Hence it has few new customized characters which don't exist in the list of standard Unicode character chart for Assamese script as well as Bengali. Therefore the current in-script keyboard for typing Assamese script has limitations in typing the unique characters specially designed for the typeface. One has to use a font character chart or symbol chart to apply those unique characters. Hence there is a need to design an in-script custom keyboard for typing *Garhayan Assamese* font that can include the unique characters as well render appropriately on the screen while typing. To address this need an aim and objectives have been set up to achieve a successful custom keyboard design.

Aim: To design an in-script Assamese keyboard for virtual use on computer devices that can accommodate the special characters designed in the *Garhayan Assamese* typeface.

Objectives: The main objectives are –

- To analyze the existing in-script Assamese keyboards for usability functions.
- To customize the key layout based on digital devices.
- To design keyboard layering for *Garhayan Assamese* typeface with dedicated keys for special characters.
- To check for operating system compatibility

7.2.1 Analysis of In-script virtual keyboard for Assamese typing

There have been various types of in-script keyboard available for Assamese typing both virtually as well as for physical use. The most widely used in-script keyboard for Assamese typing by professionals is the one developed by *Bijoy* (refer to figure 7.4). This keyboard has been very popular among DTP operators, printing houses, and Assamese document typists.



Figure 7.4: In-script Assamese/Bengali physical keyboard for computer typing developed by *Bijoy*

The typing method and character keys follow custom rules which do not follow the Unicode standard. This keyboard supports *Ramdhenu* software that produces Assamese fonts for commercial uses.

One of the onscreen virtual in-script keyboards for Assamese typing which follows the phonetic method has been developed by AMTRON (refer to figure 7.5), a Govt. of Assam Undertaking. But the keyboard is useful for online or web uses. Also since the phonetic method has lots of shortcomings while typing conjunct letters or ligatures in Assamese words, hence the usefulness of the keyboard is limited to personal uses only rather than professional purposes.



Figure 7.5: Phonetic based Assamese Text Editor Keyboard developed by AMTRON

Another very important in-script Assamese keyboard has been developed by *Leap Office* for all kinds of commercial as well document typing needs. This keyboard as well as the typing software produced by Leap Office has its own rules and method typing and character keys. This has been very popular in the print publishing industry for its various advanced features. The *I-Leap* keyboard and typing method produced by *Leap Office* used to follow the standard *Ramdhenu* keyboard for ease of use (refer to figure 7.6).



Figure 7.6: Assamese in-script developed by Leap Office

Shabdaliipi (refer to figure 7.7 and 7.8) has developed one in-script Assamese keyboard for virtual use. It also follows *Ramdheni's* standard keyboard format but with a modification in some of the key characters. Typing conjunct characters is easy here.

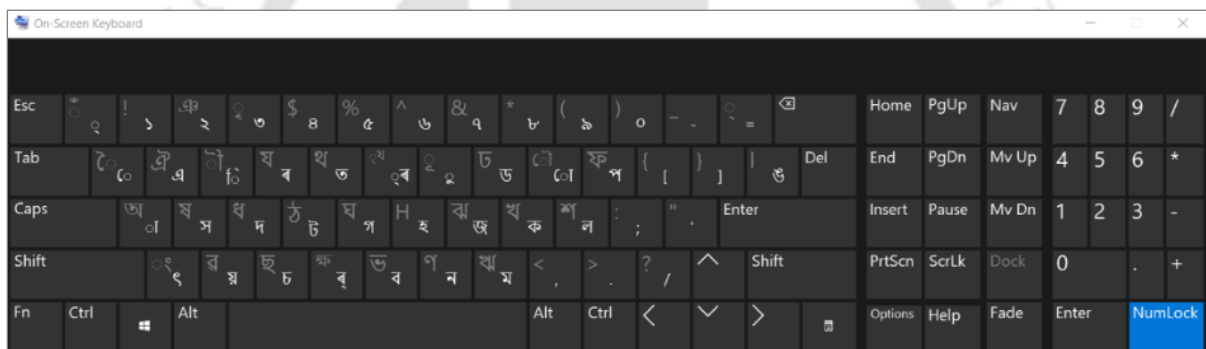


Figure 7.7: Assamese in-script developed by *Shabdaliipi* (normal state)

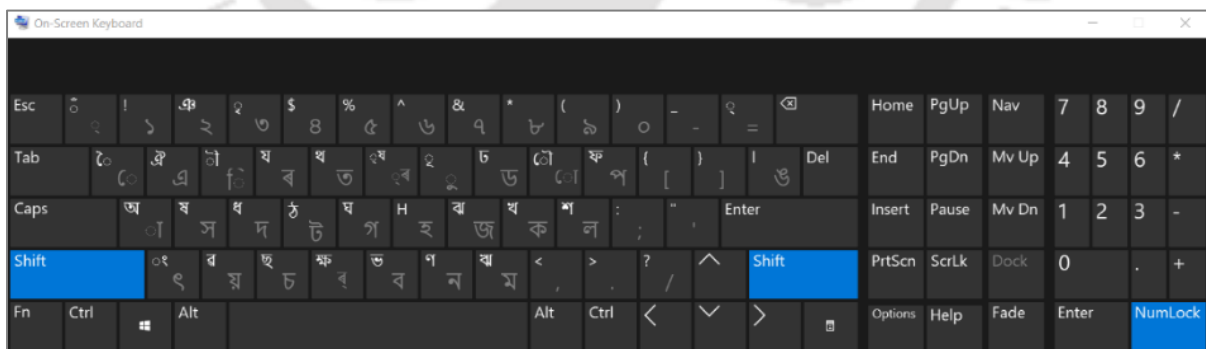


Figure 7.8: Assamese in-script virtual keyboard developed by *Shabdaliipi* (shift state)

There is another in-script Assamese virtual keyboard developed based on the windows platform but follows conventional Assamese keyboard layout such as the *Ramdheni* keyboard. In this keyboard, some of the character keys have been re-aligned to make the keyboard more user friendly for typing (refer to figure 7.9 and 7.10).

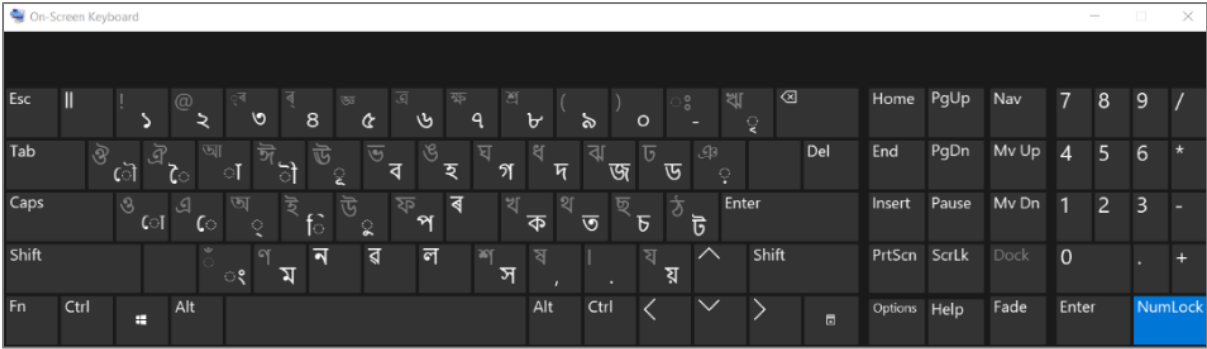


Figure 7.9: Standard in-script Assamese keyboard based on *Ramdhenu* (normal state)

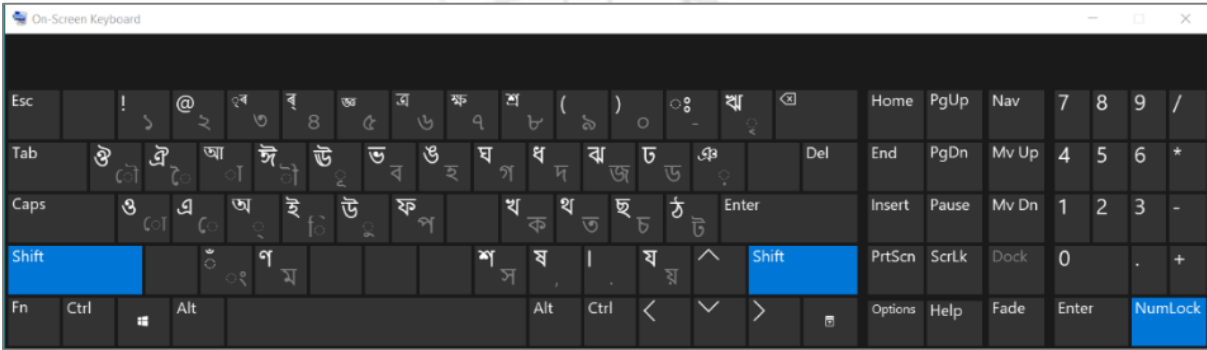


Figure 7.10: Standard in-script Assamese keyboard based on *Ramdhenu* (shift state)

The Assamese in-script virtual keyboard developed based on Unicode standard is the latest popular keyboard standardized for all types of Assamese typing be it for web or online uses, document publishing, designing, digital devices, or machine printing. As the Unicode standard is acceptable in all types of computer platforms irrespective of any operating system hence this Unicode-based keyboard developed by Microsoft for Assamese typing is considered as the current standard for all types of computer or digital uses. Shown below in figure 7.11, 7.12, and 7.13 are the screenshots of the Unicode based Assamese in-script virtual keyboard.



Figure 7.11: Standard in-script Assamese virtual keyboard based on Unicode (normal state)



Figure 7.12: Standard in-script Assamese virtual keyboard based on Unicode (shift state)

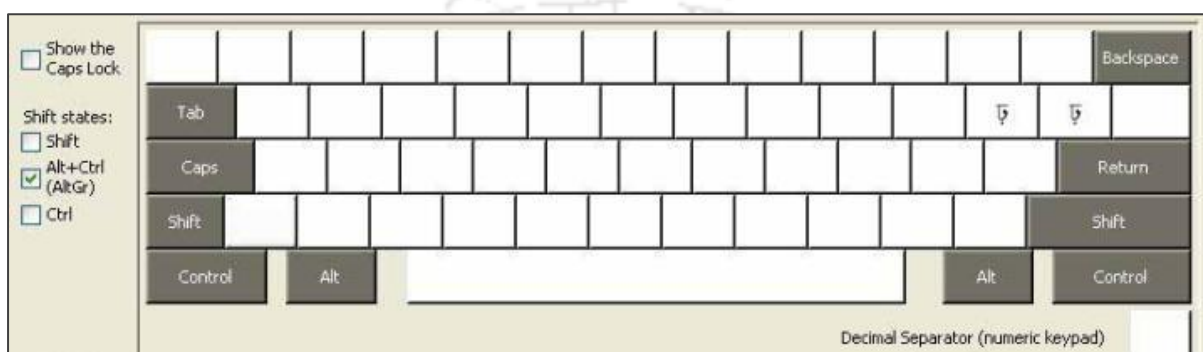


Figure 7.13: Standard in-script Assamese virtual keyboard based on Unicode (Alt+Ctrl state)

7.2.2 Keyboard customization

The standard keyboard layout for an Assamese typing as prescribed by Unicode is a little difficult for a new user who does not know the basic method of typing. Therefore a customized keyboard layout especially for this new typeface has been conceptualized which could also be easy for new users. The keyboard is designed based on a basic keyboard layout used on android mobile devices for typing Assamese script developed by Google. The keys have been placed in Assamese alphabetic order to easily recognize by the users. The keyboard has been set up in three modes such as default mode, shift mode, and Alt+Ctrl mode. All these modes are used to display different character sets to select and type a character. In the default mode, the characters have been placed on the keys in serial alphabetic order of the Assamese script system which goes on to the shift mode in the same serial order. The vowel diacritics are placed in shift modes at the end of all the vowel and consonant characters. Numbers are placed in the same keys as standard number keys. Important keys such as “halant” are required to type conjunct letters and other necessary word formations are kept in the default mode. In the Alt+Ctrl mode, the symbol characters have been assigned to the keys useful for various purposes. As the Garhayan Assamese typeface has been designed with some special

characters such as *Start matra* and *End matra* for a sentence similar to those medieval writing styles, dedicated character keys have been assigned to them in their normal state for ready use.

7.2.3 Keyboard layering

The keyboard design has been developed in Microsoft Keyboard Layout Creator 1.4. The keys have been assigned with Unicode numbering to display the desired characters in a customized structure. After designing the keyboard in MS Keyboard Layout Creator, an application file has been developed for installation in the computer which will enable the custom keyboard in a virtual display mode. One can select Assamese Unicode – *Garhgayan* from the keyboard list that appeared in display language settings to use it for typing documents etc. Recommended operating system for this keyboard to use is MS Windows 8.0 or later. As shown below in Figures 7.14, 7.15, and 7.16 are image samples of the custom keyboard layout.

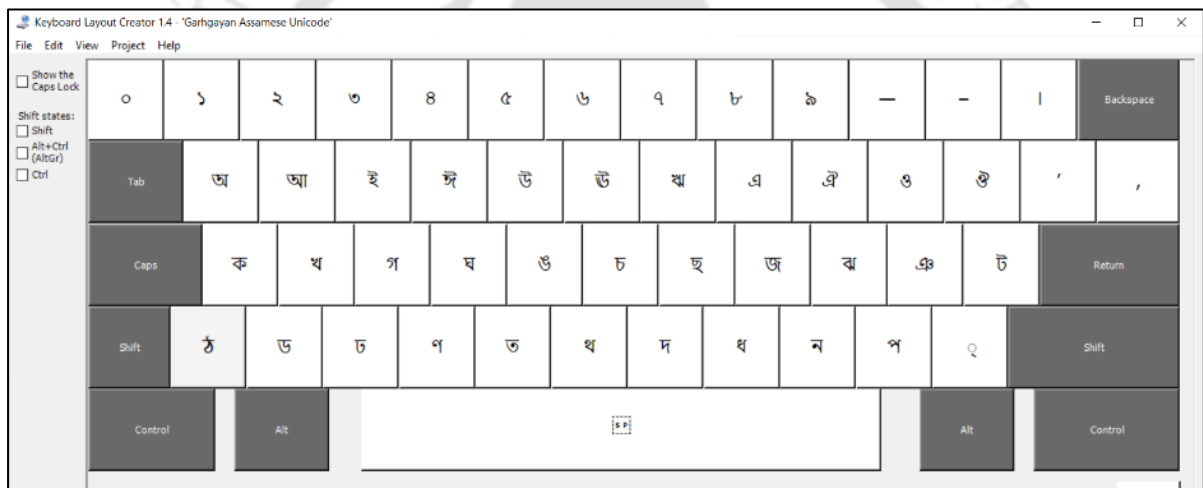


Figure 7.14: Customized Unicode keyboard for *Garhgayan Assamese* typing (default mode)

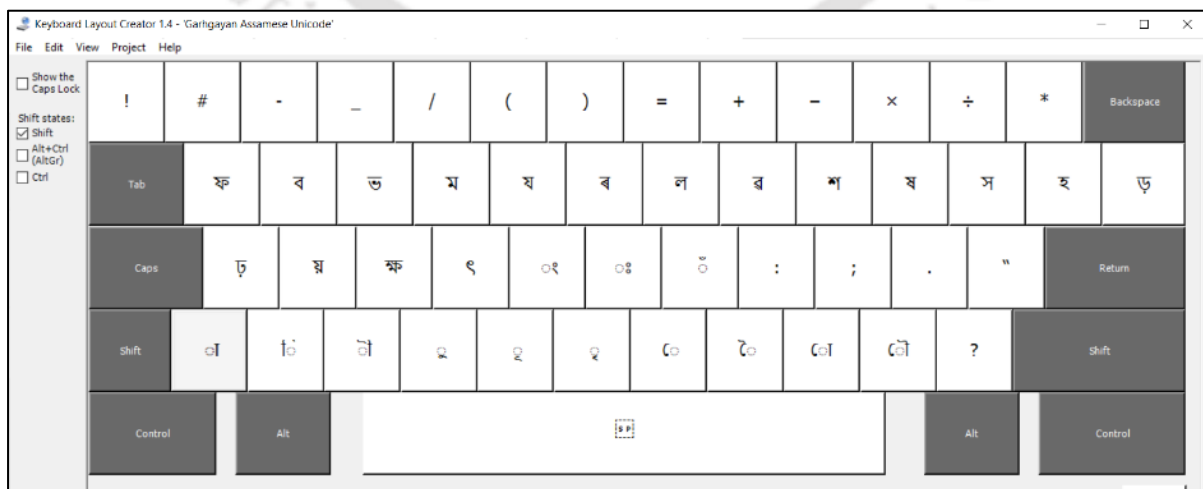


Figure 7.15: Customized Unicode keyboard for *Garhgayan Assamese* typing (Shift mode)

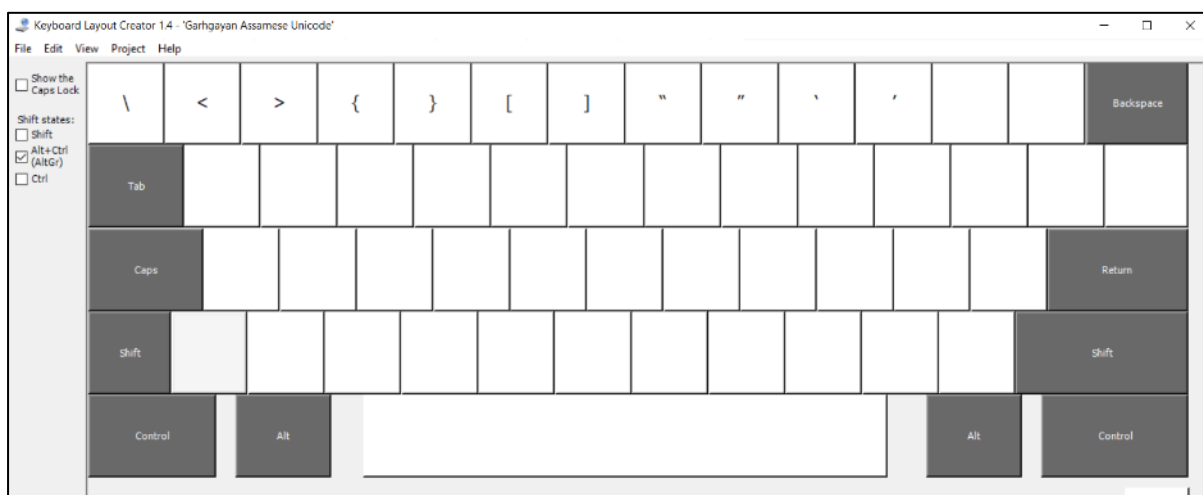


Figure 7.16: Customized Unicode keyboard for Garhgayan Assamese typing (Alt+Ctrl mode)

7.2.4 Operating system compatibility check

After developing the customized virtual keyboard for typing Garhgayan Assamese on Microsoft Keyboard Layout Creator, an application folder has been generated by the software with all the necessary installation files compatible with various operating systems. The keyboard application has been made compatible with Microsoft Windows operating system. The keyboard installation has been tested on Windows 7, Windows 8, and Windows 10 operating systems for compatibility and application. The keyboard application has been working fine with all the operating systems tested. Other very important operating systems Mac OS of Apple Computers and Linux OS could not be tested as the keyboard application is not compatible with these operating systems. It requires additional expertise to develop keyboard application for these operating systems. Therefore this additional requirement has been set aside for future scope. As shown below in figures 7.17 and 7.18 is the application view of Unicode based Garhgayan Assamese virtual keyboard applied on Microsoft Windows 10 OS.

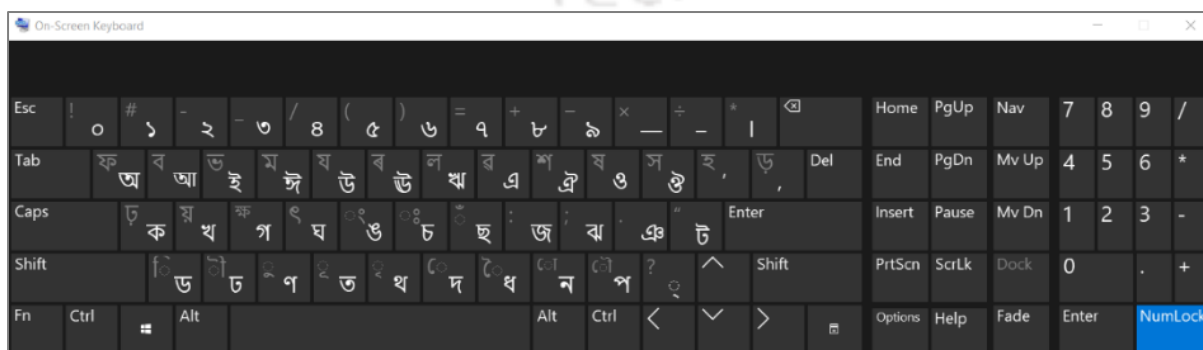


Figure 7.17: Garhgayan Assamese virtual keyboard tested on Microsoft Windows 10 OS (normal state)

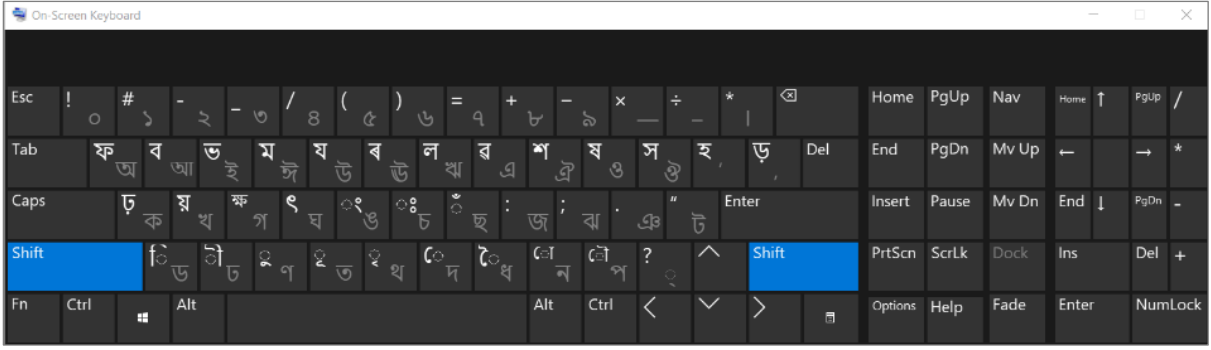


Figure 7.18: Garhgayan Assamese virtual keyboard tested on Microsoft Windows 10 OS (shift state)

A dummy paragraph taken from a newspaper has been composed to check the typing by the custom-designed Garhgayan Assamese keyboard on different platforms. The typing gave a smooth result with ease of character detection and input method due to the serial placement of Assamese letters for all the operating system platforms tested. The typing has been done on MS Word to check the comfortability, functionality, and interactivity of the keyboard. Below is the dummy paragraph used for typing on MS word with a custom-designed *Garhgayan Assamese* keyboard.

<p>Font Size: 10, Alignment: Left</p> <p>॥ সংগ্ৰামৰ গতিপথ ॥</p> <p>আমি বাৰে বাৰে এই কথা উনুকিয়াই আহিছো যে অসমৰ সৰ্বস্তৰৰ ৰাইজৰ ব্যাপক সমৰ্থনে নাগৰিকত্ব সংশোধিত আইনবিৰোধী সংগ্ৰামক সৰ্বাত্মক ৰূপ প্ৰদান কৰিছে আৰু নেতৃত্বৰ লগতে জনসাধাৰণৰ গণতান্ত্ৰিক প্ৰতিবাদ যিমানেই শৃংখলাবদ্ধ তথা শান্তিপূৰ্ণ হৈছে, সিমানেই শাসকপক্ষ শ'লঠেকত পৰিছে। আৰম্ভণিৰ সময়ছোৱাত স্বতঃস্ফূৰ্তভাৱে হোৱা আন্দোলনে দুই-এঠাইত হিংসাত্মক ৰূপ লোৱাৰ মূলতে আছিল চৰকাৰী পক্ষৰ উচটনি আৰু নিৰাপত্তা বাহিনীৰ যুদ্ধংদেহি মনোভাৱ।</p>
<p>Font Size: 12, Alignment: Centred</p> <p>॥ সংগ্ৰামৰ গতিপথ ॥</p> <p>আমি বাৰে বাৰে এই কথা উনুকিয়াই আহিছো যে অসমৰ সৰ্বস্তৰৰ ৰাইজৰ ব্যাপক সমৰ্থনে নাগৰিকত্ব সংশোধিত আইনবিৰোধী সংগ্ৰামক সৰ্বাত্মক ৰূপ প্ৰদান কৰিছে আৰু নেতৃত্বৰ লগতে জনসাধাৰণৰ গণতান্ত্ৰিক প্ৰতিবাদ যিমানেই শৃংখলাবদ্ধ তথা শান্তিপূৰ্ণ হৈছে, সিমানেই শাসকপক্ষ শ'লঠেকত পৰিছে। আৰম্ভণিৰ সময়ছোৱাত স্বতঃস্ফূৰ্তভাৱে হোৱা আন্দোলনে দুই-এঠাইত হিংসাত্মক ৰূপ লোৱাৰ মূলতে আছিল চৰকাৰী পক্ষৰ উচটনি আৰু নিৰাপত্তা বাহিনীৰ যুদ্ধংদেহি মনোভাৱ।</p>

Figure 7.19: Assamese typing test of *Garhgayan Assamese* keyboard on different platforms

7.3 Typeface application for web and digital devices

In the current time, digital devices are the most widely used and preferred equipment for all kinds of day-to-day activity be it official, professional, personal, or leisure. These devices cover all our needs from education, healthcare, travel, business, research, and so on. Digital devices include a mobile smartphone, tablets, smartwatch, smart glass, GPS systems, and many more. But one thing that is common to all types of devices is the use of communication language which can be displayed through text. A text is represented by font or typeface on these devices to appropriately display or render the communication language. Different devices are used to support different types of fonts. Nowadays smart devices are used to support Unicode compliant regional language scripts of India also to allow users to communicate in their language. Therefore the demand for regional language scripts is increasing day by day. Hence there is a need for font or typeface design for the regional language scripts of India. Many organizations are doing this for device manufacturers to enable websafe and Unicode compliant font for various regional languages of India. As Assamese script is similar to Bengali, hence it shares the same character sets for all kinds of digital platforms from web to mobile to any smart devices or applications. So to establish a digital identity for Assamese script as well as for its language and culture there is a need to bring in a new typeface application useful for digital devices and media which can represent true Assamese essence with a connection from its roots. An aim and objectives have been set up to address this need.

Aim: To design a typing app for mobile and digital devices to display the new typeface Garhgayan Assamese to create an identity.

Objectives: The preliminary objectives are –

- Analyzing the existing Assamese typing apps for usability and interaction.
- Design and develop a customized typing app for android based mobile and digital devices.
- Review and analysis of the app for better functionality.

7.3.1 Analysis of In-script virtual keyboard for Assamese typing

With the entry of smartphones and mobile application software, communication systems have been revolutionized. Due to the rapid increase and demand for digital content, we can now communicate in our language and write in our script on these smart devices. There has been much mobile application software for typing Assamese script developed by many

organizations available nowadays which we can use on our mobile phones or tablets or other digital devices. But almost all are sharing fonts made primarily for Bengali script with the addition of Assamese characters as Unicode recognizes Assamese script as a subset of Bengali script. Therefore customizing a font especially for Assamese script to be used on digital devices is a complex process. Few of the applications available online that offer Assamese language typing have been discussed below.

G-board: It is an in-script virtual keyboard offered by Google for Android devices. It supports all official Indian scripts and allows typing with Unicode standards. This virtual keyboard is the most popular one for android devices. G-board supports all types of social media applications, online web surfing, document typing, etc. for android devices. It offers features like grammar, word probability, character shortcuts, and conjunct letter options which make the keyboard application ahead of all other in-script Assamese keyboards. This application does not have its inbuilt font or typeface, rather it supports the default device font or web font. Shown below in figure 7.20 is a screenshot of the G-board typing app for the Assamese script.

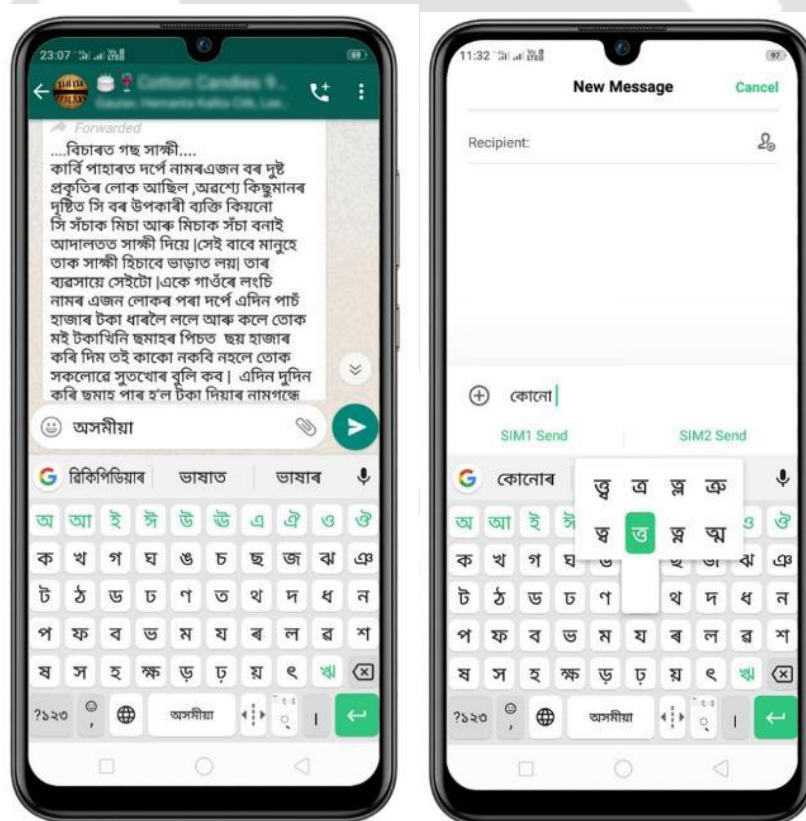


Figure 7.20: G-board, an in-script Assamese typing keyboard by Google for Android devices

Lipikaar: It is a phonetic keyboard for typing Indian regional language scripts. Lipikaar has been developed by Databyte Equipment Pvt. Ltd., Pune, India (refer to figure 7.21).

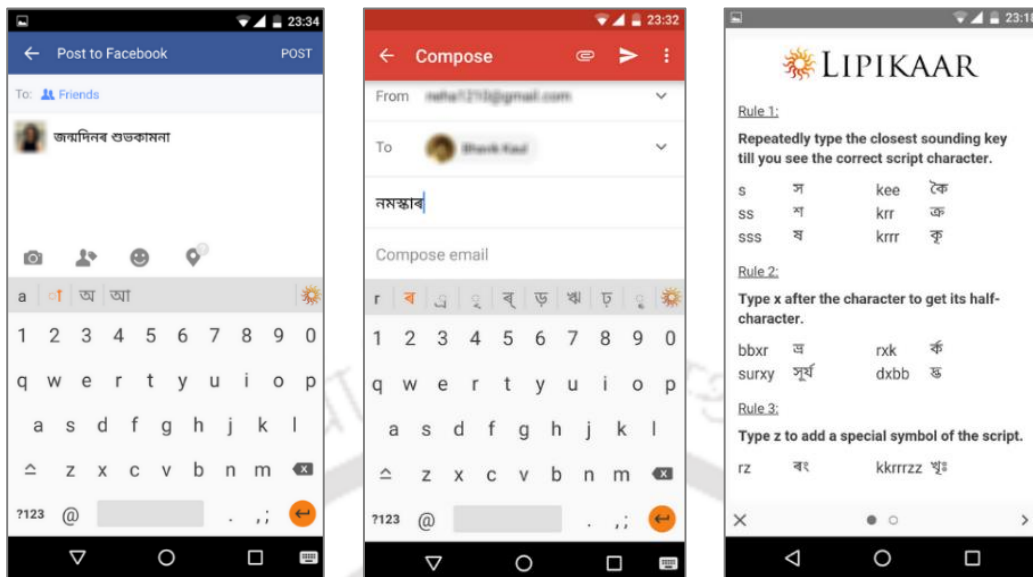


Figure 7.21: The user interface of Lipikaar, a typing app for Assamese script on android devices.

Assamese is also one of its supported scripts which can be used with phonetic typing standards. Phonetic typing is a bit easy for people who have problems with in-script Assamese character typing. But it has few issues in typing such as conjunct letter formation while typing. Sometimes it renders incorrect or undesired conjunct formation during typing because of its non-detection of phonetic characters. Lipikaar also does not have its inbuilt font library and display only default device or web fonts supported by the devices it is installed.

Rodali: This is also an android based typing application for digital devices which offer both in-script Assamese and phonetic Assamese keyboard. Rodali is offered by Gunadeep Chetia.

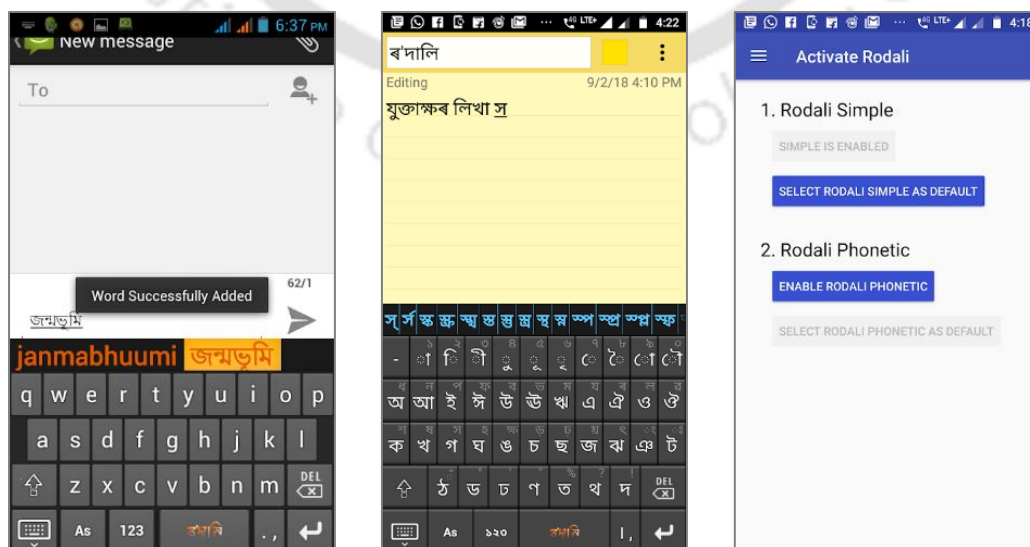


Figure 7.22: The user interface of Rodali, a typing app for Assamese script on android devices.

Because of its two different options for typing the Assamese language, the app has popularity and advantages over many other Assamese typing apps. It has an in-built dictionary and word suggestions similar to G-board. It also provides character formation suggestions for conjunct letters and other words. But the app does not have its in-built font library. It displays default device fonts only (refer to figure 7.22).

Swarachakra: It is an android based typing app developed by the *Swarachakra* team from IDC, IIT Bombay, India (refer to figure 7.23). It supports many Indian regional scripts with its unique in-script keyboard. Assamese is also one of the regional scripts supported by the *Swarachakra* app to type in Assamese script for reading and write the Assamese language. The app also has options for letter and word suggestions while typing. But its dictionary has a limitation in word suggestions. It has a unique user interface for selecting vowels and consonant conjuncts which makes the app more interesting. Though it shows custom fonts on its keys while display, but it doesn't have any in-built custom fonts. It displays only device or web fonts supported by the device on which the app is installed.

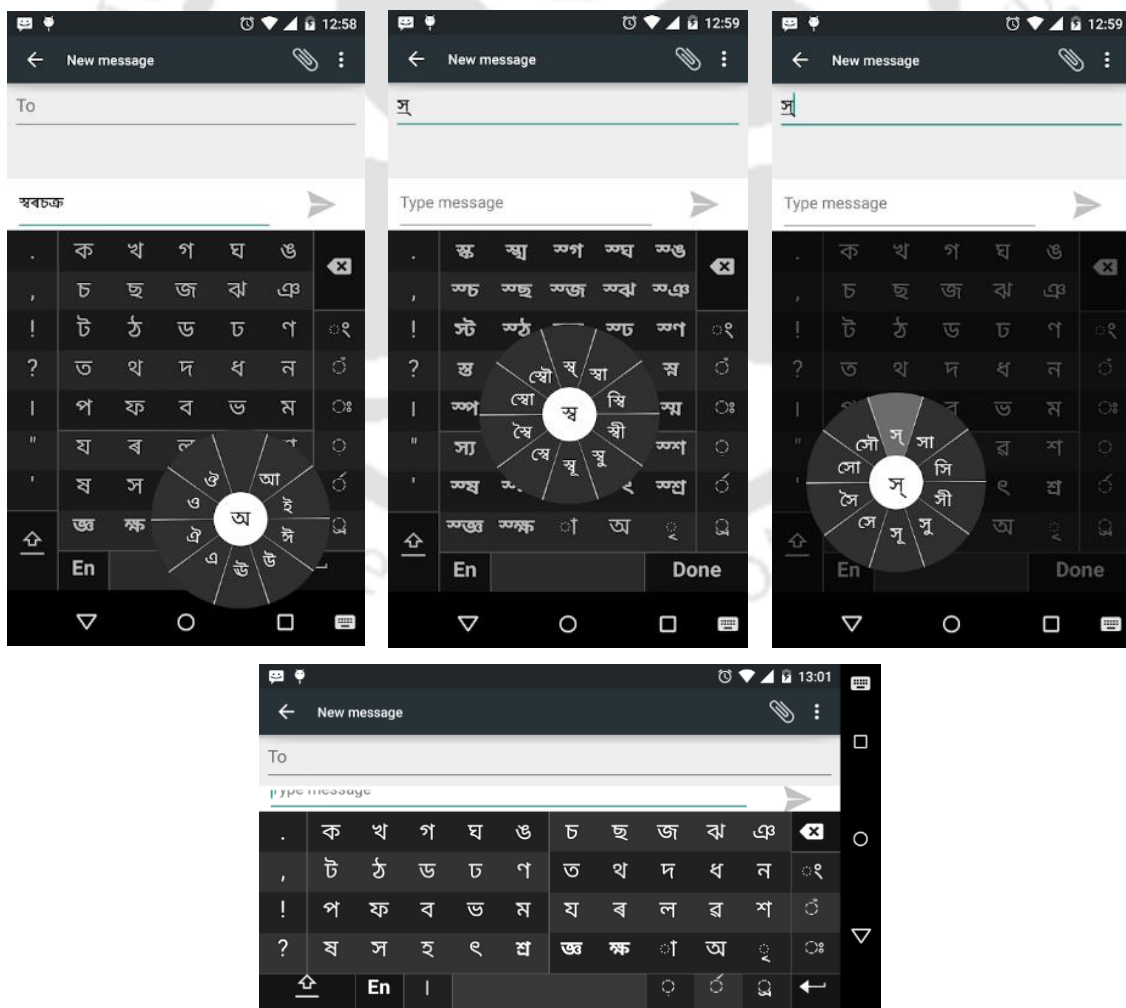


Figure 7.23: The user interface of Swarachakra, a unique typing app for Assamese script

In all these typing applications for Assamese script, none of them have any in-built custom Assamese font which can represent an Assamese identity and essence. They all support default device fonts only as all these apps have been made for multi-lingual script support.

7.3.2 Design and develop a custom typing app for digital devices

Almost all the mobile-based applications for typing Assamese script uses default device fonts installed on the digital devices or web fonts available for mobile app use. All these fonts are designed to meet the universal need for both Assamese and Bengali scripts. Hence there is a need to have an app for mobile or digital devices that could render a custom-designed font for Assamese script that can convey identity to the script, language, and culture of Assam. To address this need, an experiment has been done to design and develop a typing application for digital devices that could display custom-designed new font “*Garhgayan Assamese*”. The objective of the experiment is to establish a digital identity for the Assamese script with the help of a mobile app that renders custom-designed *Garhgayan Assamese* font which could portray a connection with the historical Assamese writing style *Garhgayan*.

7.3.2.1 Description of the mobile application

It is a typing app for android devices with an Assamese in-script keyboard to display a custom-designed *Garhgayan Assamese* typeface. This Typing App renders ancient Assamese *Garhgayan* writing style as a display typeface. It is a part of the research experiment to bring back unique identity to Assamese script by recreating digital representation of ancient *Garhgayan* style. The in-script keyboard also displays the custom-designed font to relate with the typing document. One can create, copy-paste, save and edit notes within the app. The keyboard can also be easily converted into a device keyboard or to a *Garhgayan* keyboard with shortcut keys. Special characters such as *start matra* and *end matra* have been introduced with dedicated keys in this custom-designed typeface to showcase ancient sentence writing style. Conjunct letters can be easily written either by long-pressing any keys to select the desired conjunct form or following the standard Unicode format for writing conjunct letters. Long press the bottom line keys to look for more options inside that key. Vowel signs are also clubbed inside the “Aa” kar key at the bottom line.

The custom font will work only within the app and cannot be exported to any other app like WhatsApp or Facebook as this project is still in the experimental phase.

The reason for developing this experimental app is to introduce an Assamese typeface for digital devices that could be considered unique in the world of digital contents creation in

the Assamese language. People should feel emotionally connected with the typeface which in turn makes them emotionally attached with the contents created digitally in the Assamese language. This may also lead to an increase in digital content creation in the Assamese language which is now very less if compared to other Indian languages.

To download and test the app on a mobile phone with an android operating system the Google play store link is as follows:

<https://play.google.com/store/apps/details?id=com.deb.mykeyboard&hl=en>

Shown below are a few of the screenshots to explain the app visually (refer to figures from 7.24 to 7.34).

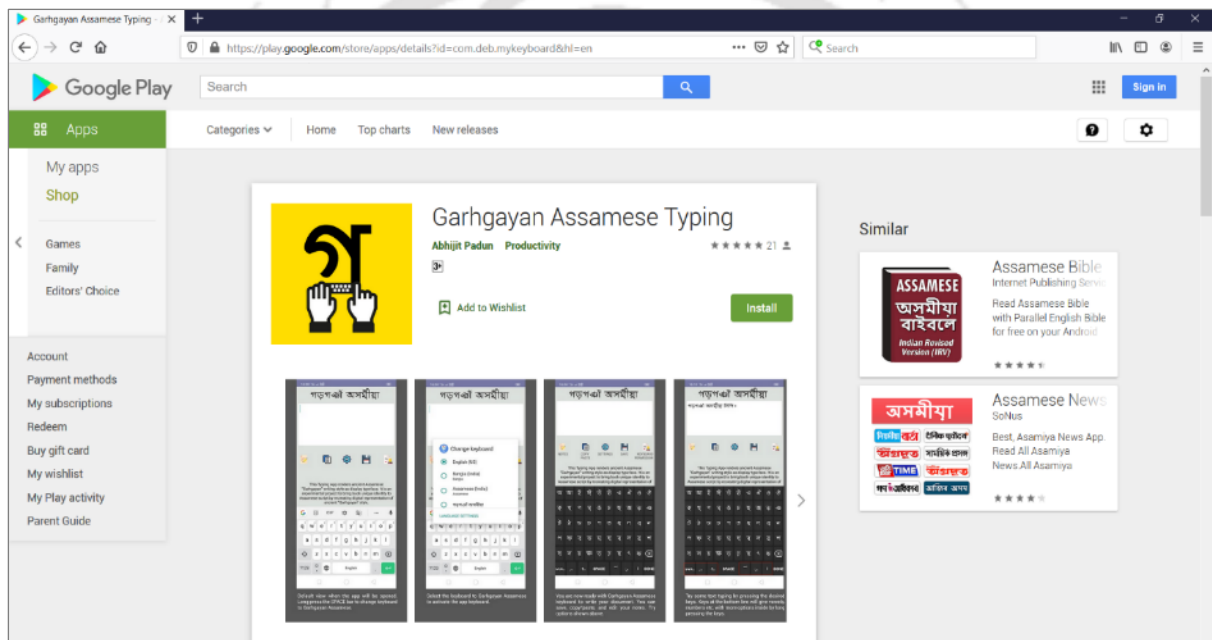
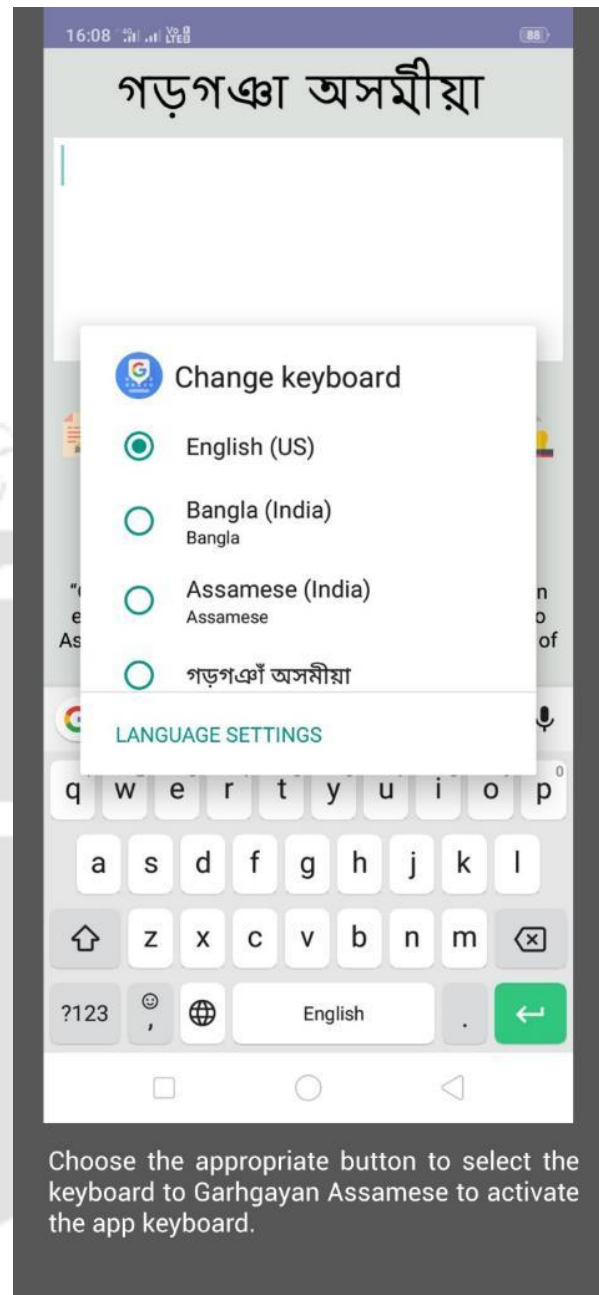
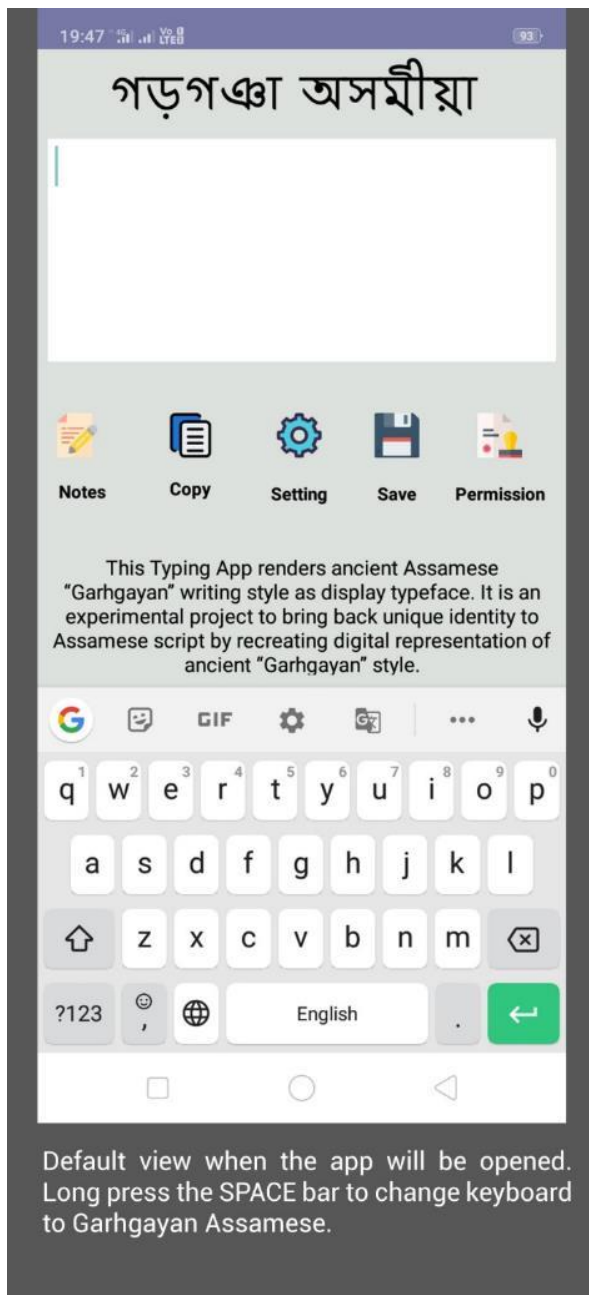


Figure 7.24: *Garhayan Assamese* typing app on Google Play Store webpage



Figure 7.25: Publicity web banner of *Garhayan Assamese* typing app for web display



(a)

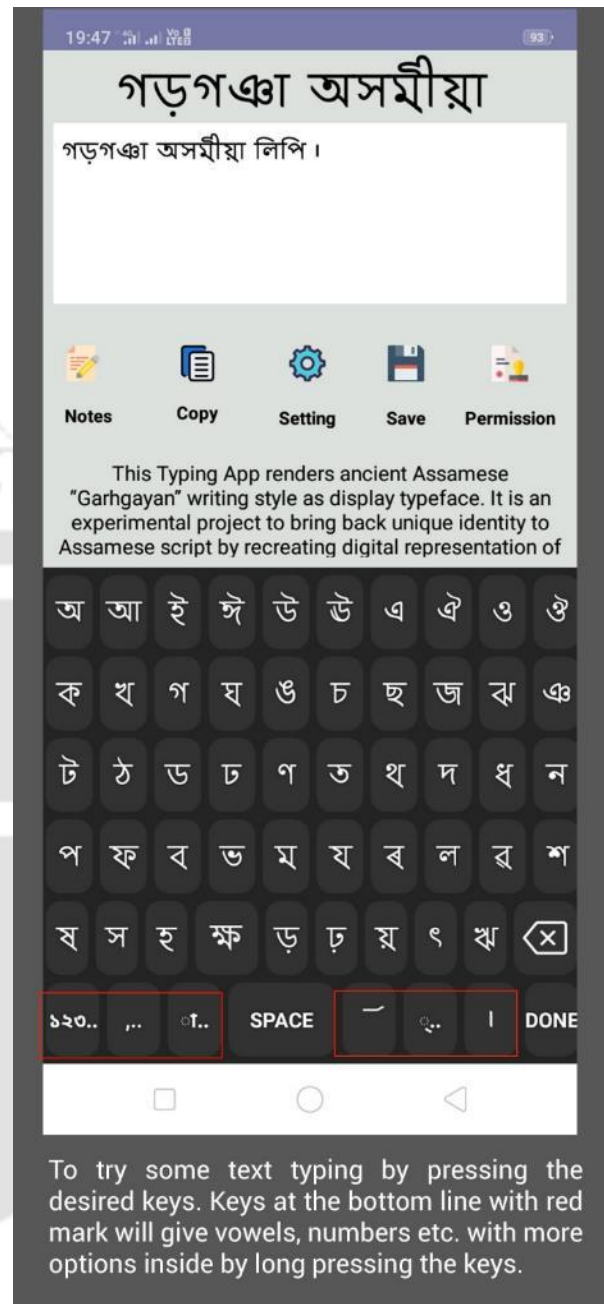
(b)

Figure 7.26 (a): Default view of the app after opening.

Figure 7.26 (b): Option to change the default keyboard to app keyboard.



(a)



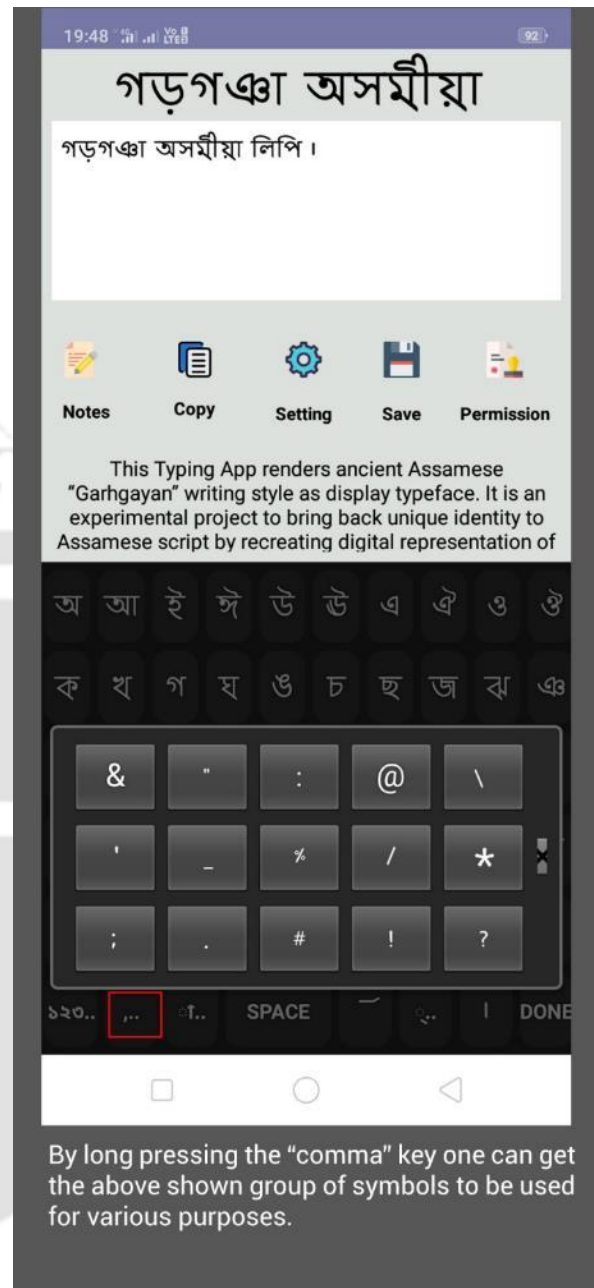
(b)

Figure 7.27 (a): Full display of app keyboard after activation.

Figure 7.27 (b): The bottom line keys marked in red boxes have more options inside.



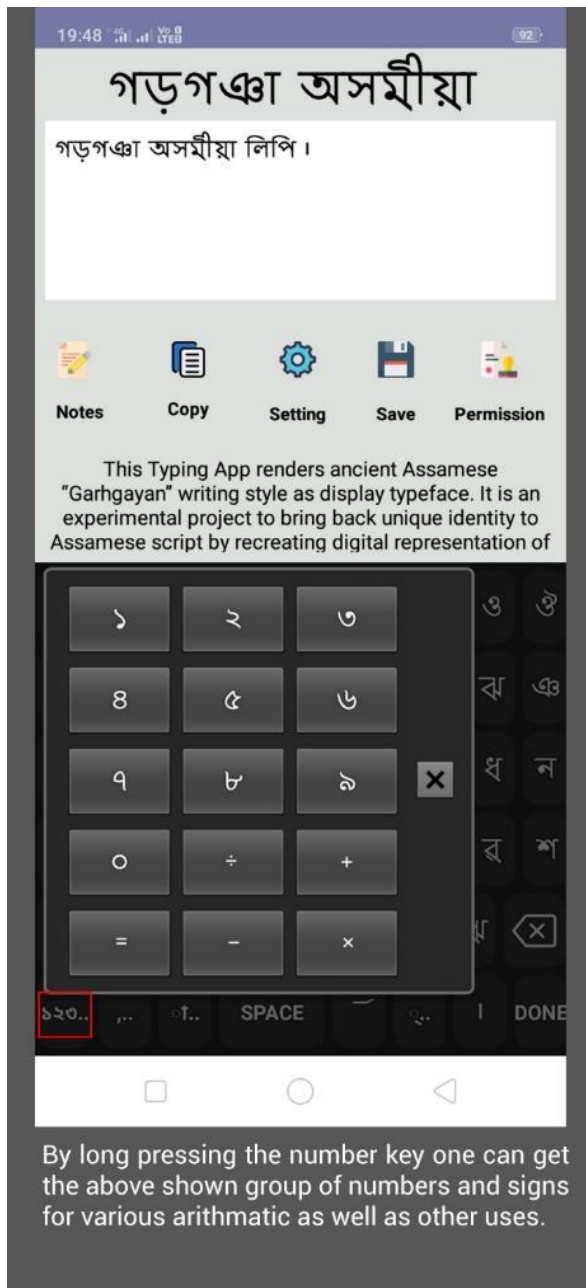
(a)



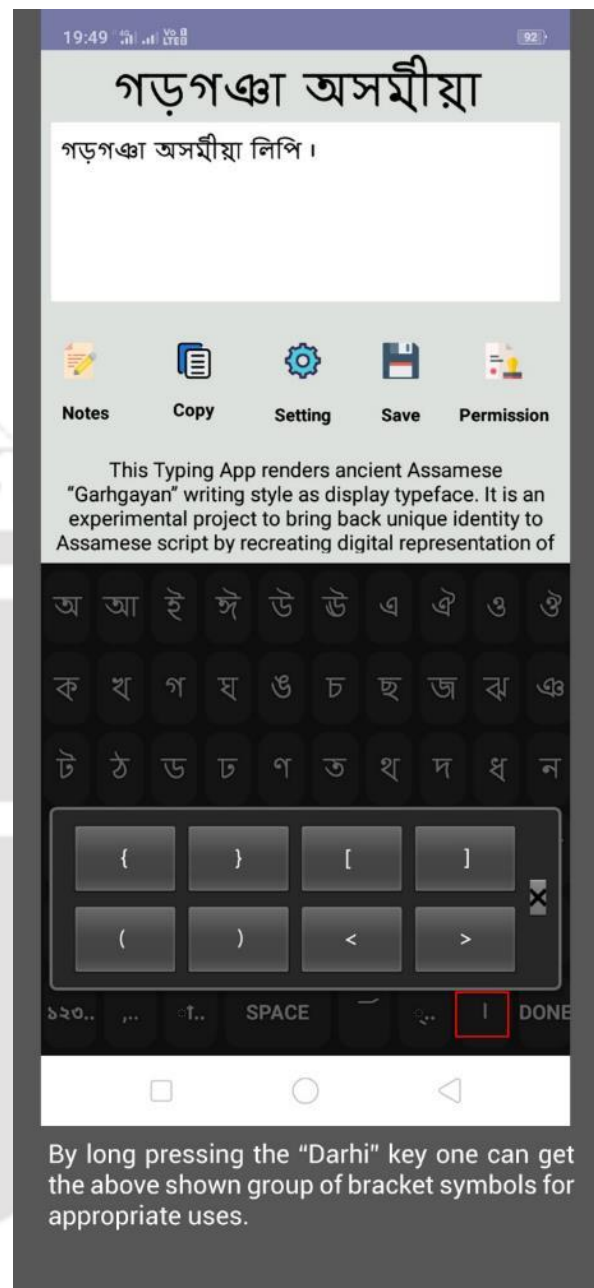
(b)

Figure 7.28 (a): Typing options for vowel symbols.

Figure 7.28 (b): Typing options other miscellaneous symbols.



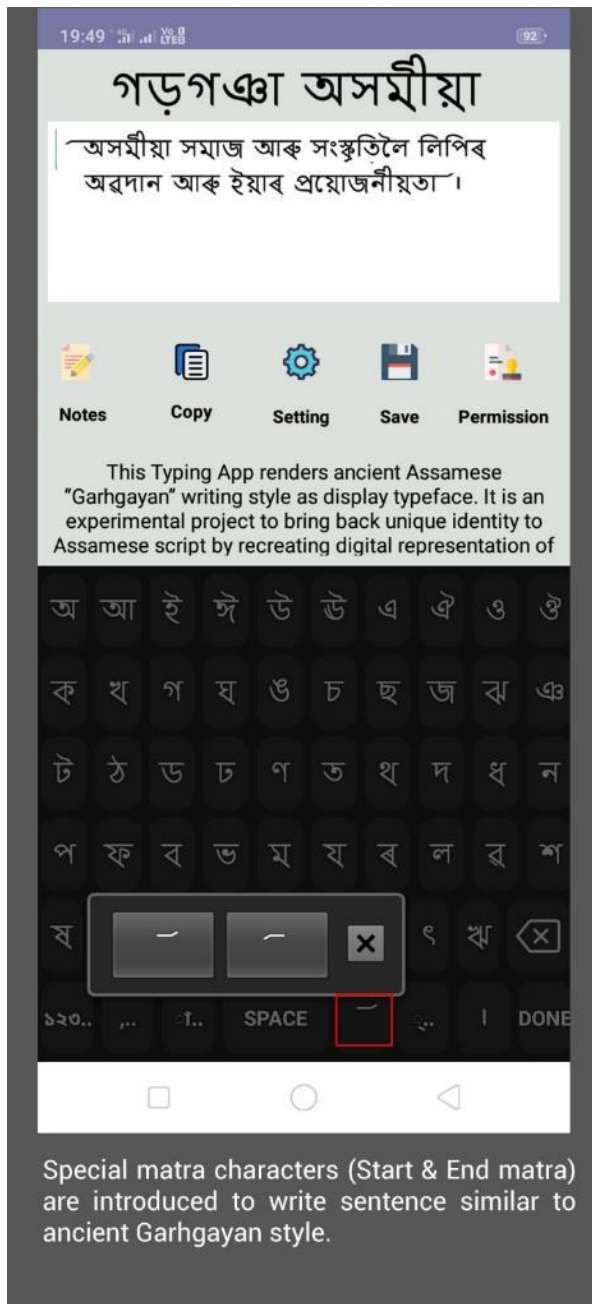
(a)



(b)

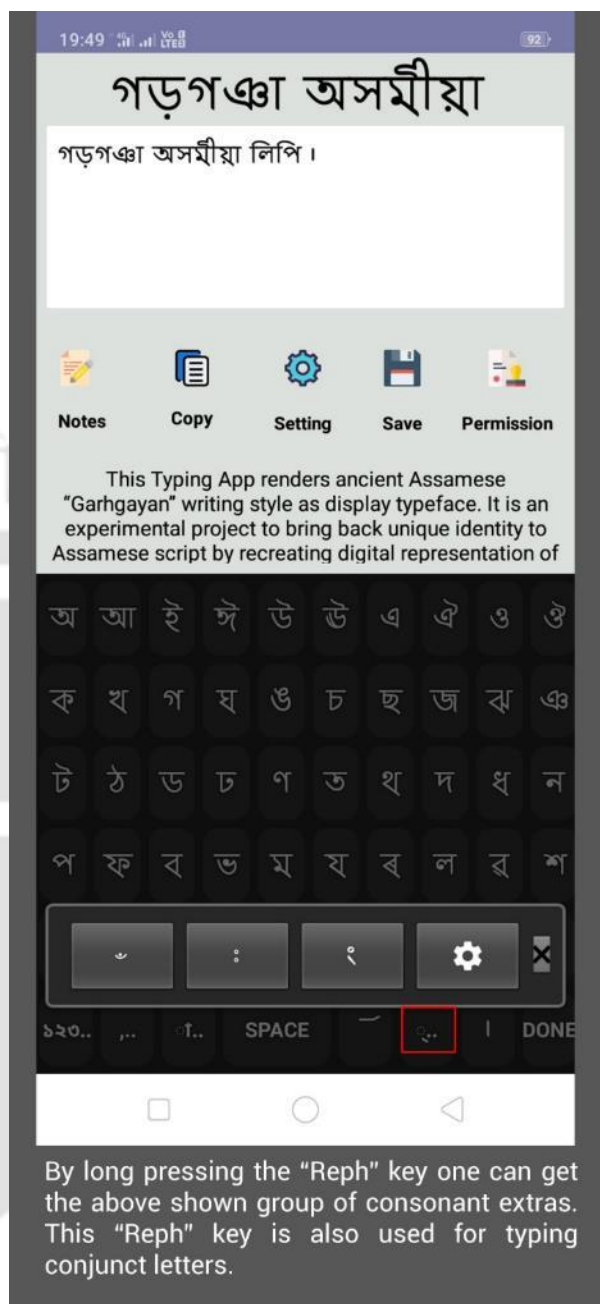
Figure 7.29 (a): Typing options for numbers

Figure 7.29 (b): Typing options for bracket types.



(a)

Figure 7.30 (a): Typing options for start & end matra.



(b)

Figure 7.30 (b): Typing options for consonant extras.



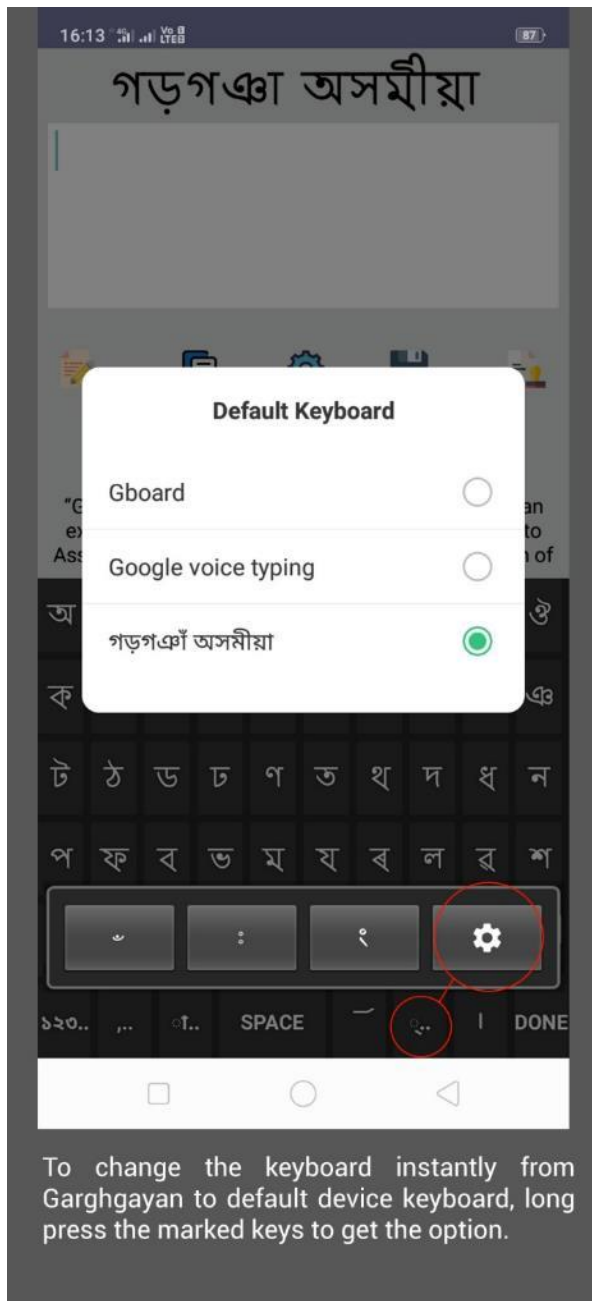
(a)



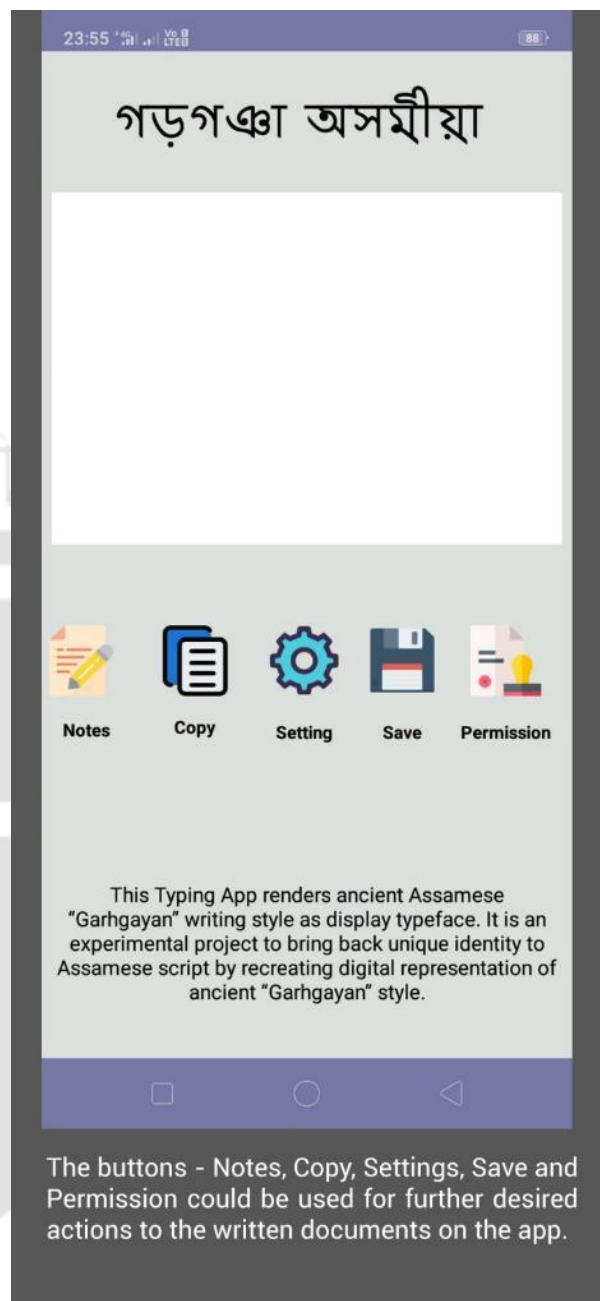
(b)

Figure 7.31 (a): Typing options for conjunct letters with shortcut keys.

Figure 7.31 (b): Typing options for conjunct letters by direct typing.



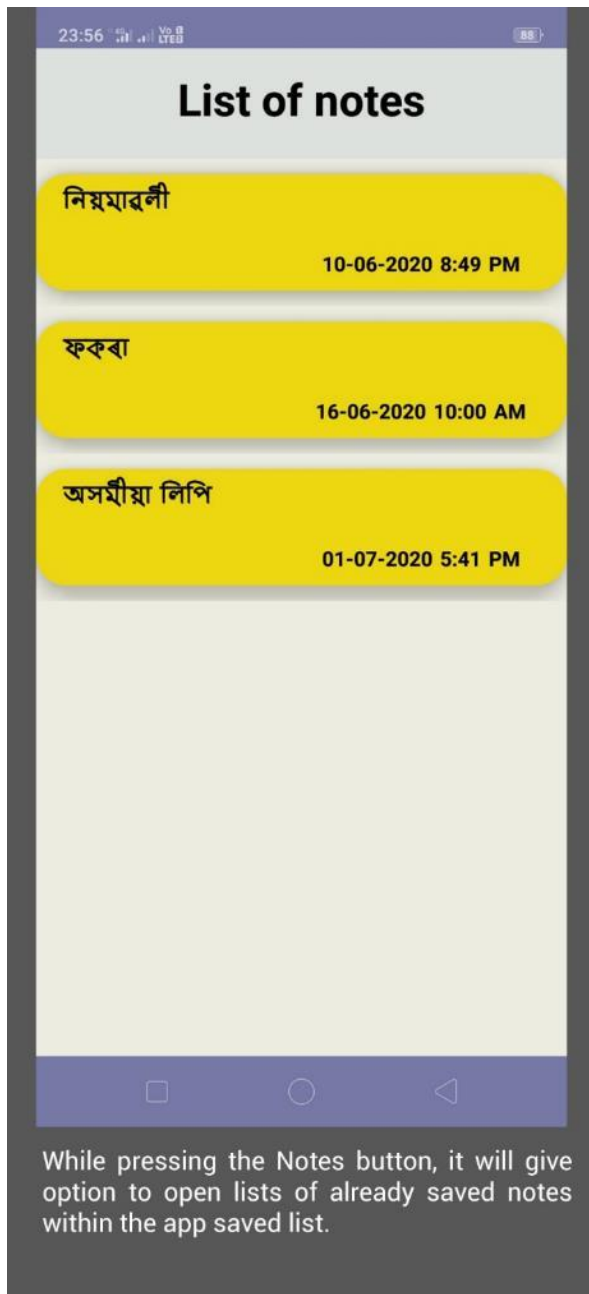
(a)



(b)

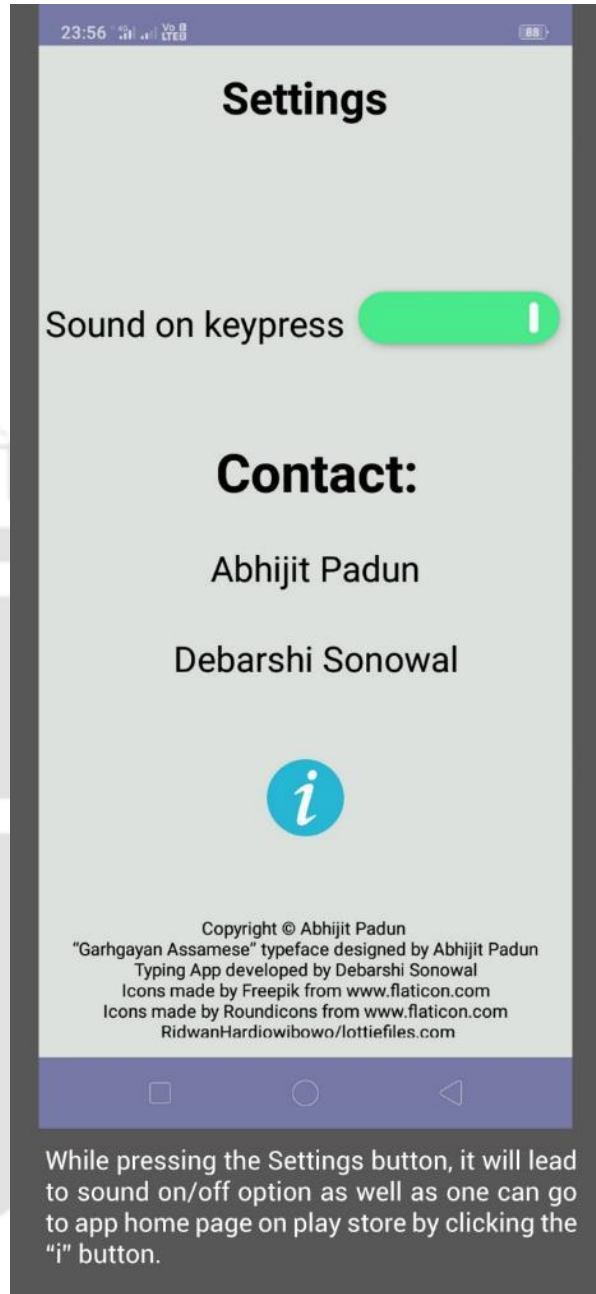
Figure 7.32 (a): Shortcut option for selecting default keyboard option.

Figure 7.32 (b): Featured buttons for further processing of the written document.



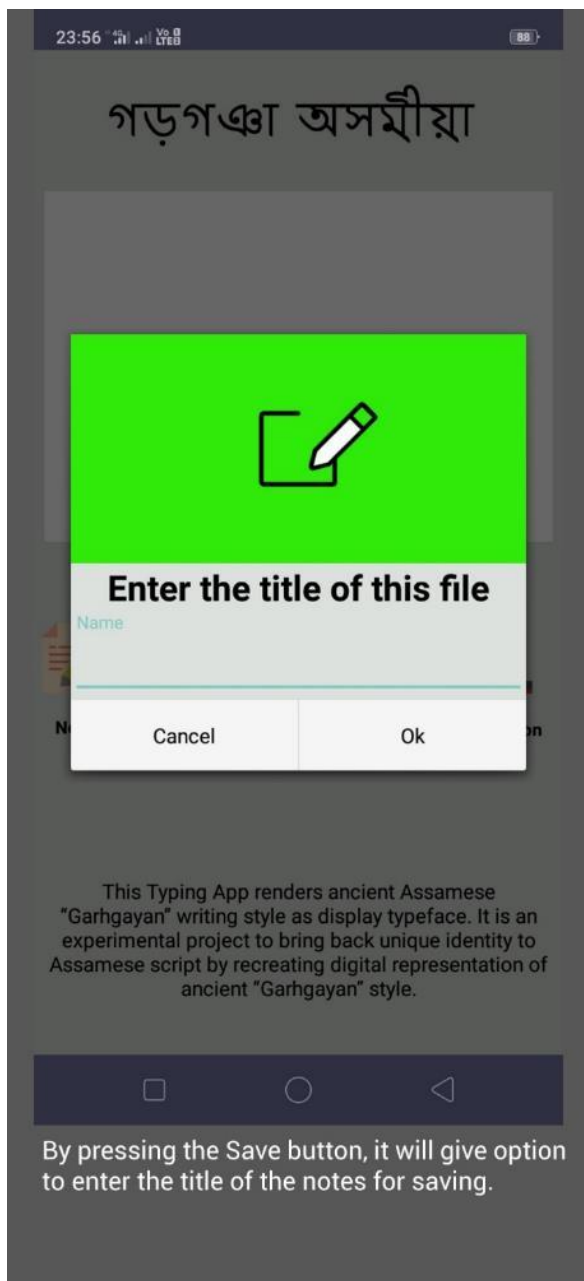
(a)

Figure 7.33 (a): Options under the “Notes” button.

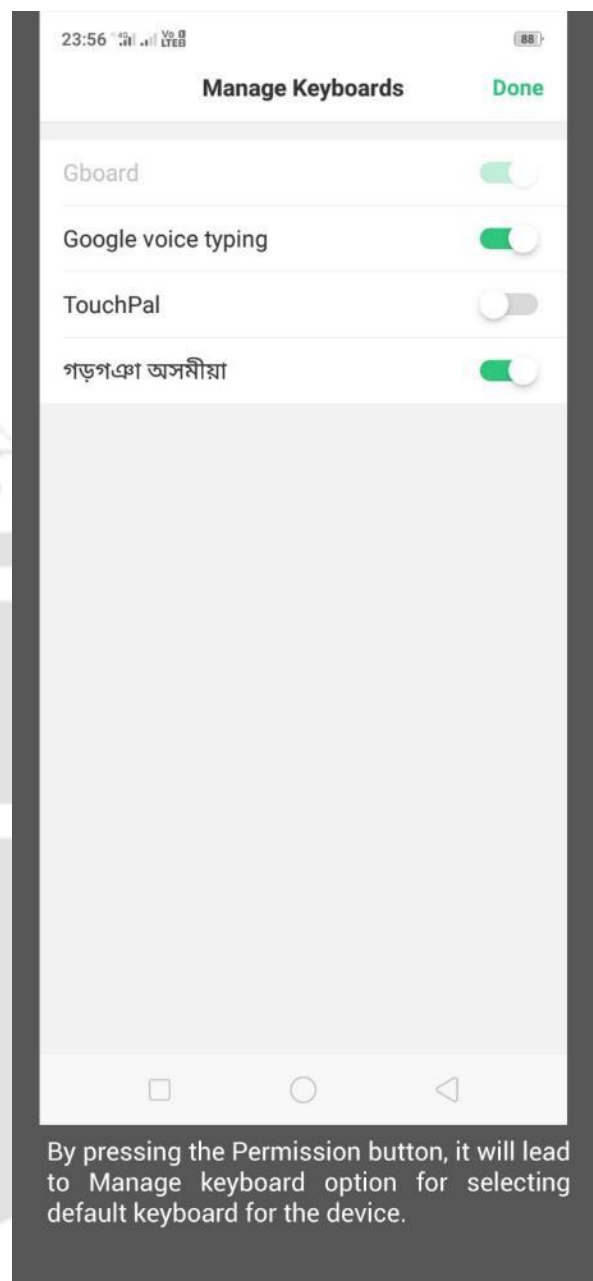


(b)

Figure 7.33 (b): Options under the “Settings” button.



(a)



(b)

Figure 7.34 (a): Options under the "Save" button.

Figure 7.34 (b): Options under the "Permission" button.

7.3.3 Review and analysis of the app

The following key points could be summarized for the typing app *Garhgayan Assamese*.

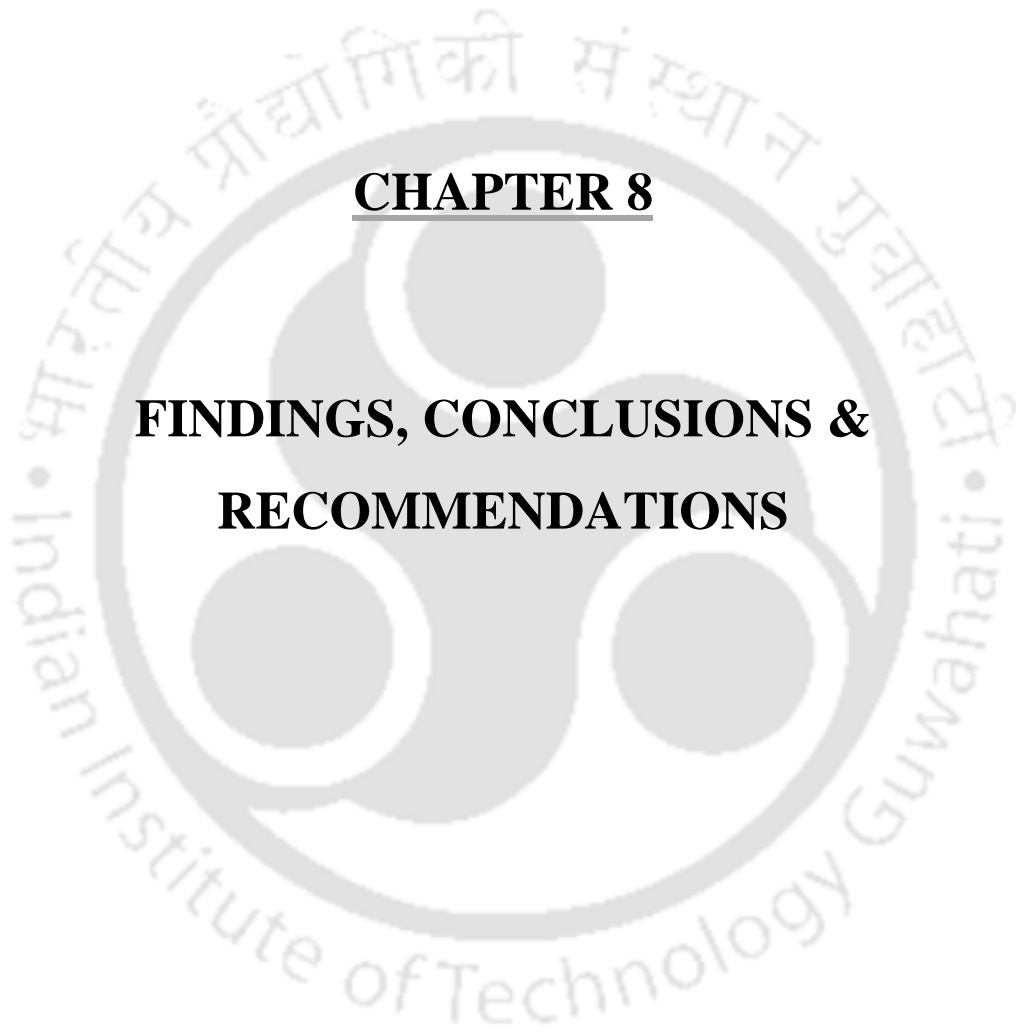
- i. The mobile app Garhgayan Assamese has been designed and developed for Android-based devices. It works fine with Android 4.4 and above version.
- ii. The primary interface of the app has been kept very simple to understand easily even by a young armature who would like to have a try on the app.
- iii. Simple buttons have been given for save, settings, notes, etc. to further processing.
- iv. The virtual touch-based in-script keyboard has been given the look and feel of the same typeface Garhgayan Assamese which is embedded with the app. That makes the keyboard interface of the app more appealing to users.
- v. The shortcut keys for selecting conjunct letters are a better option to avoid typing it manually which saves time and effort. But as the app is in its experimental stage, hence the complete list of probable conjunct letters could not be assembled in the shortcut keys.
- vi. To type conjunct letters manually, one has to follow Unicode standard method for typing conjunct letters for any Bangla/Assamese scripts by putting the “*halant*” symbol as a joiner.
- vii. Vowel symbols, numbers, brackets, arithmetic symbols, etc. are kept in groups under single individual keys. That makes the keyboard intact and displaying the full keyboard without pressing any shift keys.
- viii. Keyboard conversion from default device keyboard to app keyboard and vice versa is very smooth and easy.
- ix. The embedded app font Garhgayan Assamese renders high-quality text in the app while typing. The text typed can be copied, saved, or edited very easily. One shortcoming is that the app font could be applied on other apps such as WhatsApp or Facebook etc. as the font has been in its experimental stage and it has to be approved by other app or device manufacturers to be enabled everywhere.
- x. From a brief user survey, it has been observed that Garhgayan Assamese typing app produces promising results among the users who would like to try and explore creating digital contents in the Assamese language, especially those who speak the language as mother tongue and love to contribute in creating digital contents in the Assamese language.

7.4 Observation and discussion

In the research experiment phase – 3, the application of the new typeface *Garhayan Assamese* has been tested for computer and digital device display. The typeface works well in computer use as it has been produced as a TrueType Font. The compatibility of the font also goes well with different operating systems as True Type is the most common font format accepted universally. Any in-script Assamese keyboard whether actual or virtual can work with the typeface. But Unicode Assamese keyboard has been the preferred keyboard as the typeface was tested with that. However, due to the addition of new and unique characters into the new typeface, the standard keyboard could not be used to type those characters. Therefore other manual options need to be explored while typing those characters. Such as in MS word, to type the special characters “Start matra” and “End matra” one needs to choose the “Insert symbol” option. Similarly for other document typing software and design software, one has to choose for additional options rather than direct typing. This issue arises the need for a custom-designed keyboard where these unique characters could be put with dedicated keys for continuous typing without looking for manual options. To address this issue, a custom-designed virtual in-script Assamese keyboard has been designed where the dedicated keys have been used for direct typing of these new unique characters. The virtual keyboard has been designed in a new direction by taking reference from standard Google’s G-board, a virtual in-script keyboard for mobile devices to type Indian scripts. The objective of the keyboard was to address any amateur user who would like to try the keyboard for typing in Assamese script.

As the user feedback of custom keyboards shows inspiring results, next was to address the issues for digital devices such smartphones, tablets, etc. A typing application with an in-script Assamese keyboard has been developed for android based mobile and digital devices to render the new typeface for screen display. This typing app named “*Garhayan*” has been designed and developed as an experimental app to check the feasibility and applicability of the new typeface on mobile phones and digital devices. The app has been developed for android devices that support version 4.4 and above. Dedicated keys have been assigned for typing unique characters of the typeface and even the keyboard has been designed to display the *Garhayan Assamese* font which was embedded in the app. This made the app different from other Assamese in-script typing apps. The app has been published on Google Play Store for free download and to see how users are reacting to the app. The user review of the app shows a very encouraging result. The experiments with custom keyboard design for computer and app design for digital devices showed promising results with a positive output for the entire research work.





CHAPTER 8

FINDINGS, CONCLUSIONS & RECOMMENDATIONS



Chapter 8. Findings, Conclusions, and Recommendations

In this chapter research data, research experiments, and research results have been put for extensive user survey to evaluate and analyze the primary aim and objectives of the research work. Findings of the research work have been put forward to analyze whether the results could achieve their goal or not. Based on the analysis of the findings, research conclusions have been compiled with future scope of work and expectations, further recommendations, and scope of future study.

8.1 User Survey

After the completion of the research experiment phases, the outcome of all the experiments has been compiled for a user survey. The final compilation of research experiments comprises of the following –

- i. Design, analysis, and critical comparison of *Garhgayan Assamese* typeface with other popular digital typefaces.
- ii. Scope and application of *Garhgayan Assamese* typeface for various needs
- iii. Custom keyboard design for *Garhgayan Assamese* typeface to accommodate unique characters as well as to enhance typing usability for amateurs.
- iv. Typing app design for mobile and digital devices to make the typeface applicable and popular on smartphones and digital devices.

All these research experiments have been validated through user surveys to prove their aim and objectives. The selection of users has been categorized based on professional background, industry sector, academic sector, and interest factor. The reason for making such categorization was to bring in authentic data on the research experiments that can validate the analysis of user surveys to be logical rather than hypothetical. Following are the description of categorization.

- The professional background of a user can describe whether the user could contribute appropriate feedback and inputs on what have been asked on the survey questionnaire. For this, people mostly from design backgrounds especially graphic design, print publication design, or related professional backgrounds have been considered as the top priority.
- For the industry category, primarily print publication industry have been considered as a priority due to its extensive involvement with typeface and typography be it a regional

language, national language, or English language. After print publication, the advertising industry, entertainment industry, and movie industry have been considered for further exploration.

- One of the very important categories is the academic sector. In today's digital era academicians, students and anyone related to academics uses to take interest in digital content surfing and creation. Therefore it is very important to take their concern in the user survey to collect a good amount of review and feedback.
- Last but not the least, users have been categorized based on their interest factor. Many people use to take interest in contributing to literary work in their regional language. They may not be a writer, poet, or a literary person but they used to take concern on the latest happenings in the literary world in their regional language. Such people are always helpful in contributing to research work which influences the literary society as well.

For each of the research experiments, a specific number of users have been selected from these categories to answer few critical questions on the experiment to analyze their views and further implications. The user survey questions for each experiment have been different such as the descriptive, objective, yes/no type, point-based, etc. to get appropriate quantitative data.

A total of 53 candidates have been shortlisted out of around 200 participants who took part in the user survey. They have been shortlisted from across the categories and from various regions of Assam as well as India. They have been given the questions to answer their honest review, feedback, and ratings as per the requirements of the questions. The reviews received from the users have been very encouraging with a positive result.

8.1.1 Comparison and analysis of new typeface

The new typeface *Garhayan Assamese* has been put for comparison with other frequently used digital typefaces used for typing the Assamese language as well as a historical writing sample of *Garhayan* for critical analysis and user review. The initial comparison has been conducted with the historical *Garhayan* writing style from three different periods. Digitally traced image samples of historical *Garhayan* writing styles from the 17th, 18th, and 19th centuries have been placed with the newly designed *Garhayan Assamese* typeface for review and analysis by a selective group of users. Shown below is the image of the *Garhayan Assamese* typeface in comparison with its historical counterparts (refer to figure 8.1).

<p>পটোৱাৰি ওতাৰুদাৰুচা কুৰিয়াহানো সকলো সাবধা নেজানিব কোঁকৰুভা গল্প পাৰপৰগণা বন্তুহুৰা গাৰ্গৈ বহুজু</p> <p>Digitally traced image of historical Garhgyan writing sample (17th century)</p>	<p>কামৰূপ দেসৰ বৰুৱাস্তৰুকায হুঁচৌয়া দাৰ মুকৰিয়া সকলো সাবধা নেজানিব শ্ৰীযত্ৰুপিব বৰুজনা গৃহিনিম গৌৰীচন্দ্র বৰুৰু</p> <p>Digitally traced image of historical Garhgyan writing sample (18th century)</p>
<p>প্ৰথম প্ৰচণ্ড প্ৰতাপত পনদলিত প্ৰবল বিধু পুটলু ন্তি সাগৰ গন্তীৰ ধীৰ সকললোক মনোৰথ প্ৰৰণ কল্প গৰদিন্দু স্বন্দৰ কীৰ্ত্তিকৰ শ্ৰী শ্ৰী স্বৰ্দ্ধনাৰায়</p> <p>Digitally traced image of historical Garhgyan writing sample (19th century)</p>	<p>প্ৰথম প্ৰচণ্ড প্ৰতাপত পনদলিত প্ৰবল বিপুপট সাগৰ গন্তীৰ ধীৰ সকললোক মনোৰথ প্ৰৰণ ক গৰদিন্দু স্বন্দৰ কীৰ্ত্তিকৰ শ্ৰী শ্ৰী স্বৰ্দ্ধনাৰায়ণ</p> <p>New Garhgyan Assamese typeface design</p>

Figure 8.1: Comparison of new typeface with historic *Garhgyan* writing style

After that, the new typeface has been placed with three modern digital Assamese typefaces used currently. These three digital typefaces have been designed for both Bengali and Assamese languages with Unicode standards. These are *Nirmala UI*, *Vrinda*, and *Hind Siliguri*. Shown below is the image of Garhgyan Assamese in comparison with the other three digital typefaces used for the Assamese language (refer to figure 8.2).

Garhgyan Assamese typeface Font size: 12 point Promoter: Abhijit Padun	Nirmala UI typeface Font size: 12 point Promoter: Microsoft Corp.	Vrinda typeface Font size: 12 point Promoter: Microsoft Corp.	Hind Siliguri typeface Font size: 12 point Promoter: Google Inc.
॥ সংগ্ৰামৰ গতিপথ ॥	॥ সংগ্ৰামৰ গতিপথ ॥	॥ সংগ্ৰামৰ গতিপথ ॥	॥ সংগ্ৰামৰ গতিপথ ॥
আমি বাৰে বাৰে এই কথা উনুকিয়াই আহিছো যে অসমৰ সৰ্বস্তৰৰ ৰাইজৰ ব্যাপক সমৰ্থনে নাগৰিকত্ব সংশোধিত আইনবিৰোধী সংগ্ৰামক সৰ্বাত্মক ৰূপ প্ৰদান কৰিছে আৰু নেতৃত্ব লগতে জনসাধাৰণৰ গণতান্ত্ৰিক প্ৰতিবাদ যিমানেই শৃংখলাবদ্ধ তথা শান্তিপূৰ্ণ হৈছে, সিমানেই শাসকপক্ষ শ'লঠেকত পৰিছে। আৰম্ভণিৰ সময়ছোৱাত স্বতঃস্ফূৰ্তভাৱে হোৱা আন্দোলনে দুই-এঠাইত হিংসাত্মক ৰূপ লোৱাৰ মূলতে আছিল চৰকাৰী পক্ষৰ উচটনি আৰু নিৰাপত্তা বাহিনীৰ যুদ্ধংদেহি মনোভাৱ।	আমি বাৰে বাৰে এই কথা উনুকিয়াই আহিছো যে অসমৰ সৰ্বস্তৰৰ ৰাইজৰ ব্যাপক সমৰ্থনে নাগৰিকত্ব সংশোধিত আইনবিৰোধী সংগ্ৰামক সৰ্বাত্মক ৰূপ প্ৰদান কৰিছে আৰু নেতৃত্ব লগতে জনসাধাৰণৰ গণতান্ত্ৰিক প্ৰতিবাদ যিমানেই শৃংখলাবদ্ধ তথা শান্তিপূৰ্ণ হৈছে, সিমানেই শাসকপক্ষ শ'লঠেকত পৰিছে। আৰম্ভণিৰ সময়ছোৱাত স্বতঃস্ফূৰ্তভাৱে হোৱা আন্দোলনে দুই-এঠাইত হিংসাত্মক ৰূপ লোৱাৰ মূলতে আছিল চৰকাৰী পক্ষৰ উচটনি আৰু নিৰাপত্তা বাহিনীৰ যুদ্ধংদেহি মনোভাৱ।	আমি বাৰে বাৰে এই কথা উনুকিয়াই আহিছো যে অসমৰ সৰ্বস্তৰৰ ৰাইজৰ ব্যাপক সমৰ্থনে নাগৰিকত্ব সংশোধিত আইনবিৰোধী সংগ্ৰামক সৰ্বাত্মক ৰূপ প্ৰদান কৰিছে আৰু নেতৃত্ব লগতে জনসাধাৰণৰ গণতান্ত্ৰিক প্ৰতিবাদ যিমানেই শৃংখলাবদ্ধ তথা শান্তিপূৰ্ণ হৈছে, সিমানেই শাসকপক্ষ শ'লঠেকত পৰিছে। আৰম্ভণিৰ সময়ছোৱাত স্বতঃস্ফূৰ্তভাৱে হোৱা আন্দোলনে দুই-এঠাইত হিংসাত্মক ৰূপ লোৱাৰ মূলতে আছিল চৰকাৰী পক্ষৰ উচটনি আৰু নিৰাপত্তা বাহিনীৰ যুদ্ধংদেহি মনোভাৱ।	আমি বাৰে বাৰে এই কথা উনুকিয়াই আহিছো যে অসমৰ সৰ্বস্তৰৰ ৰাইজৰ ব্যাপক সমৰ্থনে নাগৰিকত্ব সংশোধিত আইনবিৰোধী সংগ্ৰামক সৰ্বাত্মক ৰূপ প্ৰদান কৰিছে আৰু নেতৃত্ব লগতে জনসাধাৰণৰ গণতান্ত্ৰিক প্ৰতিবাদ যিমানেই শৃংখলাবদ্ধ তথা শান্তিপূৰ্ণ হৈছে, সিমানেই শাসকপক্ষ শ'লঠেকত পৰিছে। আৰম্ভণিৰ সময়ছোৱাত স্বতঃস্ফূৰ্তভাৱে হোৱা আন্দোলনে দুই- এঠাইত হিংসাত্মক ৰূপ লোৱাৰ মূলতে আছিল চৰকাৰী পক্ষৰ উচটনি আৰু নিৰাপত্তা বাহিনীৰ যুদ্ধংদেহি মনোভাৱ।

Figure 8.2: Comparison of new typeface with other three digital Assamese typefaces.

Both these two comparisons have been presented to a group of users for review and analysis with a specific set of questionnaires. The users for the survey have been selected with the following criteria to achieve the best review and feedback.

- Four people have been selected from the print publication industry.

- ii. Four people are from the graphic design profession
- iii. Six people are from the academic sector with literary interests.
- iv. Two people from a general background with a keen interest in digital contents creation.
- v. Four students, two from undergraduate and two from postgraduate level.

A group of 20 people has been picked up for the user survey out of 53 candidates. The set of questionnaire comprises of various questions related to the following key subjective areas have been given to the users for their critical feedback.

- a) The appeal of the new typeface comparing to the historical writing style
- b) Continuation of originality from its historical references
- c) Readability, legibility, and aesthetic appeal compared to other digital typefaces
- d) Cultural and emotional connection with the typeface
- e) Originality and uniqueness created by the typeface

Complete questionnaire series have been compiled in Annexure – 1c. Results and analysis of the questionnaire have been discussed separately in the later section.

8.1.2 User survey of typeface and its application

Application of the new *Garhgayan Assamese* typeface has been already discussed in the previous chapter with examples of images from the web, mobile, and document display. The same has been shown here for reference to be applied for a user survey (refer to figure 8.3, 8.4, and 8.5). The application of typeface shown on the webpage of *Asomiya Pratidin* and the mobile screen of WhatsApp are taken as a reference only for testing purposes to see the performances. The original website and the mobile app have not been disturbed or degraded.

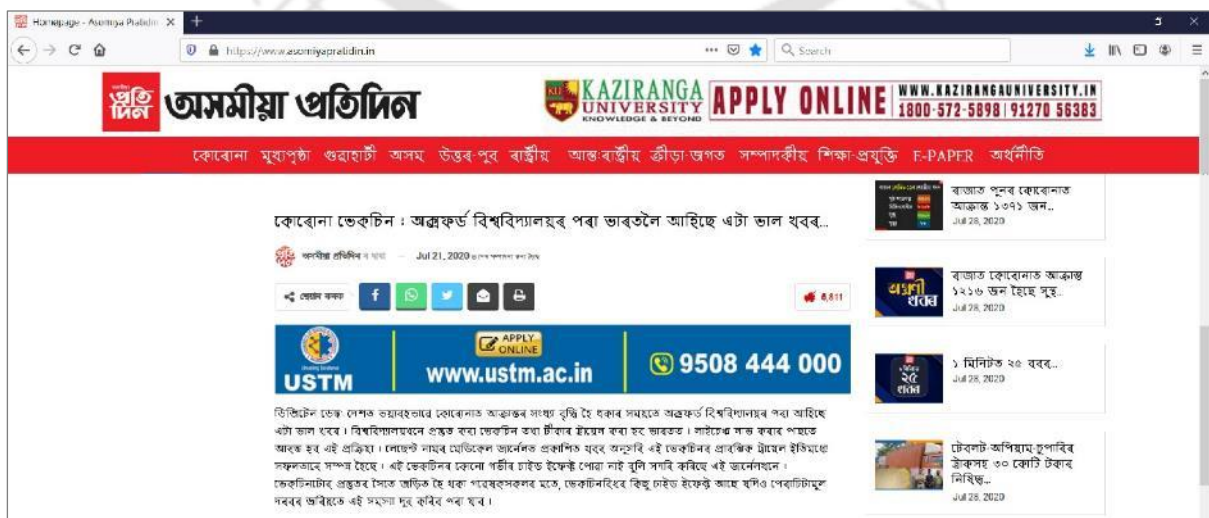


Figure 8.3: Application of *Garhgayan Assamese* font on *Asomiya Pratidin* website (ref. from fig. 6.30)



Figure 8.4: Application of the font on mobile devices (ref. from fig. 6.34)

Font Size: Heading – 12, Body – 10, Align: Justify	Font Size: Heading – 14, Body – 12, Align: Centre	Font Size: Heading – 20, Body – 16, Align: Left
<p>ঈশ্বৰহীনতা</p> <p>অসহজ সময়ৰ ধাৰাবাহিকতা চলি আছে। আগেয়ে কাহানিও নোপোৱা এক অভিজ্ঞতাৰ মাজেৰে দেশৰ মানুহে দিন কটাবলগীয়া হৈছে। কেৱল দেশেই নহয়, পৃথিৱীৰ ১৩০ কোটি মানুহৰ ঘৰৰ ভিতৰতে কেইবা সপ্তাহ সোমাই থাকিবলগীয়া এই বাধ্যবাধকতা মানৱ সভ্যতাত প্ৰথম। জীৱন বন্ধাৰ বাবে 'স্কন্ধতাৰ' এই সম্পৰীক্ষাত পক্ষ আৰু প্ৰতিপক্ষ এচাম মানুহ বনাম আন এচাম মানুহ নহয়। সমগ্ৰ মানৱ জাতি এফালে আৰু দানৱ অৰ্থাৎ ভাইৰাছবিধ আন এফালে।</p> <p>অসহজ সময়ৰ ধাৰাবাহিকতা চলি আছে। আগেয়ে কাহানিও নোপোৱা এক অভিজ্ঞতাৰ মাজেৰে দেশৰ মানুহে দিন কটাবলগীয়া হৈছে। কেৱল দেশেই নহয়, পৃথিৱীৰ ১৩০ কোটি মানুহৰ ঘৰৰ ভিতৰতে কেইবা সপ্তাহ সোমাই থাকিবলগীয়া এই বাধ্যবাধকতা মানৱ সভ্যতাত প্ৰথম। জীৱন বন্ধাৰ বাবে 'স্কন্ধতাৰ' এই সম্পৰীক্ষাত পক্ষ আৰু প্ৰতিপক্ষ এচাম মানুহ বনাম আন এচাম মানুহ নহয়। সমগ্ৰ মানৱ জাতি এফালে আৰু দানৱ অৰ্থাৎ ভাইৰাছবিধ আন এফালে।</p>	<p>॥ ঈশ্বৰহীনতা ॥</p> <p>অসহজ সময়ৰ ধাৰাবাহিকতা চলি আছে। আগেয়ে কাহানিও নোপোৱা এক অভিজ্ঞতাৰ মাজেৰে দেশৰ মানুহে দিন কটাবলগীয়া হৈছে। কেৱল দেশেই নহয়, পৃথিৱীৰ ১৩০ কোটি মানুহৰ ঘৰৰ ভিতৰতে কেইবা সপ্তাহ সোমাই থাকিবলগীয়া এই বাধ্যবাধকতা মানৱ সভ্যতাত প্ৰথম। জীৱন বন্ধাৰ বাবে 'স্কন্ধতাৰ' এই সম্পৰীক্ষাত পক্ষ আৰু প্ৰতিপক্ষ এচাম মানুহ বনাম আন এচাম মানুহ নহয়। আগেয়ে কাহানিও নোপোৱা এক অভিজ্ঞতাৰ মাজেৰে দেশৰ মানুহে দিন কটাবলগীয়া হৈছে। জীৱন বন্ধাৰ বাবে 'স্কন্ধতাৰ' এই সম্পৰীক্ষাত পক্ষ আৰু প্ৰতিপক্ষ এচাম মানুহ বনাম আন এচাম মানুহ নহয়। সমগ্ৰ মানৱ জাতি এফালে আৰু দানৱ অৰ্থাৎ ভাইৰাছবিধ আন এফালে।</p>	<p>ঈশ্বৰহীনতা</p> <p>অসহজ সময়ৰ ধাৰাবাহিকতা চলি আছে। আগেয়ে কাহানিও নোপোৱা এক অভিজ্ঞতাৰ মাজেৰে দেশৰ মানুহে দিন কটাবলগীয়া হৈছে। কেৱল দেশেই নহয়, পৃথিৱীৰ ১৩০ কোটি মানুহৰ ঘৰৰ ভিতৰতে কেইবা সপ্তাহ সোমাই থাকিবলগীয়া এই বাধ্যবাধকতা মানৱ সভ্যতাত প্ৰথম। জীৱন বন্ধাৰ বাবে 'স্কন্ধতাৰ' এই সম্পৰীক্ষাত পক্ষ আৰু প্ৰতিপক্ষ এচাম মানুহ বনাম আন এচাম মানুহ নহয়। সমগ্ৰ মানৱ জাতি এফালে আৰু দানৱ অৰ্থাৎ ভাইৰাছবিধ আন এফালে।</p>

Figure 8.5: Application of the font for document display (ref. from fig. 6.29)

A new group of users with a similar background as the earlier group has been invited to participate in the survey for the application of typeface. The new group that has been formed consists of previous users as well as the entry of few new users. The questionnaire set has been modified from the previous experiment to be more focused on the practicality of the application. The questions have been composed based on the following key factors.

- a. Ease of application on a different platform
- b. Readability, legibility, and clarity on different screens
- c. Independency in representing the essence of Assamese identity for different platform
- d. Continuation of holding uniqueness for all type uses
- e. The communication factor as a typeface

Complete questionnaire series have been compiled in Annexure – 1d. Results and analysis of the questionnaire have been discussed in the later section.

8.1.3 User survey of in-script keyboard design

As already discussed in the previous chapter, an in-script Assamese keyboard has been designed to address all groups of users keeping in mind the amateur users as a priority. Since typing regional scripts on a regular keyboard needs basic training, hence it may be difficult for amateur users to use a keyboard designed with a standard in-script layout of Unicode guidelines. Hence the keyboard has been customized based on in-script virtual keypads used for mobile phones. To validate the usefulness of this customized design, a user survey has been conducted among 20 users from the selected category of users. A set of questions have been composed based on the following criteria for the survey.

- a) Ease of typing on a computer
- b) Ease in the detection of keys to type a characters
- c) Ease in the detection of vowel symbols and their uses
- d) Typing of conjunct letters and key detection
- e) Typing of special characters and symbols

Complete questionnaire series have been compiled in Annexure – 1e. Results and analysis of the questionnaire have been discussed in the later section.

8.1.4 User survey of typing app for digital devices

The typing app design for mobile and digital devices to display the new typeface on mobile phones and smart device screens shows promising outcomes while tested. But to validate the outcome, it is essential to conduct a user survey to get the appropriate result and

feedback of the experiment. A new group of 20 people with a mix of users who already participated in the previous user surveys have been invited to take part in the survey of this experiment as well. The questionnaire with a set of 10 questions based on the following criteria has been composed and given to the users.

- a. An initial impression of the typing app
- b. Ease in typing with a virtual keypad
- c. Display of typeface on screen
- d. Typing of conjunct letters, symbols, typing options, etc.
- e. Features of the typing app

Complete questionnaire series have been compiled in Annexure – 1f. Results and analysis of the questionnaire have been discussed in the later section.

8.2 Analysis of survey data

The user survey has been divided into four sections of research results to compile and verify the survey data as already mentioned in the previous section. A total of ten (10) key factors have been measured from each section to calculate a grading based survey. The grading will be measured in points from a minimum of 1 to a maximum of 10 where a user will have to mark each factor by giving a point based on their observation of the experiment results. After that, the average rating point for each factor has been calculated to standardize the rating of all the factors across four sections. The formula for the calculation of average rating points is as follows.

Total rating points received from 20 users (R) ÷ maximum rating points of 20 users (20×10=200) × maximum rating point for a single factor (10)
 = $R \div 200 \times 10$ (where R is the total rating point received from 20 users)

8.2.1 Survey data: Typeface comparison

The following Table 8.1 shows the calculation of average rating points received by each factor.

Table 8.1: Survey data of typeface comparison

Factor 1	The new typeface Garhayan Assamese carries the legacy of the historical Garhayan writing style.	
Average rating	R = 155	$155 \div 200 \times 10 = 7.75$
Factor 2	Bringing originality in the new typeface.	

Average rating	R = 168	$168 \div 200 \times 10 = 8.40$
Factor 3	Readability of the new typeface.	
Average rating	R = 170	$170 \div 200 \times 10 = 8.50$
Factor 4	Legibility of the new typeface.	
Average rating	R = 166	$166 \div 200 \times 10 = 8.30$
Factor 5	Aesthetic appeal of the new typeface.	
Average rating	R = 172	$172 \div 200 \times 10 = 8.60$
Factor 6	Showcasing unique characteristics of the new typeface.	
Average rating	R = 162	$162 \div 200 \times 10 = 8.10$
Factor 7	Emotional connection with Assamese culture and language.	
Average rating	R = 145	$145 \div 200 \times 10 = 7.25$
Factor 8	Uniqueness in creating identity among other typefaces.	
Average rating	R = 138	$138 \div 200 \times 10 = 6.90$
Factor 9	Recall value of the typeface.	
Average rating	R = 132	$132 \div 200 \times 10 = 6.60$
Factor 10	Ease of using the typeface with UNICODE standard typing.	
Average rating	R = 167	$167 \div 200 \times 10 = 8.35$

8.2.2 Survey data: Typeface application

The following Table 8.2 shows the calculation of average rating points received by each factor.

Table 8.2: Survey data of typeface application

Factor 1	Ease of application of Garhayan Assamese typeface on different Windows operating systems.	
Average rating	R = 158	$158 \div 200 \times 10 = 7.90$
Factor 2	Ease of application of Garhayan Assamese typeface on other operating systems such as Mac OS and Linux.	
Average rating	R = 145	$145 \div 200 \times 10 = 7.25$
Factor 3	Screen display and clarity of the font on computers and digital devices.	
Average rating	R = 180	$180 \div 200 \times 10 = 9.00$
Factor 4	Readability and legibility on a computer screen and mobile devices.	
Average rating	R = 176	$176 \div 200 \times 10 = 8.80$
Factor 5	Appeal factor of the font on the screen.	
Average rating	R = 155	$155 \div 200 \times 10 = 7.75$
Factor 6	The clarity in the display of conjunct characters and special characters on screen.	

Average rating	R = 142	$142 \div 200 \times 10 = 7.10$
Factor 7	Emotional connection with Assamese essence on-screen display.	
Average rating	R = 140	$140 \div 200 \times 10 = 7.00$
Factor 8	The clarity in communication with the users on different platforms.	
Average rating	R = 142	$142 \div 200 \times 10 = 7.10$
Factor 9	Continuation in holding the unique identity across different platforms such as websites, mobile apps, document display, etc.	
Average rating	R = 135	$135 \div 200 \times 10 = 6.75$
Factor 10	Creating an identity among typefaces for all types of the screen display.	
Average rating	R = 146	$146 \div 200 \times 10 = 7.30$

8.2.3 Survey data: In-script Assamese keyboard design for computer

The following Table 8.3 shows the calculation of average rating points received by each factor.

Table 8.3: Survey data of custom keyboard design

Factor 1	The key layout structure of the in-script keyboard.	
Average rating	R = 145	$145 \div 200 \times 10 = 7.25$
Factor 2	Character assignment to keys in serial order.	
Average rating	R = 138	$138 \div 200 \times 10 = 6.90$
Factor 3	Ease in the detection of letters on keys.	
Average rating	R = 155	$155 \div 200 \times 10 = 7.75$
Factor 4	Ease in typing and speed of typing with the new keyboard layout.	
Average rating	R = 138	$138 \div 200 \times 10 = 6.90$
Factor 5	Ease in the detection of vowel symbols and special characters.	
Average rating	R = 144	$144 \div 200 \times 10 = 7.20$
Factor 6	Ease in typing conjunct letters as per UNICODE standard.	
Average rating	R = 146	$146 \div 200 \times 10 = 7.30$
Factor 7	Assign keys in normal mode, shift mode, and Alt+Ctrl mode	
Average rating	R = 140	$140 \div 200 \times 10 = 7.00$
Factor 8	Ease in typing in normal mode, shift mode, and Alt+Ctrl mode	
Average rating	R = 136	$136 \div 200 \times 10 = 6.80$
Factor 9	Key assign and ease in typing unique characters (Start and End Matras).	
Average rating	R = 154	$154 \div 200 \times 10 = 7.70$
Factor 10	Overall typing experience with the new keyboard layout.	
Average rating	R = 162	$162 \div 200 \times 10 = 8.10$

8.2.4 Survey data: Typing App design for digital devices

The following Table 8.4 shows the calculation of average rating points received by each factor.

Table 8.4: Survey data of typing app design for mobile and digital devices

Factor 1	Ease in the installation of typing app	
Average rating	R = 165	$165 \div 200 \times 10 = 8.25$
Factor 2	Descriptions and instructions of typing app on its App store home page.	
Average rating	R = 155	$155 \div 200 \times 10 = 7.75$
Factor 3	First impression view of the typing app.	
Average rating	R = 161	$161 \div 200 \times 10 = 8.05$
Factor 4	Display of virtual keyboard and ease in typing	
Average rating	R = 157	$157 \div 200 \times 10 = 7.85$
Factor 5	Display of Garhgyan Assamese typeface on app screen while typing.	
Average rating	R = 182	$181 \div 200 \times 10 = 9.10$
Factor 6	Key options for typing vowel symbols, numbers, special characters, other symbols, etc.	
Average rating	R = 177	$177 \div 200 \times 10 = 8.85$
Factor 7	Shortcut key options for typing conjunct letters.	
Average rating	R = 171	$171 \div 200 \times 10 = 8.55$
Factor 8	Ease in typing conjunct letters with Unicode standard method.	
Average rating	R = 159	$159 \div 200 \times 10 = 7.95$
Factor 9	Features offered in the typing app.	
Average rating	R = 138	$138 \div 200 \times 10 = 6.90$
Factor 10	Creating emotional connection and cultural identity by the app among users.	
Average rating	R = 186	$186 \div 200 \times 10 = 9.30$

After calculating average rating points received by each factor, all the four sections of research experiments have been then compiled for quantitative analysis where graphical representation using bar graph has been composed.

8.3 Quantitative representation of survey data

Quantitative representation of survey data has been projected in the form of a column graph where average rating points received by each factor of a research result have been presented for further analysis. A column can suitably present the average rating points of various factors in a linear method hence it has been considered for creating a graphical

representation. The graphical representation has been designed in such a way that points received by each factor can be displayed in a uniform standard. On the graph, the X-axis shows the various factors of the research experiment from F-1 to F-10 and the Y-axis shows the average rating points received by factors. The scale of the Y-axis is from 0 to 10 units where every unit has been counted as 1 rating point. A color-coding table has been prepared which denotes a factors' success description. Based on the color-coding table, the success rate of all the factors can be evaluated with a distinct description. The color coding table has been placed at the bottom side of all the graphs to check the success rate of each factor. Shown below are the column graphs describing experiment results.

8.3.1 Graphical representation – 1: Typeface comparison

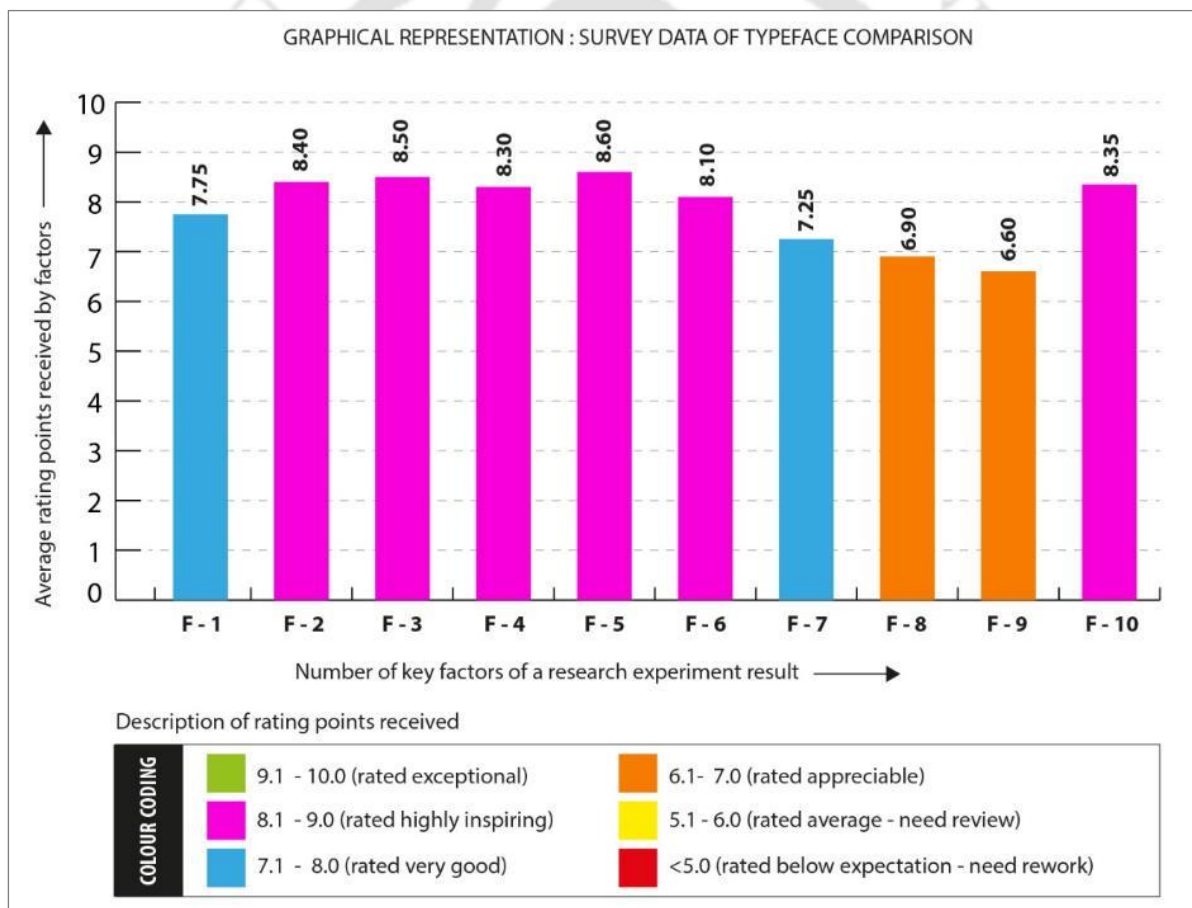


Figure 8.6: Graphical representation of average rating point received on Typeface comparison

Analysis of Graph – 1: Typeface comparison

From the graphical representation (refer to Figure 8.6), the analysis of rating points received by various factors can describe that the result of the experiment showed a highly positive outcome. The overall rating points received by all the factors are above the appreciable

level which is above 6.1 out of 10 points. The maximum rating point received is by factor 5, which is 8.60 out of 10 points and the minimum is by factor 9, which is 6.6 out of 10 points. The percentage of an average rating point of all the factors is 78.75% which could be described as “very good” as per the color-coding description in the graph. Therefore it can be said that the result of the typeface comparison experiment shows a positive direction.

8.3.2 Graphical representation – 2: Typeface application

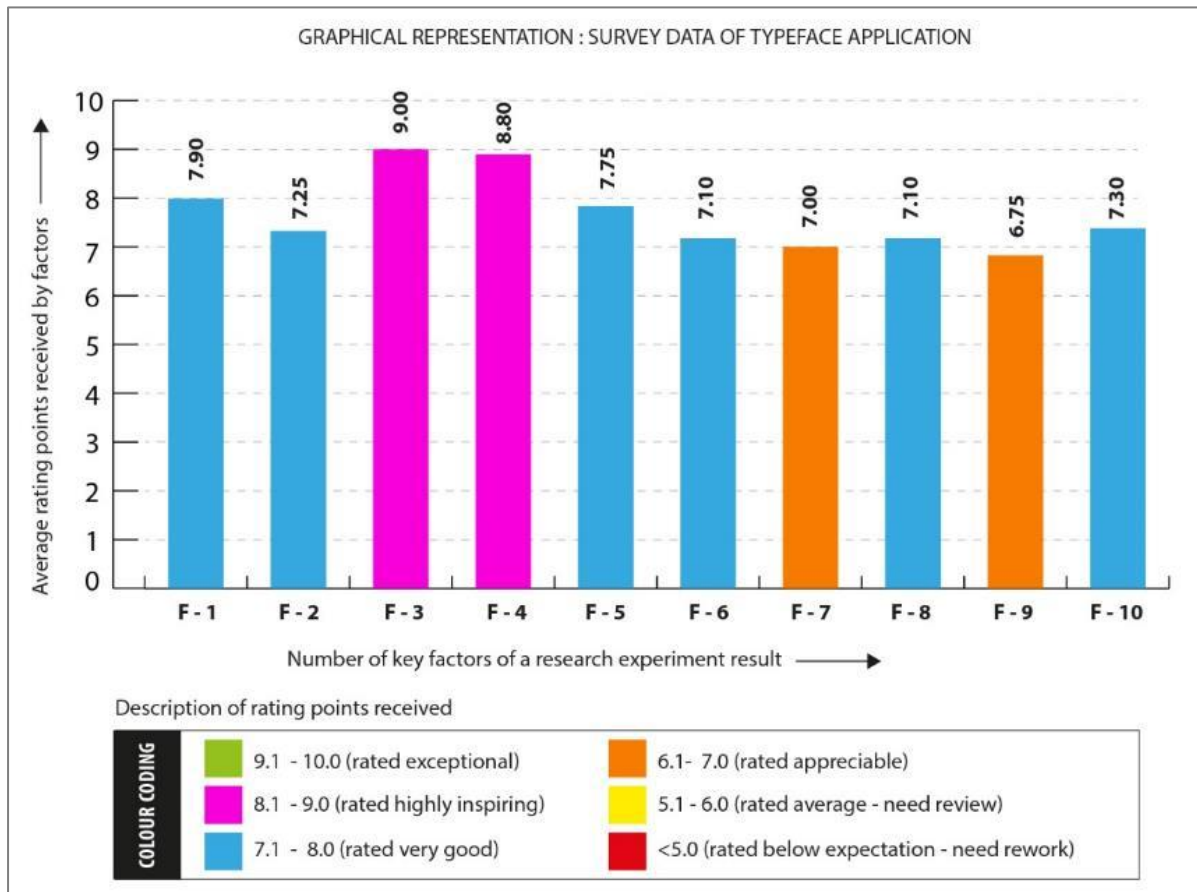


Figure 8.7: Graphical representation of average rating point received on Typeface application

Analysis of Graph – 2: Typeface application

From the graphical representation (refer to Figure 8.7), the analysis of rating points received by various factors show a very good outcome. All the factors have received rating points rated “appreciable” and above which 6.1 and above out of 10 points. The maximum rating point received by factor 3 is 9.0 out of 10 which is highly inspiring and even the minimum rating point received by factor 9 is 6.75 which also appreciable. The overall percentage of rating points received by all the factors is 75.95% which is almost equal to 76%. Based on the color code the rating is considered as “very good” which will inspire the experiment for further progress.

8.3.3 Graphical representation – 3: Custom keyboard design

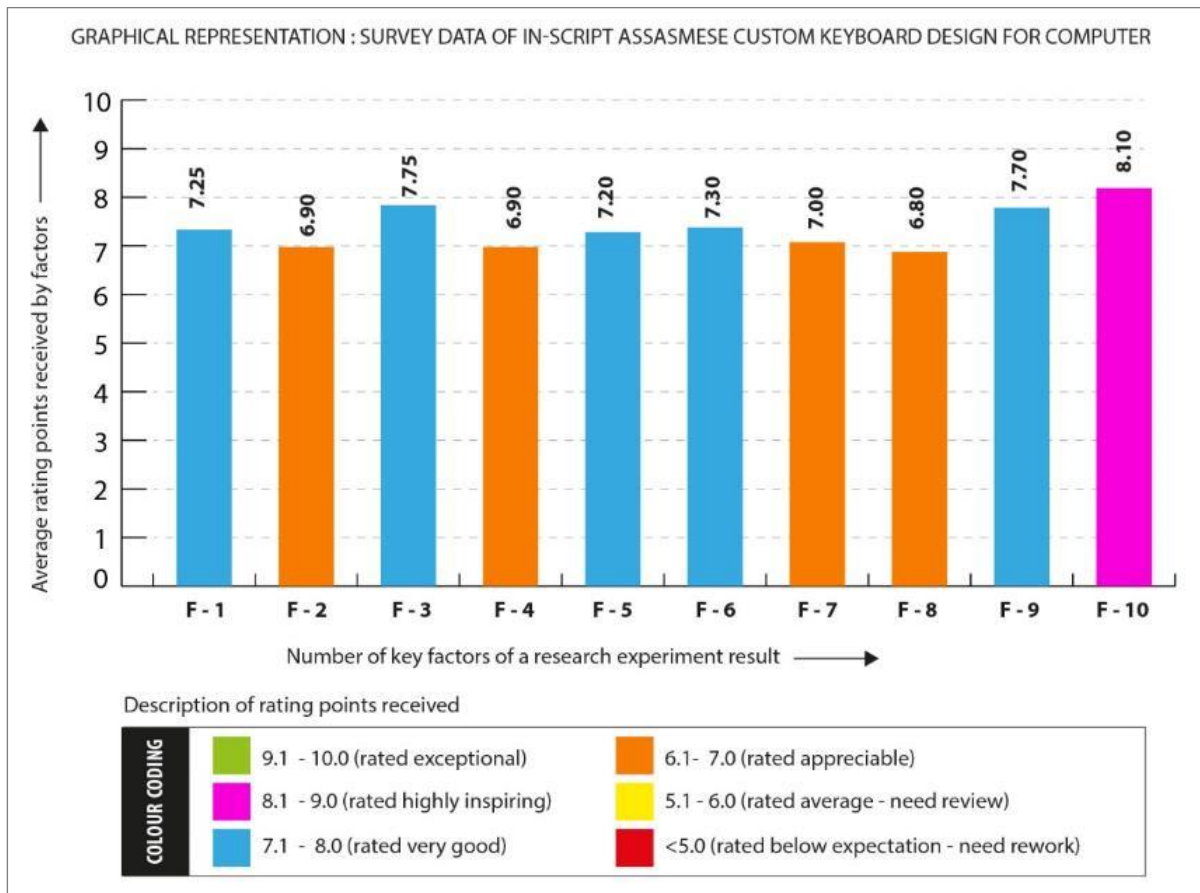


Figure 8.8: Graphical representation of average rating point received on custom keyboard design

Analysis of Graph – 3: Custom keyboard design

From the graphical representation (refer to Figure 8.8), the analysis of average rating points of various factors shows a quite appreciable result. The average rating points for all the factors are above the “appreciable” rate. The total average percentage rating of all the factors is 72.9% which falls under the “very good” rate as per the color code table. The maximum rating received is 8.10 out of 10 points by factor 10 whereas the minimum rating received is 6.80 out of 10 points by factor 8. But the minimum rating is also under the “appreciable” category. Therefore it can be concluded that the result of the experiment is highly appreciable.

8.3.4 Graphical representation – 4: Typing App design

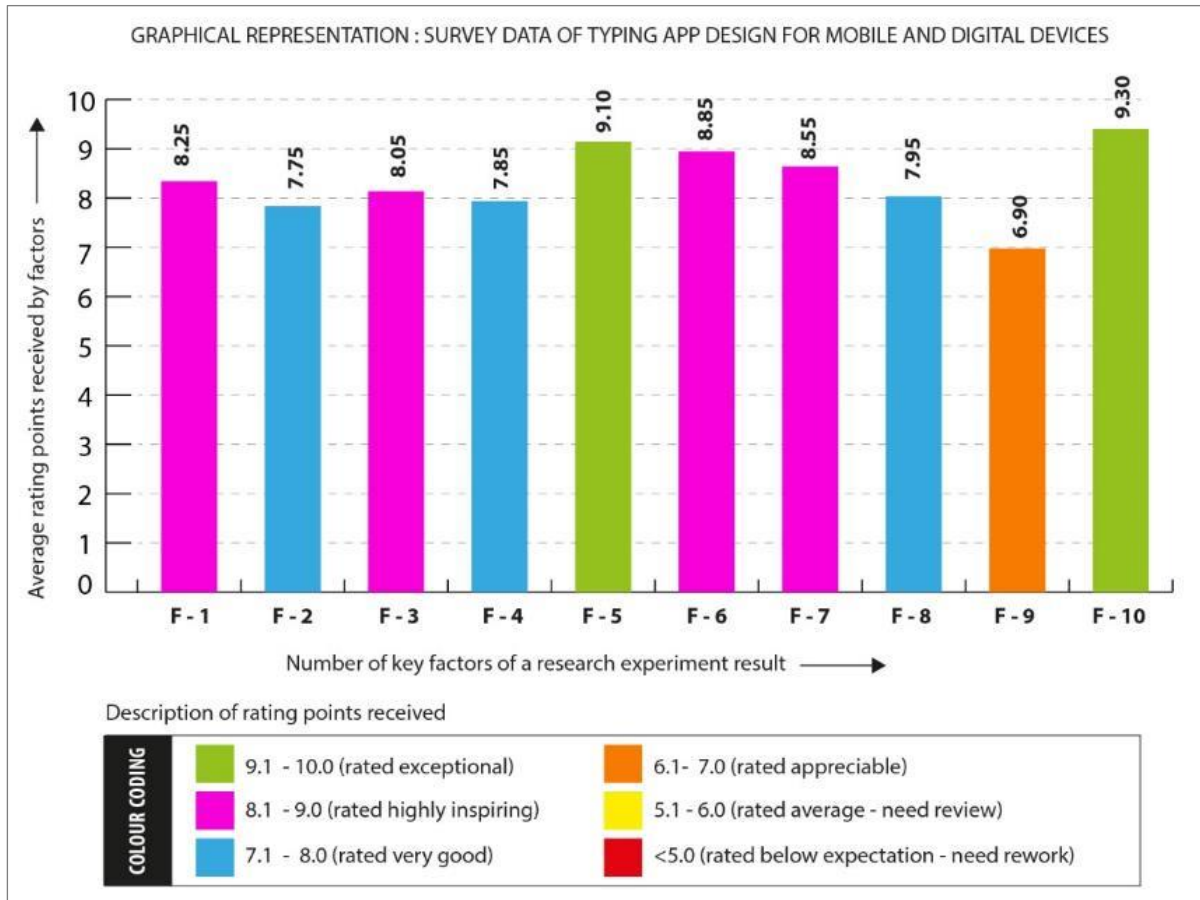


Figure 8.9: Graphical representation of average rating point received on Typing app design

Analysis of Graph – 4: Typing App design

From the graphical representation (refer to Figure 8.9), the analysis of average rating points of all the factors showed a highly inspiring result where most of the factors rated “very good” and above. The total average percentage of all the factors has been calculated as 82.55% which falls under the “highly inspiring” category. The maximum rating point received is 9.30 out of 10 points by factor 10 whereas the minimum rating point received is 6.90 out of 10 points by factor 9. As the total average percentage received by all the factors falls in the “highly inspiring” category, therefore it can be concluded that the experiment result comes out to be the best in performance among all the experiments.

8.4 Survey results

The survey result describes the outcome of the graphical representation of each of the four research experiment results. The survey results of all the research experiments can be concluded as highly promising and inspiring as the users who participated in the survey gave very encouraging inputs with high rating points to each of the factors of all the research experiments which have been presented for the survey. This may be due to the infusion of innovative ideas and contemporary exploration on the role of typeface design for Assamese script and language in today's digital era which may influence the cultural identity of Assamese people as a whole.

8.5 Major findings and Interpretation

The major findings in the entire research work could be divided into three sections as follows.

- i. **Findings in design context:** This research work on Assamese typeface design touches many corners of research study and exploration. The most important and major area that covers the research work is design exploration. The exploration of historical Assamese letterforms to designing a conceptual handmade typeface for type testing to digital Assamese typeface design for display and usability testing to developing a device applicable typeface development for Assamese script with Unicode standard, all falls under the scope of design exploration and implementation. Therefore it can be summarized that design played the most significant role in shaping the entire research work to achieve its aim and objectives by contributing in every crucial step be it in methodology preparation to research experiments to results and outcomes.
- ii. **Findings in technical context:** Technical context refers to font development and experiments on application and usability on devices as well platforms. This research experiment resulted in a new Assamese typeface named “Garhayan Assamese” which has been designed with unique character identities and targeted to be applicable for digital uses and digital devices. To be applicable for digital devices and computer uses, highly technical experiments of custom Assamese in-script keyboard design and Typing app design have been performed. The outcome of these technical experiments showed highly appreciable and inspiring results. Therefore to be summarized, the technical considerations adopted for the research experiments in developing device applicable Assamese typeface, custom keyboard design for typing the new typeface, and typing app design for mobile and digital devices has been highly critical for achieving the final

results. Without proper analysis and implementation of technical aspects and considerations, this research work may not have come up with a positive result.

iii. Findings in socio-cultural context: Socio-cultural context is the most important and primary objective of the research aim. The entire focus of the research was on “How to create an identity for Assamese language and culture in the current digital era in the form of typography”. This leads to the thinking of designing a unique typeface for Assamese script that could be applicable and user-friendly for digital media which can also portray the essence of true Assamese culture with a trace from history. The user survey finally proves that the experiment conducted on Assamese typeface design based on historical context has been a very successful endeavor to explore the socio-cultural influence on the digital era. Based on the survey result it can be said that the new Assamese typeface has been able to create an exclusive identity among users with its unique characteristics, forms, and style which has a connection with the historical writing style of Assam that conveys the essence of true Assamese culture.

Interpretation: The findings of the research work explain the achievements of research results in design, technical and socio-cultural context. The whole study has been directed to achieve a socio-cultural identity for the Assamese language, people, and its culture in a world of today's digital era. As time progresses, the amount of digital content creation for every native language in the world which has their script has been growing. India is also not an exception. But in comparison to other Indian regional languages, the Assamese language has a limited digital content library due to a lesser number of contributors. Moreover, the Assamese language borrows its script from Bengali for digital content creation because of the Unicode standard guidelines. Therefore, if a typeface that could portray a true Assamese identity with unique features and characteristics with a trace from historical Assamese writing style is available then such issues could be addressed constructively. This entire research work has been aimed at addressing that issue by designing a new and unique Assamese typeface that can create an identity for Assamese language, culture, and people in the digital world. The emotional connection that the typeface is trying to create with its users has been the most influential part as that will hold the identity for Assamese language and culture in the world of digital media as well as the creation of digital contents in the Assamese language.

8.6 Future scope and expectations

In this research work, experiments on designing a new typeface for Assamese script with a unique identity that traces its connection from historical Assamese writing style *Garhayan* has been successfully achieved. The new typeface named “*Garhayan Assamese Regular*” shows extremely inspiring results as validated by the user survey. Though the research results contribute a significant influence into the field of Assamese typography in the digital era, there has been a huge scope still left to study the subject further. The future scope and expectations of the research could be summarized with the following points.

- More exploration on typeface variation could be further experimented such as bold version, thin version, italic version, etc. As the current design of the typeface has only a regular version with one single thickness of the stroke lines, therefore it may not be enough to address all types of typographic needs. Hence explorations on typeface variations would be the next scope to consider for a future project.
- Another very important scope could be the addition of multi-script characters into the new typeface designed. Multi-script character means the addition of roman script characters, special pronunciation characters, various mathematical symbols and characters, standard currency symbols, etc. which could be designed in-line with the new Assamese characters. This scope is a huge exercise but it will open up the typeface to be acceptable on international levels.
- As the use of machines and digital communications rises rapidly throughout, the typefaces or texts that have been written on any products, documents, or screens used to be verified through a digital scanner. For that purpose specific typefaces used to be designed for detection by optical character reader (OCR). Hence it opens up a future scope for designing typeface in Assamese script to be detected easily by optical character reader. This may take the Assamese typeface design field to a bigger level of commercialization.

8.7 Conclusion and Recommendations

This research work establishes the fact that to create an individual identity for a language and its culture, script plays a pivotal role. Without a native script, a language and its culture have a very weak presence on the digital platform in today’s time. On the other hand, a script has been represented by many typefaces that express the emotions written in that script. So a typeface can play an important role to portray the emotions of a language and its culture

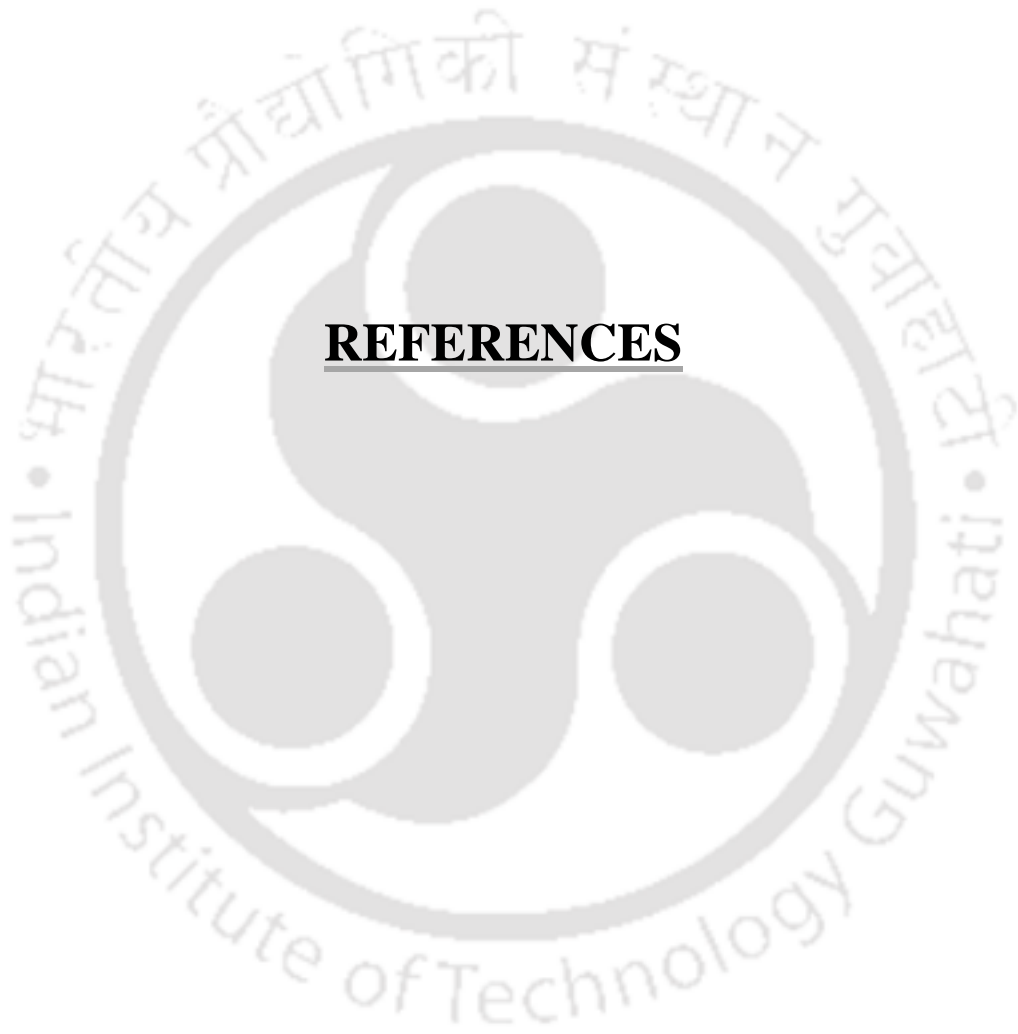
through its script. Therefore it is very essential for a typeface to be original and should have a historical as well as the emotional connection with the users. The results of the experiments with Garhayan Assamese typeface rendered those achievements. This research work also opens up the scope of typeface designing for Assamese script for a wider platform irrespective of any media. Future implications of this research work may offer more promising and prolific results if conducted with an assenting approach.

The following points could well establish a collective recommendation.

- Assamese language and its script can establish its own identity on digital media through a new typeface specially meant for Assamese that can create uniqueness by connecting its roots from history.
- The survey analysis shows the demand for an individual identity for a script and its language on the digital platform is gradually increasing due to the awareness among users which offers more scopes for type designers.
- As the script of a language represents its identity literarily as well as culturally, therefore a typeface can represent both these requirements to help create that identity very effectively. The typeface is the only alternative of a script that people use regularly to express their emotions in their native language in today's digital world.
- The most important factor to success is to be emotionally connected with people who speak the language and follow the culture yet could not achieve an identity on a larger platform.
- *Garhayan Assamese* typeface tried to address all these key considerations that establish an individual identity for Assamese script, language, and culture in a holistic way.

8.8 Scopes for future study

This research work opens up extensive scopes for future study. As we know that there are two more types of historical writing styles that existed in Assam namely *Bamuniya* and *Kaitheli* which have been discussed in the literature review as well as design exploration chapters. The same writing styles could be taken as reference for a similar type of research study as future scope. As both the writing styles have their unique forms and characteristics, hence the appropriate direction of study could offer a highly encouraging outcome with a futuristic approach.



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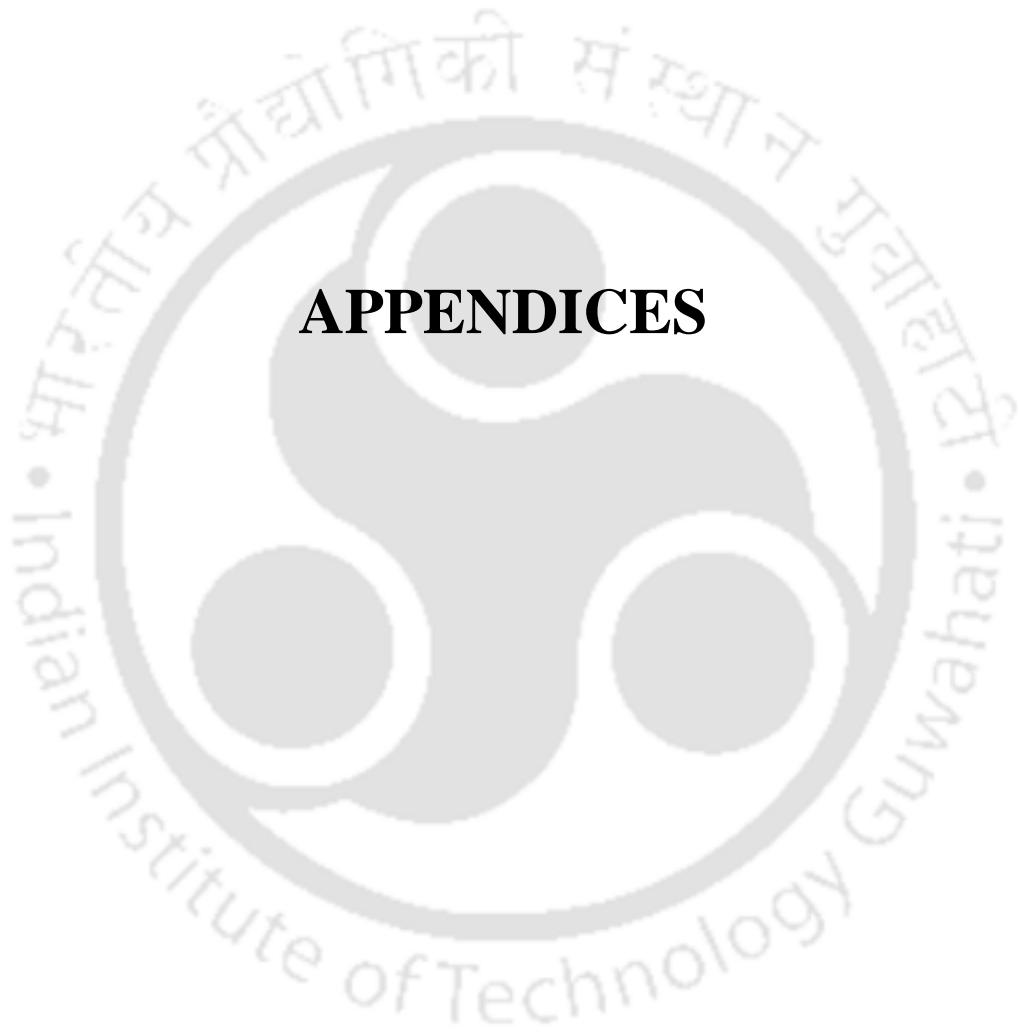
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APPENDICES



APPENDIX – 1: RESEARCH QUESTIONNAIRES

RESEARCH QUESTIONNAIRE – 1

Preliminary survey: A casual open-ended interaction for extracting basic information on Assamese language, culture, and script. Conducted during the field visit and interview with people.

Target audience: People from the field of academics, teaching, print publication, design, and general background

Interaction mode: Online and face to face

Subject area for the survey:

- Information about the history of Assamese script and its progression from the medieval period to the printing press era.
- Information from the beginning of the printing era to the entry of digital technology.
- Progression of the script after the entry of digital and web technology.
- The current position of the script in the age of mobile gadgets and applications.

Research questionnaire samples

<i>Personal details</i>	Name: Background: Profession: Email id: Contact details (optional):
Question type: Descriptive / explanatory	
<i>Question no. 1</i>	How do you feel about historical Assamese writing styles found on Xaansi tree bark, copperplate, rock, coins, and other articles preserved in our museums and religious places? Do you think they are the source of Assamese culture?
<i>Answer</i>	
<i>Question no. 2</i>	Do you think these historical writing styles are beautiful and depict the true essence of Assamese literary history?
<i>Answer</i>	
<i>Question no. 3</i>	What is your opinion about the connection between the modern Assamese script that we are using now and those historical writing styles?

<i>Answer</i>	
<i>Question no. 4</i>	What are your general opinion about the printing industry in Assam and their influence on the progression of Assamese literature?
<i>Answer</i>	
<i>Question no. 5</i>	What is your opinion about the progression of Assamese script from age-old letterpress printing to modern-day computer printing? Share your experience if you did any print publishing work.
<i>Answer</i>	
<i>Question no. 6</i>	Do you ever try typing Assamese script on your mobile phone? If yes, please share your first impression on using it.
<i>Answer</i>	
<i>Question no. 7</i>	Have you ever visited any website published in the Assamese language such as news websites or blogs or others? If yes then what is your impression of such a website and the display of Assamese language on screen? Please share
<i>Answer</i>	
<i>Question no. 8</i>	Do you think the digital publication of the Assamese language or script has an emotional connection with the reader or audience? Please share your views.
<i>Answer</i>	
<i>Question no. 9</i>	Do you have any idea about UNICODE and Assamese script as there have been a lot of discussions on this topic recently?
<i>Answer</i>	
<i>Question no. 10</i>	What is your instant views and opinion about using Assamese script on mobile phones or digital devices? If you have ever tried it using on your mobile phone then please share your views.
<i>Answer</i>	
Question type: Objective / Yes-No type	
<i>Question no. 11</i>	Have you seen any historical articles with Assamese script written on them?
<i>Answer</i>	Yes / No type
<i>Question no. 12</i>	Have you seen any very old printed books in the Assamese language? Name it.
<i>Answer</i>	Yes / No type and one-word answer

<i>Question no. 13</i>	Did you ever try typing Assamese script on a computer?
<i>Answer</i>	Yes / No type
<i>Question no. 14</i>	If yes, which software did you use for typing?
<i>Answer</i>	One / two-word answer
<i>Question no. 15</i>	Have you ever tried online typing software for Assamese script?
<i>Answer</i>	Yes / No type
<i>Question no. 16</i>	If yes, name the website and software.
<i>Answer</i>	One word answer
<i>Question no. 17</i>	Have you ever used Assamese typing on your mobile phone?
<i>Answer</i>	Yes / No type
<i>Question no. 18</i>	If yes, name the application or software that offers Assamese typing.
<i>Answer</i>	One or two-word answer
<i>Question no. 19</i>	Are the typing methods for computers and mobile phone the same or different?
<i>Answer</i>	Yes / No type and one-word answer
<i>Question no. 20</i>	Do you feel connected with the culture while typing in Assamese script on a computer or mobile phone?
<i>Answer</i>	Yes / No type and one-word answer

RESEARCH QUESTIONNAIRE – 2

Survey on research experiments: A descriptive information-oriented interaction about the research experiments to examine and validation of probable findings.

Target audience: People from the field of academics, teaching, print publication, design, and general background

Interaction mode: Online and face to face

Subject area survey:

- Existing available Assamese typefaces for print publishing and their popularity
- Exploration on new Assamese typeface design
- Emotional and cultural connection
- Display and appeal on-screen display
- Usability and application on devices

Research questionnaire samples

<i>Personal details</i>	Name: Background: Profession: Email id: Contact details (optional):
Question type: Descriptive / explanatory	
<i>Question no. 1</i>	What is your basic knowledge or information about the Assamese font or typeface used in the print publication industry?
<i>Answer</i>	
<i>Question no. 2</i>	For the printing industry, the fonts or typefaces used for the Assamese language has been borrowed from the Bengali print industry with the addition of Assamese characters. What is your opinion on this information?
<i>Answer</i>	
<i>Question no. 3</i>	Do you find any native Assamese essence in its font style in any of the new books or magazines printed for the Assamese language? Share your opinion.

<i>Answer</i>	
<i>Question no. 4</i>	Do you ever notice any differences in print type between Bengali magazines and Assamese magazines?
<i>Answer</i>	
<i>Question no. 5</i>	What is your opinion on a new typeface or font exclusively designed for Assamese script?
<i>Answer</i>	
<i>Question no. 6</i>	What kind of special properties, features, or uniqueness do you like to see in the new font design for the Assamese script?
<i>Answer</i>	
<i>Question no. 7</i>	Do you think bringing historical essence or identity to the new font design could provide uniqueness in design?
<i>Answer</i>	
<i>Question no. 8</i>	A new Assamese typeface named Garhayan Assamese has been designed based on historical Garhayan writing style to address the need for a unique Assamese script. Do you find the typeface unique? Share your views on the historical Garhayan style and bringing the essence of this style to design the new typeface.
<i>Answer</i>	
<i>Question no. 9</i>	Does it able to portray emotional and cultural connection to Assamese language and script? Share your views.
<i>Answer</i>	
<i>Question no. 10</i>	Share your comments and feedback on the font about its appeal, screen presence, readability, legibility, and script representation.
<i>Answer</i>	
Question type: Decision based (Agree / Not agree / No comments)	
<i>Question no. 11</i>	Assamese typefaces used for print publishing and digital media needs a special identity depicting Assamese culture.
<i>Answer</i>	Agree / Not agree / No comments
<i>Question no. 12</i>	Bringing historical essence into the design of a new typeface may signify Assamese culture.
<i>Answer</i>	Agree / Not agree / No comments

<i>Question no. 13</i>	Emotional connection is necessary with a typeface to create a cultural identity.
<i>Answer</i>	Agree / Not agree / No comments
<i>Question no. 14</i>	Introducing unique identities in Garhgayan Assamese typeface design makes it different from other typefaces.
<i>Answer</i>	Agree / Not agree / No comments
<i>Question no. 15</i>	The display of Garhgayan Assamese typeface on different devices does not disturb its original essence and uniqueness.
<i>Answer</i>	Agree / Not agree / No comments
<i>Question no. 16</i>	Choosing the historical Garhgayan style for taking design reference was a good decision.
<i>Answer</i>	Agree / Not agree / No comments
<i>Question no. 17</i>	Garhgayan Assamese typeface design has been able to portray historical essence and emotional connection.
<i>Answer</i>	Agree / Not agree / No comments
<i>Question no. 18</i>	Garhgayan Assamese could be able to create a cultural identity on the digital platform.
<i>Answer</i>	Agree / Not agree / No comments
<i>Question no. 19</i>	The name Garhgayan Assamese is appropriate for the typeface to create a cultural connection among users.
<i>Answer</i>	Agree / Not agree / No comments
<i>Question no. 20</i>	The name also portrays the ethnicity and authenticity of Assamese culture.

RESEARCH QUESTIONNAIRE – 3: PART - A (Typeface comparison)

Survey on research experiment results: A grading based quantitative analysis about the research experiment results to examine and validate of research outcome.

Target audience: People from the field of academics, teaching, print publication, design, and general background

Interaction mode: Online and face to face

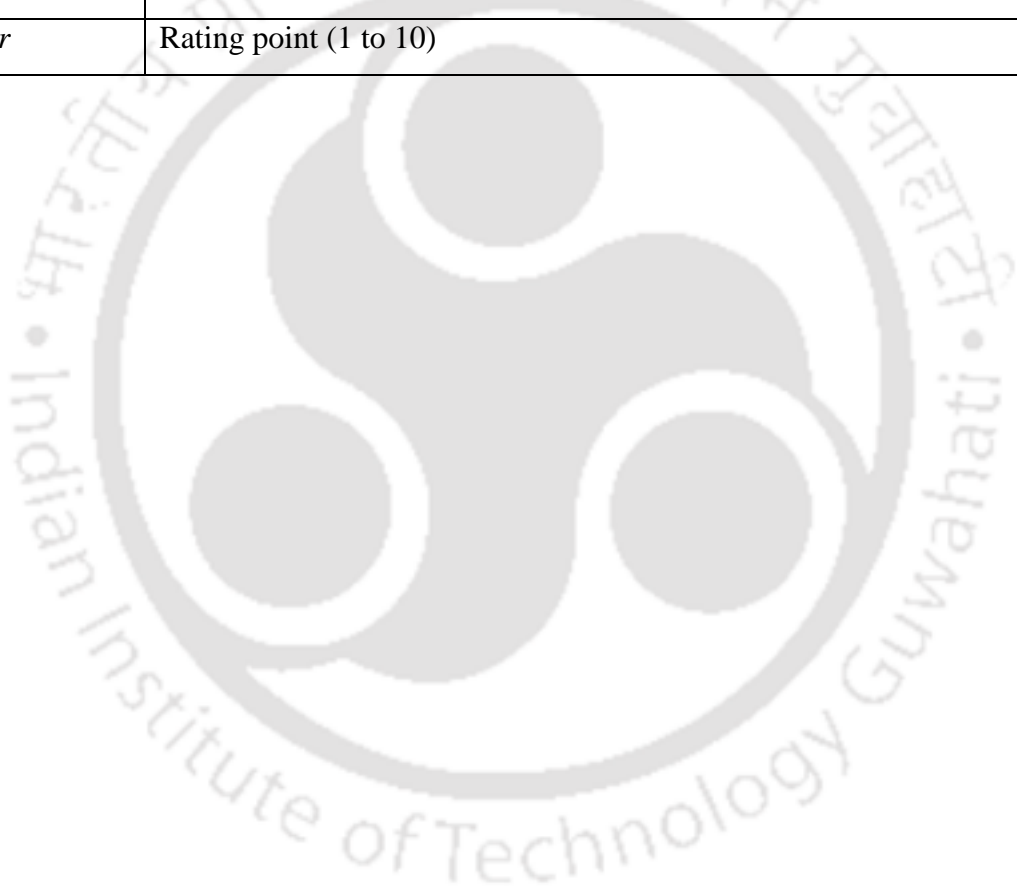
Subject area for the survey:

- The appeal of the new typeface comparing to the historical writing style
- Continuation of originality from its historical references
- Readability, legibility, and aesthetic appeal compared to other digital typefaces
- Cultural and emotional connection with the typeface
- Originality and uniqueness created by the typeface

Research questionnaire sample

<i>Personal details</i>	Name: Background: Profession: Email id: Contact details (optional):
Question type: Quantitative / Point-based (A rating of 1 to 10 points to be given to each statement made on the experiment result).	
<i>Factor 1</i>	The new typeface Garhayan Assamese carries the legacy of the historical Garhayan writing style.
<i>Answer</i>	Rate this statement with a rating point (1 to 10).
<i>Factor 2</i>	Bringing originality in the new typeface.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 3</i>	Readability of the new typeface.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 4</i>	Legibility of the new typeface.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 5</i>	Aesthetic appeal of the new typeface.

<i>Answer</i>	Rating point (1 to 10)
<i>Factor 6</i>	Showcasing unique characteristics of the new typeface.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 7</i>	Emotional connection with Assamese culture and language.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 8</i>	Uniqueness in creating identity among other typefaces.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 9</i>	Recall the value of the typeface.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 10</i>	Ease of using the typeface with UNICODE standard typing.
<i>Answer</i>	Rating point (1 to 10)



RESEARCH QUESTIONNAIRE – 3: PART - B (Typeface application)

Survey on research experiment results: A grading based quantitative analysis about the research experiment results to examine and validate the research outcome.

Target audience: People from the field of academics, teaching, print publication, design, and general background

Interaction mode: Online and face to face

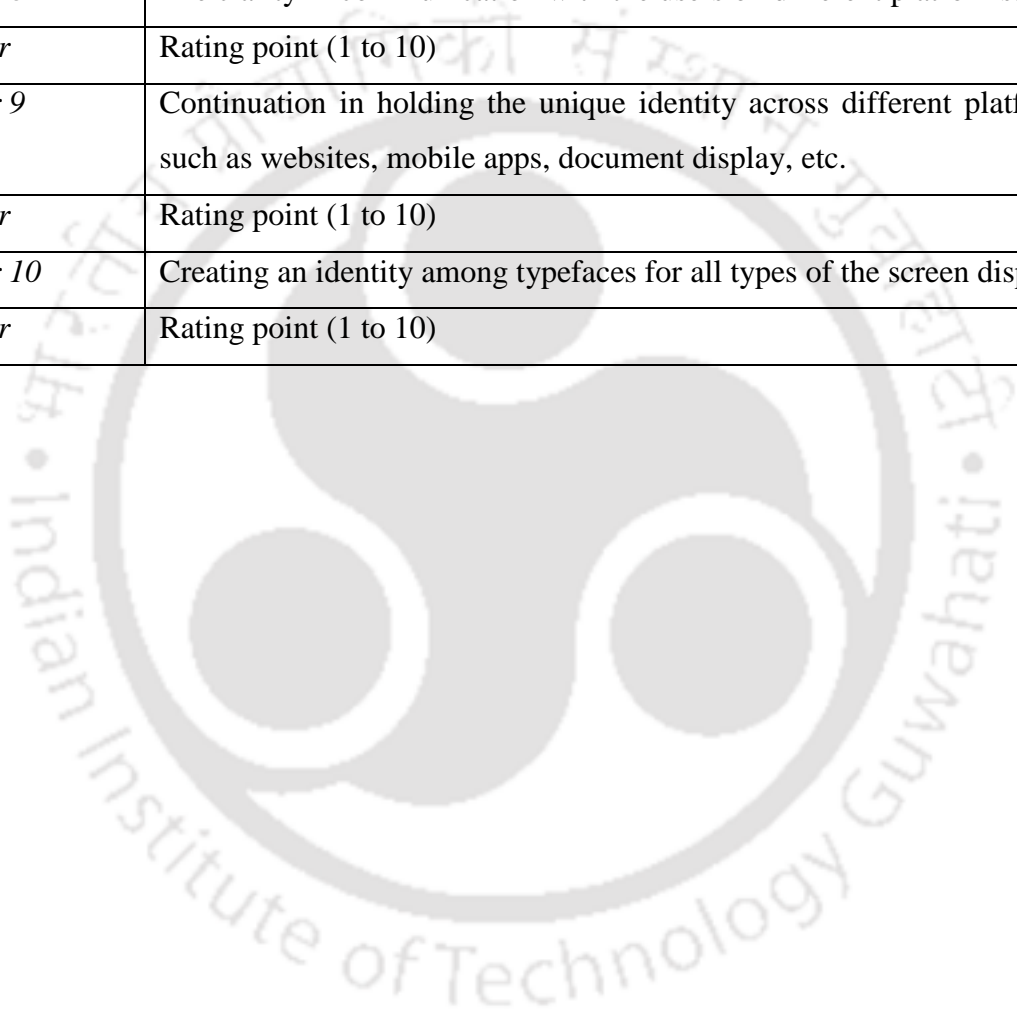
Subject area for the survey:

- Ease of application on a different platform
- Readability, legibility, and clarity on different screens
- Independency in representing the essence of Assamese identity for different platform
- Continuation of holding uniqueness for all type uses
- The communication factor as a typeface

Research questionnaire sample

<i>Personal details</i>	Name: Background: Profession: Email id: Contact details (optional):
Question type: Quantitative / Point-based (A rating of 1 to 10 points to be given to each statement made on the experiment result).	
<i>Factor 1</i>	Ease of application of Garhmayan Assamese typeface on different Windows operating systems
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 2</i>	Ease of application of Garhmayan Assamese typeface on other operating systems such as Mac OS and Linux.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 3</i>	Screen display and clarity of the font on computers and digital devices.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 4</i>	Readability and legibility on a computer screen and mobile devices.
<i>Answer</i>	Rating point (1 to 10)

<i>Factor 5</i>	Appeal factor of the font on the screen.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 6</i>	The clarity in the display of conjunct characters and special characters on screen.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 7</i>	Emotional connection with Assamese essence on-screen display.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 8</i>	The clarity in communication with the users on different platforms.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 9</i>	Continuation in holding the unique identity across different platforms such as websites, mobile apps, document display, etc.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 10</i>	Creating an identity among typefaces for all types of the screen display.
<i>Answer</i>	Rating point (1 to 10)



RESEARCH QUESTIONNAIRE – 3: PART - C (In-script Assamese keyboard design for computer)

Survey on research experiment results: A grading based quantitative analysis about the research experiment results to examine and validate of research outcome.

Target audience: People from the field of academics, teaching, print publication, design, and general background

Interaction mode: Online and face to face

Subject area for the survey:

- Ease of typing on the computer
- Ease in the detection of keys to type a characters
- Ease in the detection of vowel symbols and their uses
- Typing of conjunct letters and key detection
- Typing of special characters and symbols

Research questionnaire sample

<i>Personal details</i>	Name: Background: Profession: Email id: Contact details (optional):
Question type: Quantitative / Point-based (A rating of 1 to 10 points to be given to each statement made on the experiment result).	
<i>Factor 1</i>	The key layout structure of the in-script keyboard.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 2</i>	Character assignment to keys in serial order.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 3</i>	Ease in the detection of letters on keys.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 4</i>	Ease in typing and speed of typing with the new keyboard layout.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 5</i>	Ease in the detection of vowel symbols and special characters.

<i>Answer</i>	Rating point (1 to 10)
<i>Factor 6</i>	Ease in typing conjunct letters as per UNICODE standard.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 7</i>	Assign keys in normal mode, shift mode, and Alt+Ctrl mode
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 8</i>	Ease in typing in normal mode, shift mode, and Alt+Ctrl mode
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 9</i>	Key assign and ease in typing unique characters (Start and End Matras).
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 10</i>	Overall typing experience with the new keyboard layout.
<i>Answer</i>	Rating point (1 to 10)



RESEARCH QUESTIONNAIRE – 3: PART - D (Typing App design for digital devices)

Survey on research experiment results: A grading based quantitative analysis about the research experiment results to examine and validate the research outcome.

Target audience: People from the field of academics, teaching, print publication, design, and general background

Interaction mode: Online and face to face

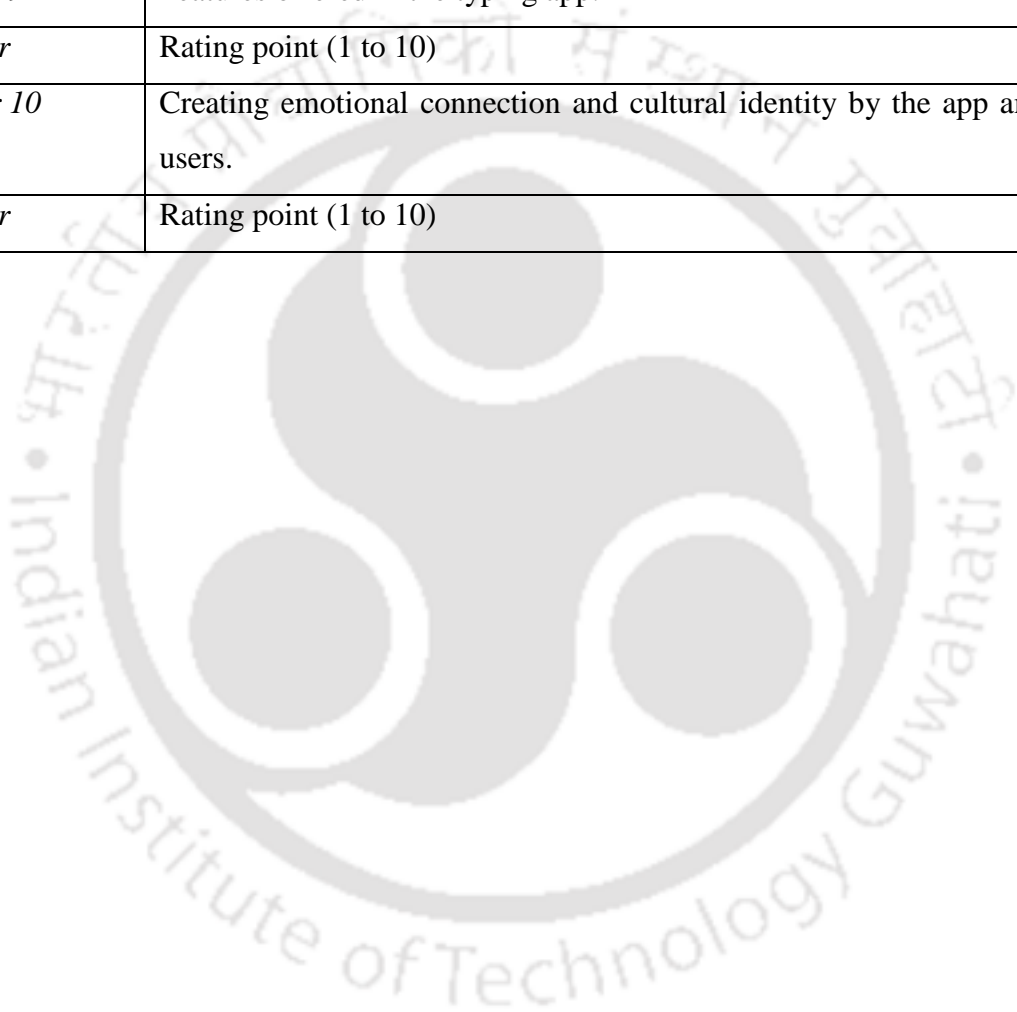
Subject area for the survey:

- The initial impression of the typing app
- Ease in typing with a virtual keypad
- Display of typeface on screen
- Typing of conjunct letters, symbols, typing options, etc.
- Features of the typing app

Research questionnaire sample

<i>Personal details</i>	Name: Background: Profession: Email id: Contact details (optional):
Question type: Quantitative / Point-based (A rating of 1 to 10 points to be given to each statement made on the experiment result).	
<i>Factor 1</i>	Ease in the installation of typing app
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 2</i>	Descriptions and instructions of typing app on its App store home page.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 3</i>	First impression view of the typing app.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 4</i>	Display of virtual keyboard and ease in typing
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 5</i>	Display of Garhayan Assamese typeface on app screen while typing.
<i>Answer</i>	Rating point (1 to 10)

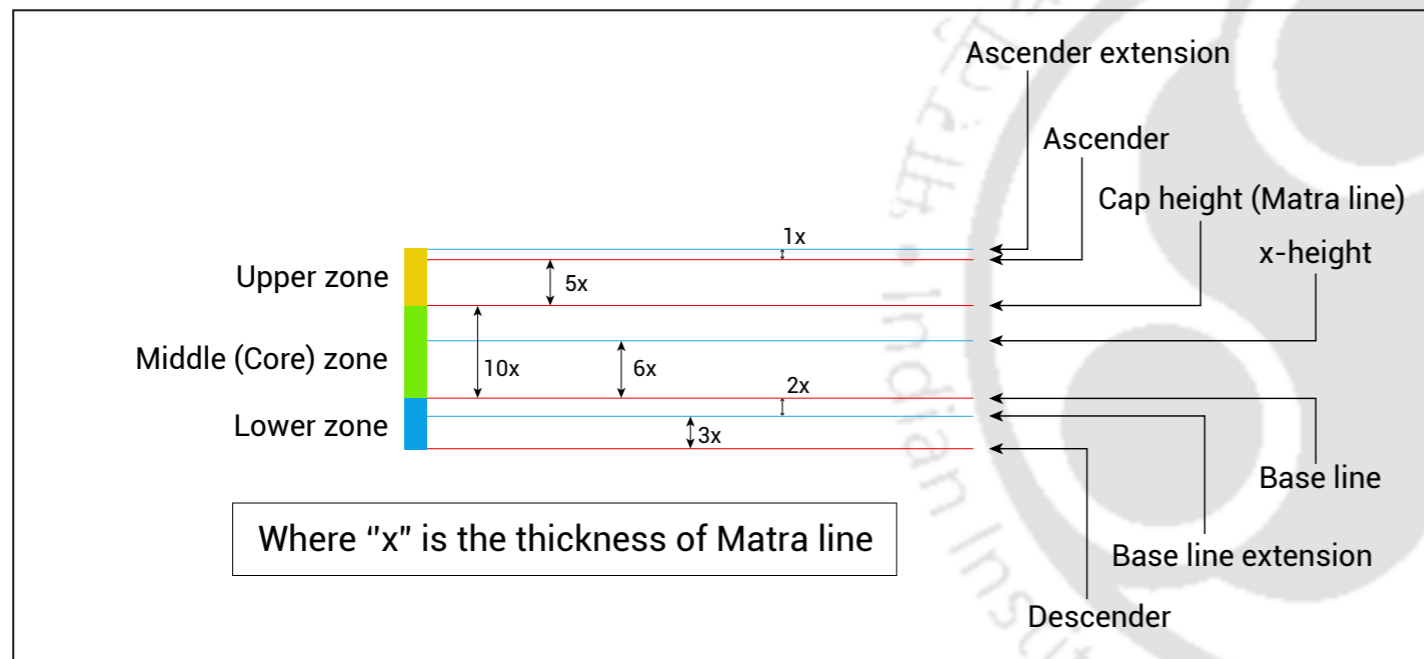
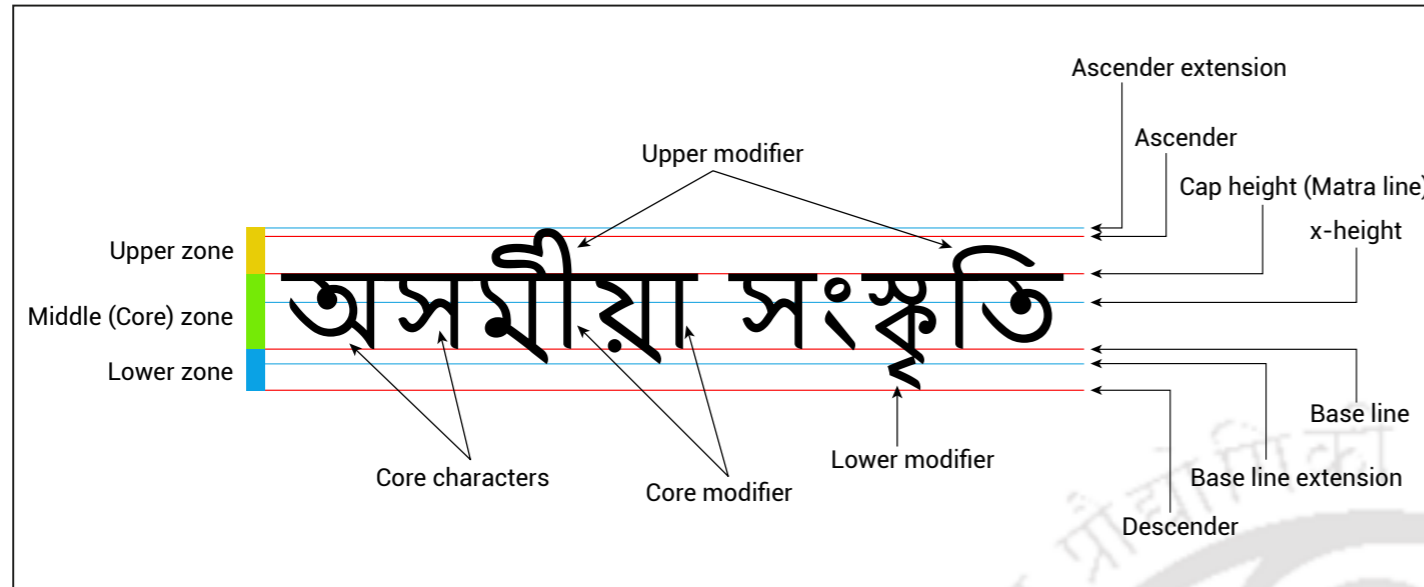
<i>Factor 6</i>	Key options for typing vowel symbols, numbers, special characters, other symbols, etc.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 7</i>	Shortcut key options for typing conjunct letters.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 8</i>	Ease in typing conjunct letters with UNICODE standard method.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 9</i>	Features offered in the typing app.
<i>Answer</i>	Rating point (1 to 10)
<i>Factor 10</i>	Creating emotional connection and cultural identity by the app among users.
<i>Answer</i>	Rating point (1 to 10)



APPENDIX – 2

- 1. Anatomical Structure**
- 2. Garhmayan Assamese Regular font documentation**
- 3. Font character layout**





DESCRIPTION

The anatomical structure of "Garhgayan Assamese Regular 2.0" has been divided into three distinct zones namely:

- 1. **Upper zone:** Contains upper modifier characters.
- 2. **Middle or Core zone:** Contains core characters as well as core modifiers.
- 3. **Lower zone:** Contains lower modifier characters

The entire character structure has been fixed with specific guidelines laid out based on Roman script with a little modification needed for this new typeface. The description of guidelines are as follows:

- 1. **Base line:** It is the imaginary line where core characters rest. In the figure the base line is the line where the bottom part of all the core characters touches.
- 2. **X-height:** It is the imaginary line which shows the height of lower case "x" in Roman script. Here it is taken at an

approximately 2/3 height of a full core character. Technically it defines the junction point for vertical conjunct formation.

3. **Cap height (Matra line):** It is the imaginary line that defines the height of a core character from its base line. This is the line where matra of all core characters placed.

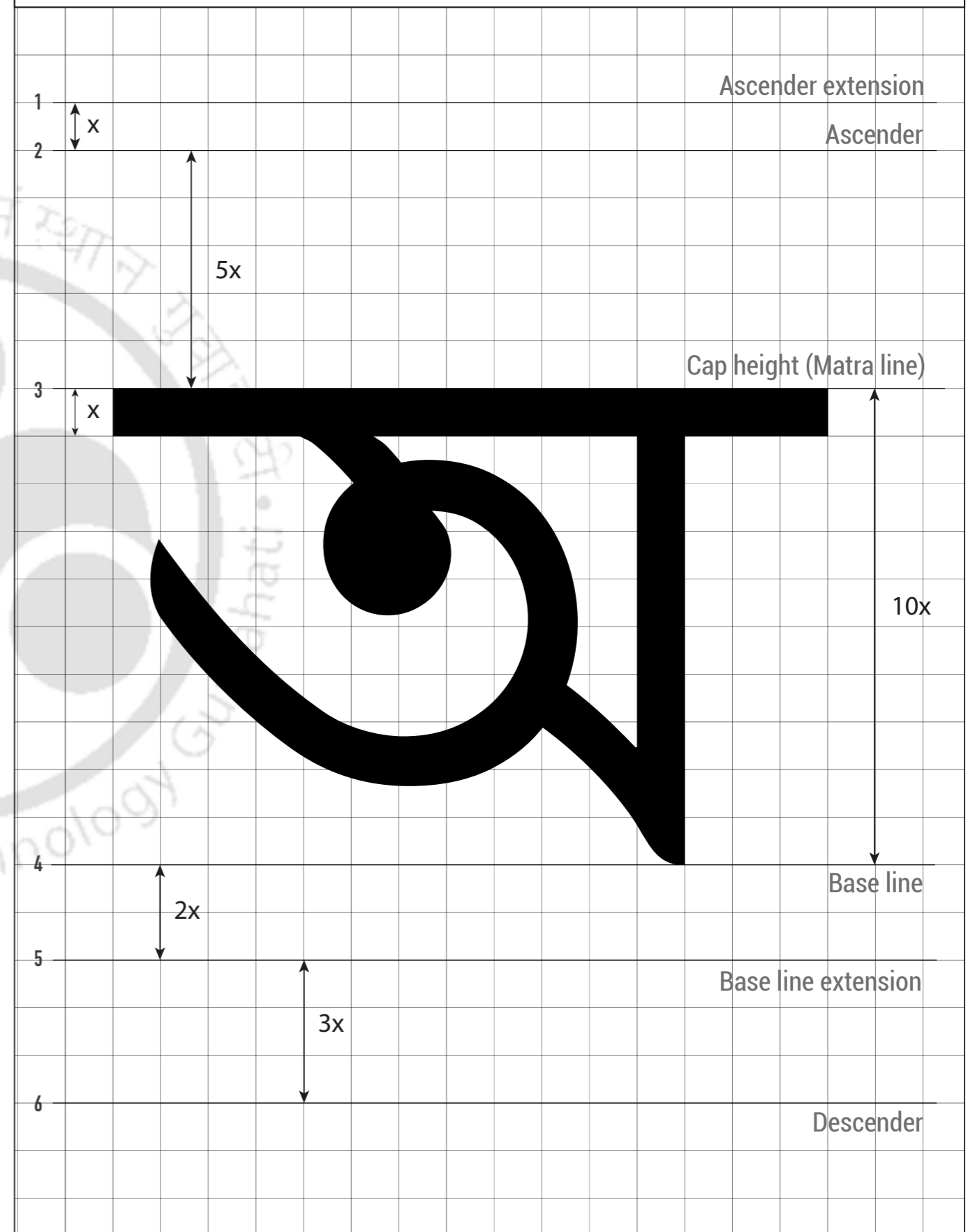
4. **Ascender:** It is the imaginary line which is placed above cap height or "matra line". Almost all the upper modifiers are within the ascender line.

5. **Ascender extension:** It is the imaginary line taken above the ascender line. Few of the upper modifiers which cross the ascender line are fixed at ascender extension line.

6. **Base line extension:** It is the imaginary line taken below the base line. Many of the core characters which have an extended edge beyond its end joining point are fixed in this line. The extended edges will go till the base line extension.

7. **Descender:** Descender is the last line below base line extension. All lower modifier characters are placed within this line.

"x" is taken as the size of a square = thickness of "Matra" line

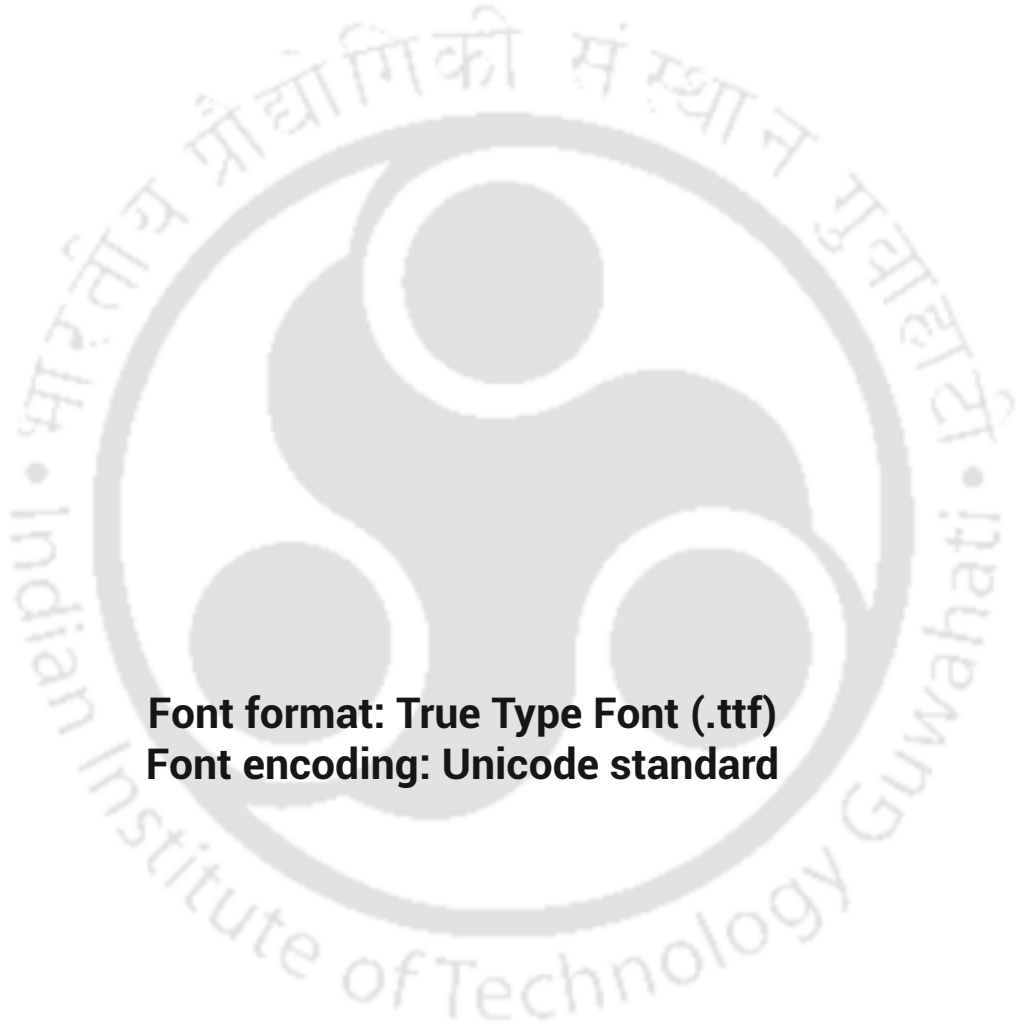




APPENDIX - 2B

BRIEF DOCUMENTATION

TYPEFACE NAME: GARHGAYAN ASSAMESE REGULAR



Font format: True Type Font (.ttf)
Font encoding: Unicode standard

NOTE: This is a brief documentation to describe the new Typeface "Garhgayan Assamese Regular" and it's character set. The document describes the Phonetic note, UNICODE number, rule for conjunct letter formation and use of symbols and special characters. Anatomical layout of all the primary characters of the typeface has also been included in the documentation.



LAYOUT OF COMPLETE CHARACTER LIST INCLUDING SYMBOLS

VOWELS & DIACRITICS															
অ	আ	ই	ঈ	উ	ঊ	ঋ	এ	ঐ	ও	ঔ					
	।	ি	ী	ু	ূ	্ৰ	ে	ৈ	ো	ৌ					
CONSONANTS AND EXTRAS															
ক	খ	গ	ঘ	ঙ	য	ৰ	ল	ৱ							
চ	ছ	জ	ঝ	ঞ	শ	স	ষ	হ							
ট	ঠ	ড	ঢ	ণ	ক্ষ	য়	ড়	ত							
ভ	থ	দ	ধ	ন	ং	ঃ		ং							
প	ফ	ব	ভ	ম	্ৰ	্ৰ	্ৰ	্ৰ							
NUMBERS															
০	১	২	৩	৪	৫	৬	৭	৮	৯						
SYMBOLS															
!	?	"	"	'	,	()	#	*	:	;	.	{	}	[]
-	-	/	\	<	>	=	x	÷	+	-					

UNICODE NUMBERING WITH PHONETIC NOTE
VOWELS AND VOWEL DIACRITICS

অ	আ	ই	ঈ	উ	ঊ	ঋ
"O"	"Aa"	"Harsha-le"	"Dirgho-le"	"Harsha-U"	"Dirgho-Uu"	"Ri"
U-0985	U-0986	U-0987	U-0988	U-0989	U-098A	U-098B
এ	ঐ	ও	ঔ			
"E"	"Oi"	"U"	"Ou"			
U-098F	U-0990	U-0993	U-0994			
া	ি	ী	ু	ূ	ৃ	ে
"Aa-kar"	"I-kar"	"le-kar"	"U-kar"	"Uu-kar"	"Ri-kar"	"E-kar"
U-09BE	U-09BF	U-09C0	U-09C1	U-09C2	U-09C3	U-09C7
ৈ	ৌ	ৌ				
"Oi-kar"	"U-kar"	"Ou-kar"				
U-09C8	U-09CB	U-09CC				

UNICODE NUMBERING WITH PHONETIC NOTE
CONSONANTS AND EXTRAS

ক	খ	গ	ঘ	ঙ	চ	ছ
"Ka"	"Kha"	"Ga"	"Gha"	"Ngo"	"Pratham So"	"Dwitiyo So"
U-0995	U-0996	U-0997	U-0998	U-0999	U-099A	U-099B
জ	ঝ	ঞ	ট	ঠ	ড	ঢ
"Bargia-Ja"	"Jha"	"Nyo"	"Murdhanya-Ta"	"Murdhanya-Tha"	"Murdhanya-Da"	"Murdhanya-Dha"
U-099C	U-099D	U-099E	U-099F	U-09A0	U-09A1	U-09A2
ণ	ত	থ	দ	ধ	ন	প
"Murdhanya-Na"	"Dantya-Ta"	"Dantya-Tha"	"Dantya-Da"	"Dantya-Dha"	"Dantya-Na"	"Pa"
U-09A3	U-09A4	U-09A5	U-09A6	U-09A7	U-09A8	U-09AA
ফ	ব	ভ	ম	য	ৰ	ল
"Pha"	"Ba"	"Bha"	"Ma"	"Antasta-Ja"	"Ra"	"La"
U-09AB	U-09AC	U-09AD	U-09AE	U-09AF	U-09B0	U-09B2

UNICODE NUMBERING WITH PHONETIC NOTE
CONSONANTS AND EXTRAS

ৱ	শ	স	ষ	হ	ক্ষ	য়
"Wa"	"Talabya - Xa"	"Dantya - Xa"	"Murdhanya - Xa"	"Ha"	"Khya"	"Ya"
U-09F1	U-09B6	U-09B8	U-09B7	U-09B9	u0995+u09CD +u09B7	U-09DF
ড়	ঢ়	ৎ	ং	:	ঁ	্
"Da-Rha"	"Dha-Rha"	"Harsnta-Ta"	"Anusar"	"Bisarga"	"Chandrabindu"	"Halant"
U-09DC	U-09DD	U-09CE	U-0982	U-0983	U-0981	U-09CD
।	্ৰ	্ৰ	ৱ	্ৰ		
"Dahri"	"Em-dash" (start-matra)	"En-dash" (end-matra)	"Ra"	"Reph"		
U-0964	U-2014	U-2013	U-09F0	U-09B0_09CD		

UNICODE NUMBERING WITH PHONETIC NOTE NUMBER SYSTEM & SYMBOLS

০	১	২	৩	৪	৫	৬
"Shunya"	"Ek"	"Dui"	"Tini"	"Sari"	"Pans"	"Soi"
U-09E6	U-09E7	U-09E8	U-09E9	U-09EA	U-09EB	U-09EC
৭	৮	৯				
"Haat"	"Aanth"	"Nou"				
U-09ED	U-09EE	U-09EF				
!	?	"	"	'	'	,
"Exclam"	"Question"	"quotedblleft"	"quotedblright"	"quoteleft"	"quoteright"	"Comma"
U-0021	U-003F	U-201C	U-201D	U-2018	U-2019	U-002C
:	;	.	{	}	[]
"Colon"	"Semicolon"	"Period"	"Braceleft"	"Braceright"	"Bracketleft"	"Bracketright"
U-003A	U-003B	U-002E	U-007B	U-007D	U-005B	U-005D

UNICODE NUMBERING WITH PHONETIC NOTE SYMBOLS

-	_	/	\	#	<	>
"Hyphen"	"Underscore"	"Slash"	"Backslash"	"Numbersign"	"Less"	"Greater"
U-002D	U-005F	U-002F	U-005C	U-0023	U-003C	U-003E
=	×	÷	+	-	()
"Equal"	"Multiply"	"Devide"	"Plus"	"Minus"	"Parenleft"	"Parenright"
U-003D	U-00D7	U-00F7	U-002B	U-2212	U-0028	U-0029
*						
"Asterisk"						
U-002A						

CONJUNCT LETTER FORMATION SYSTEM

UNICODE NAMING OF CONJUNCT LETTER SYSTEM

DIFFERENT TYPES OF CONJUNCT LETTER FORMATION AND UNICODE NAME	
Conjunct letter formation	Unicode name
ক + া = কা	U-0995 _ U-09BE
ক + ি = কি	U-0995 _ U-09BF
ক + ী = কী	U-0995 _ U-09C0
ক + ্ + ক = ক্ক	U-0995 _U-09CD_ U-0995
ক্ক + ী = ক্কী	U-0995 _U-09CD_ U-0995_U-09C0
গ + ্ + ব + ্ + ধ = গ্ধ	U-0997 _U-09CD_ U-09AC_U-09CD_ U-09A7
গ্ধ + ি = গ্ধি	U-0997 _U-09CD_ U-09AC_U-09CD_ U-09A7 _U-09BF
ক + ্ + ষ = ক্ধ	U-0995 _U-09CD_ U-09B7
গ + ্ = গ্	U-0997_U-09C1
ব + ্ + ক = ব্ক	U-09F0_U-09CD_ U-0995

USE OF SPECIAL CHARACTERS: EM-DASH & EN-DASH

—	—
“Em-dash” (start-matra)	“En-dash” (end-matra)
U-2014	U-2013

EXAMPLE:

অসমীয়া ভাষা

Without start and end matra

— অসমীয়া ভাষা —

With start and end matra

— অসমীয়া ভাষা —

Highlighting the matras in red

The logo of the Indian Institute of Technology Guwahati is a circular emblem. It features a central stylized figure with three rounded, bulbous shapes extending from its body, resembling a traditional Assamese motif. The figure is set against a light background within a circular border. The text "Indian Institute of Technology Guwahati" is written in English around the bottom half of the circle, and its Assamese equivalent "গুৱাহাটীৰ ভাৰতীয় প্ৰযুক্তিবিজ্ঞানীয়া প্ৰাচ্যোগিকী সংস্থান" is written along the top half.

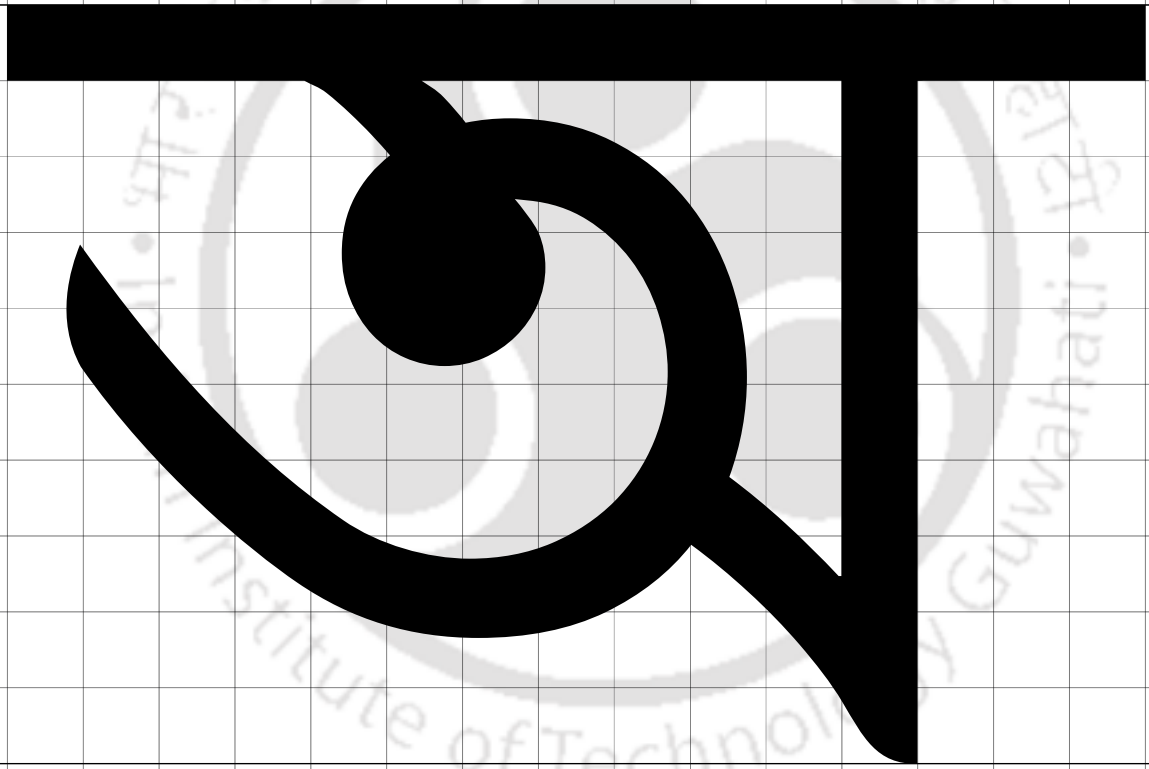
ANATOMICAL LAYOUT OF PRIMARY CHARACTERS
TYPEFACE NAME: GARHGAYAN ASSAMESE REGULAR



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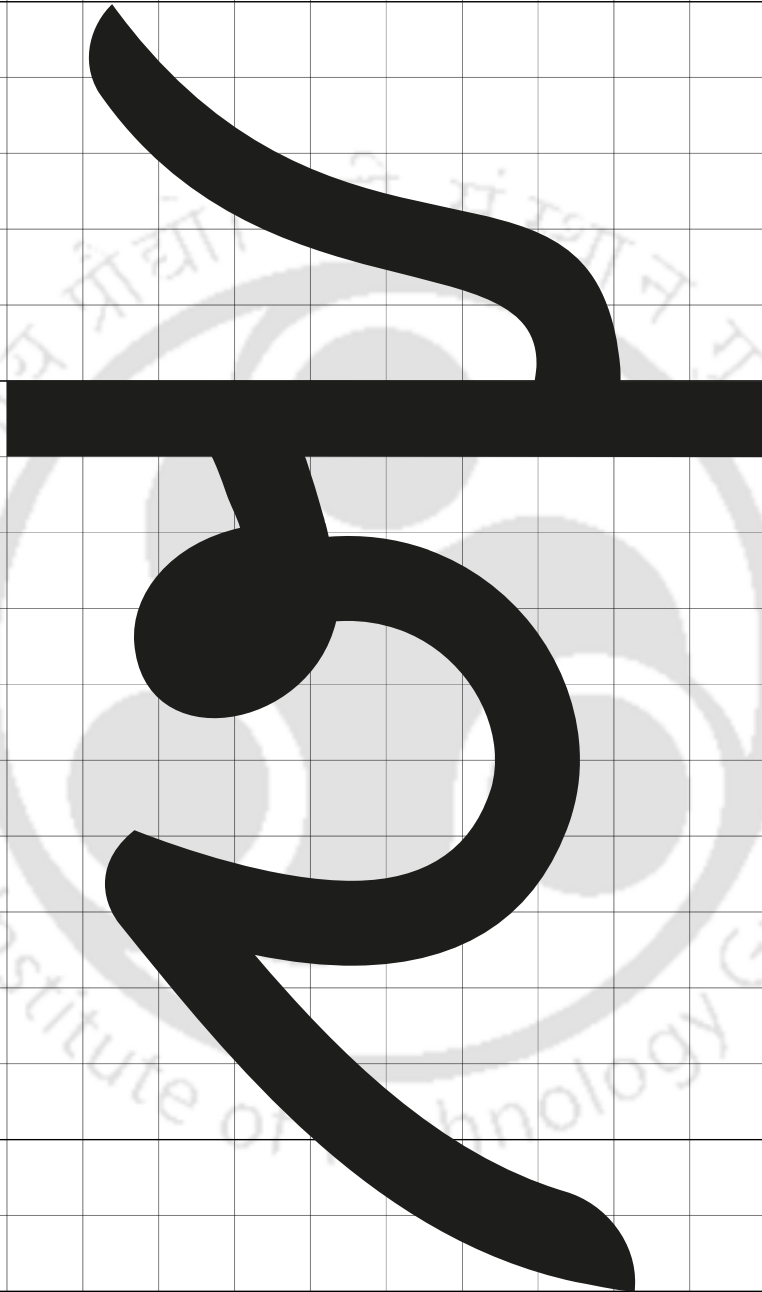
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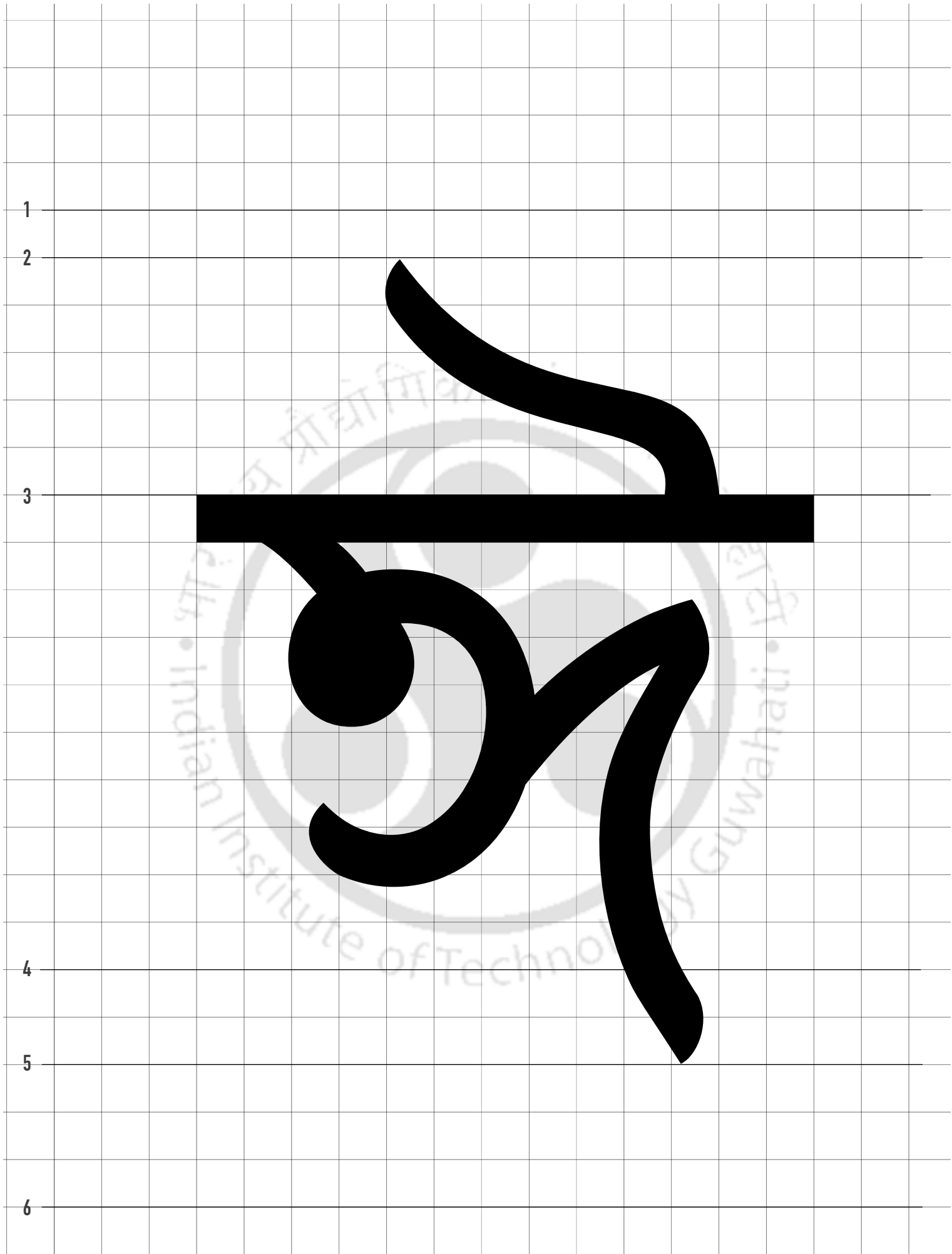
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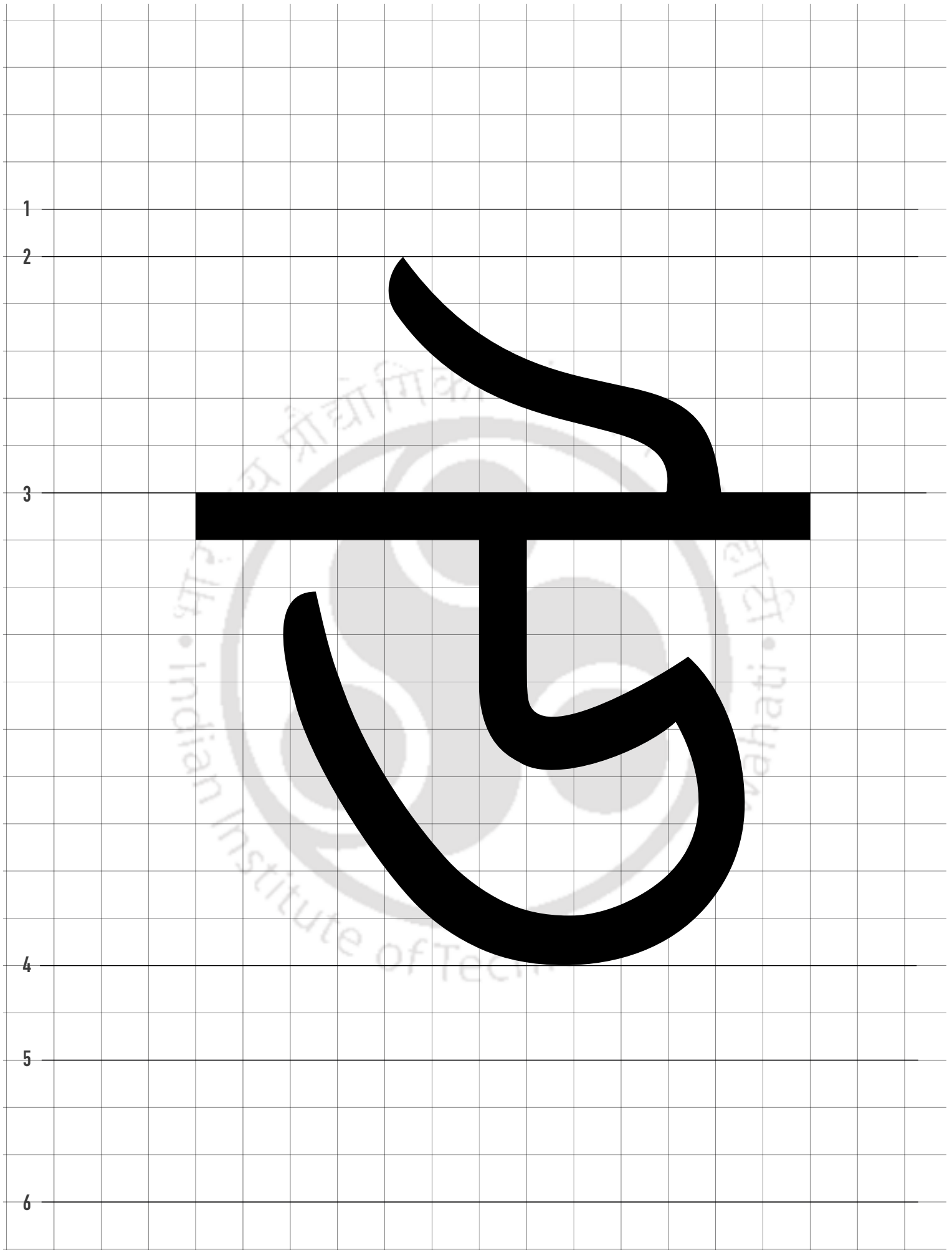
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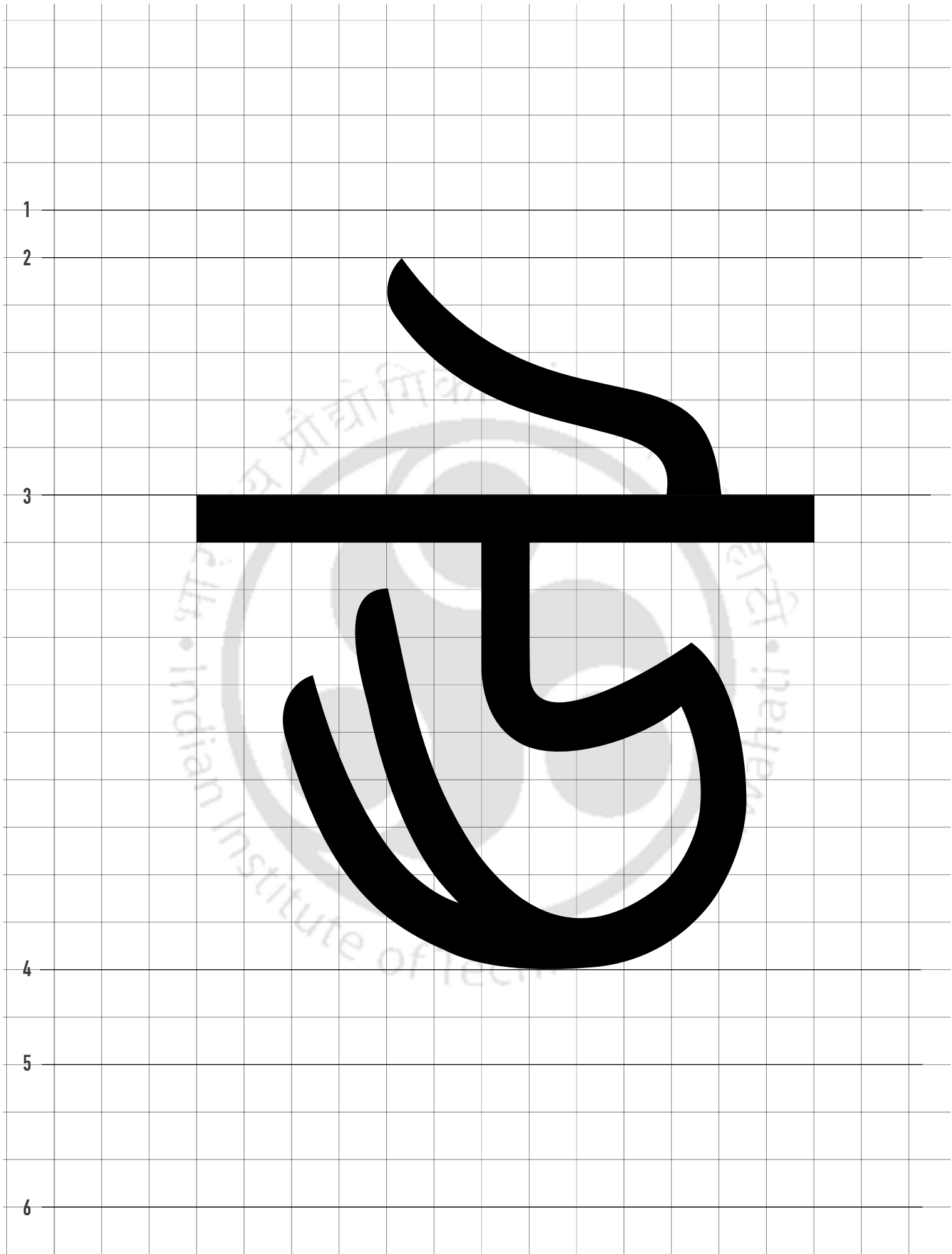
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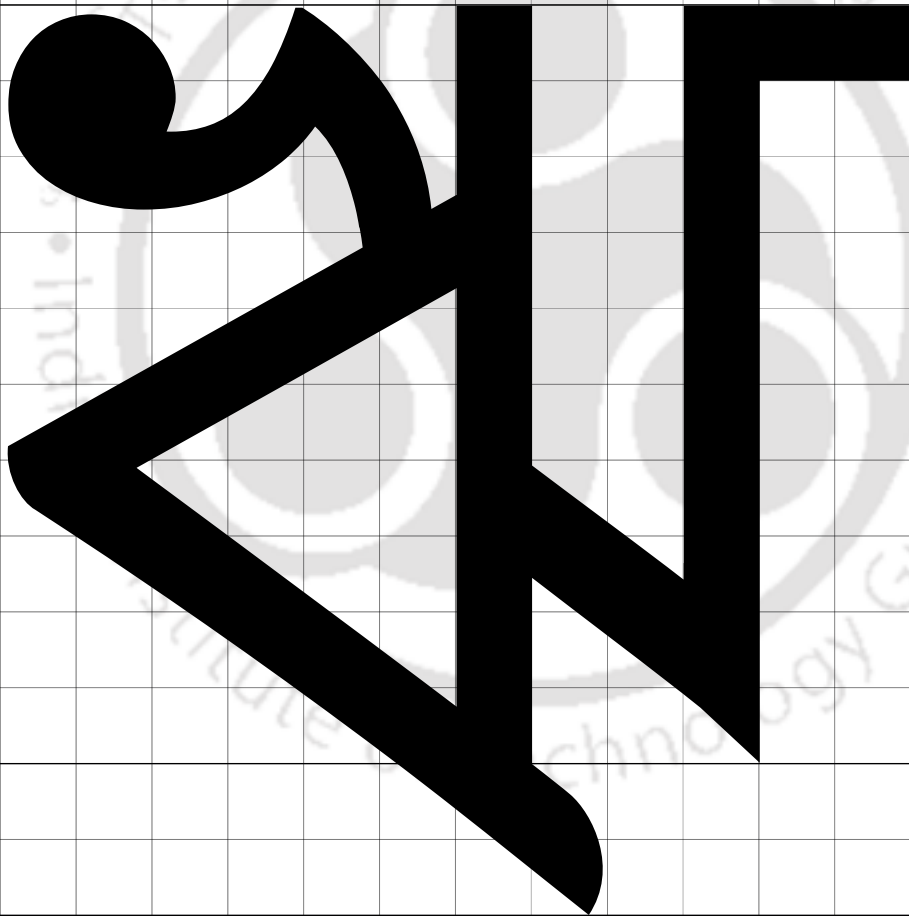
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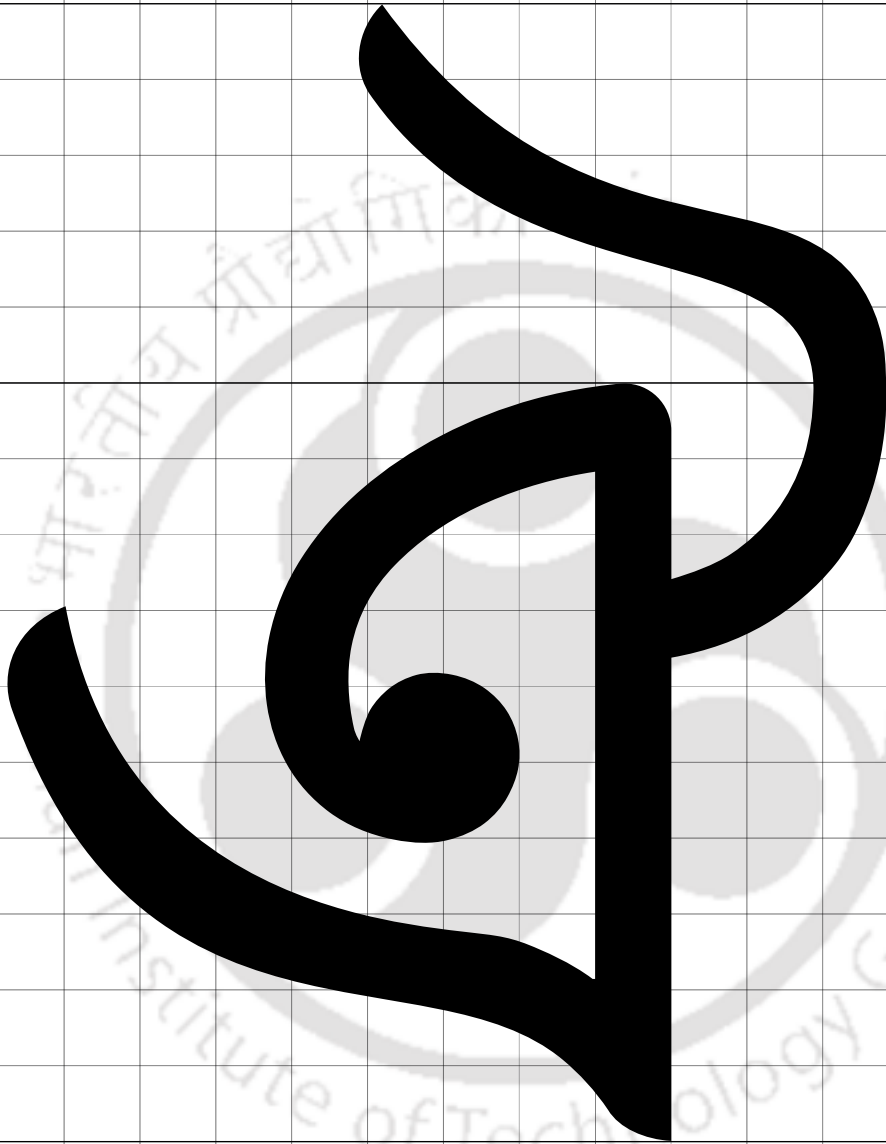
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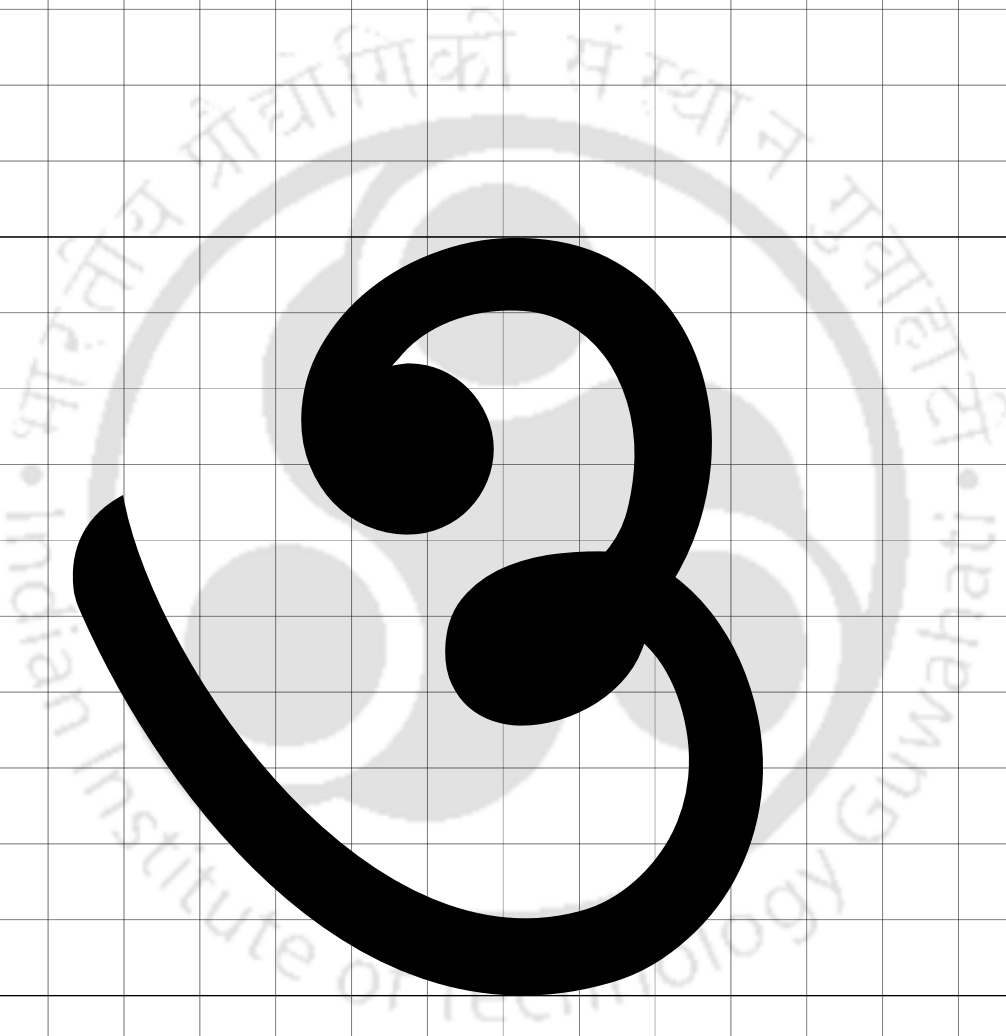
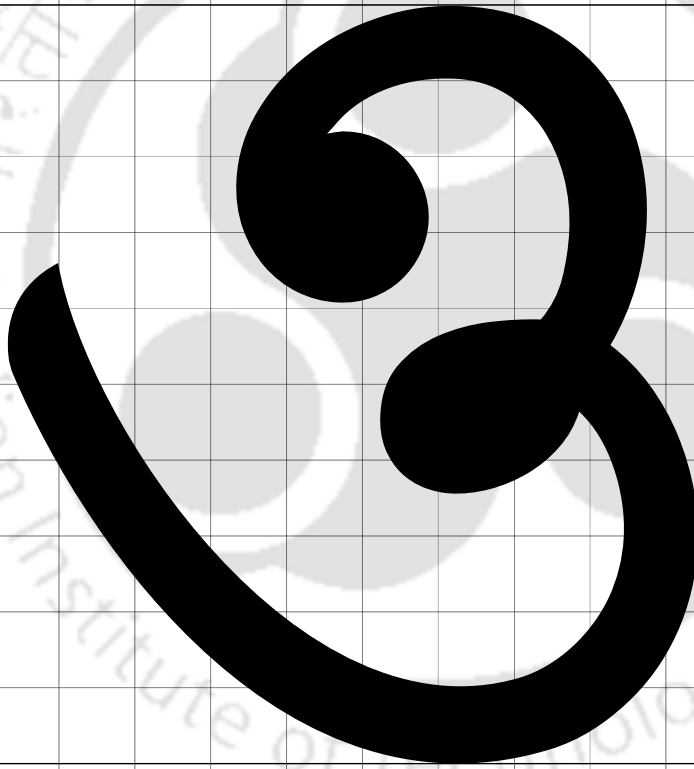
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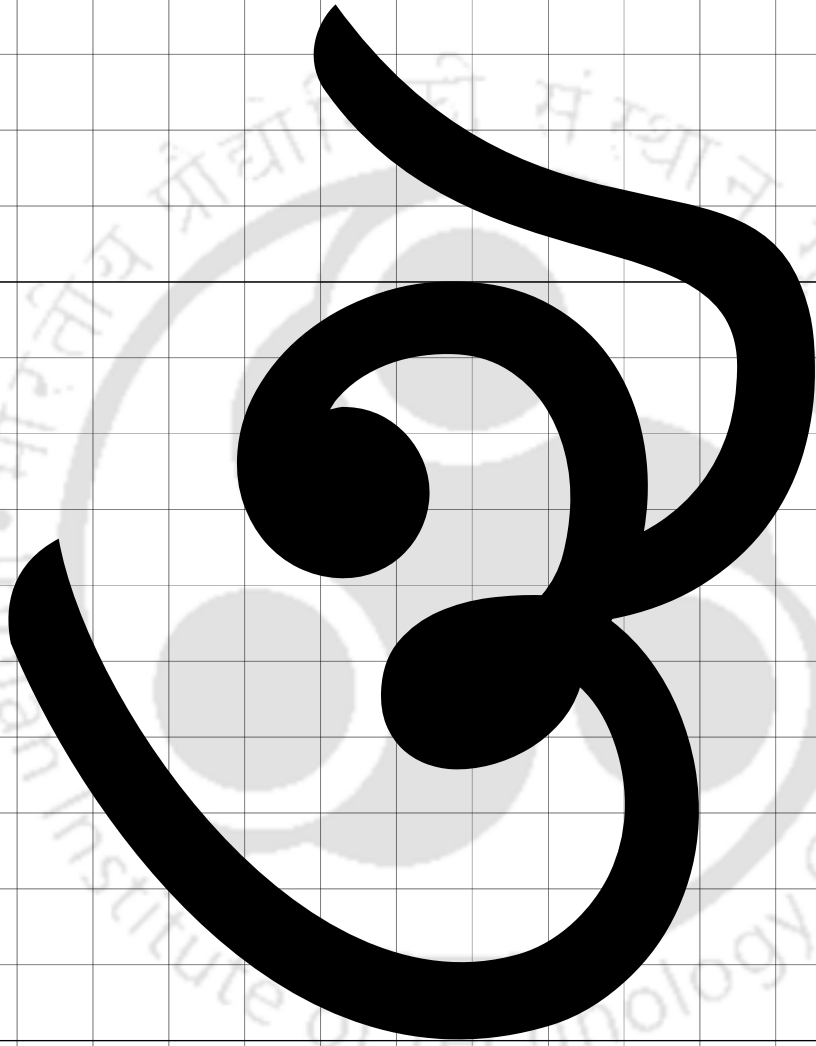
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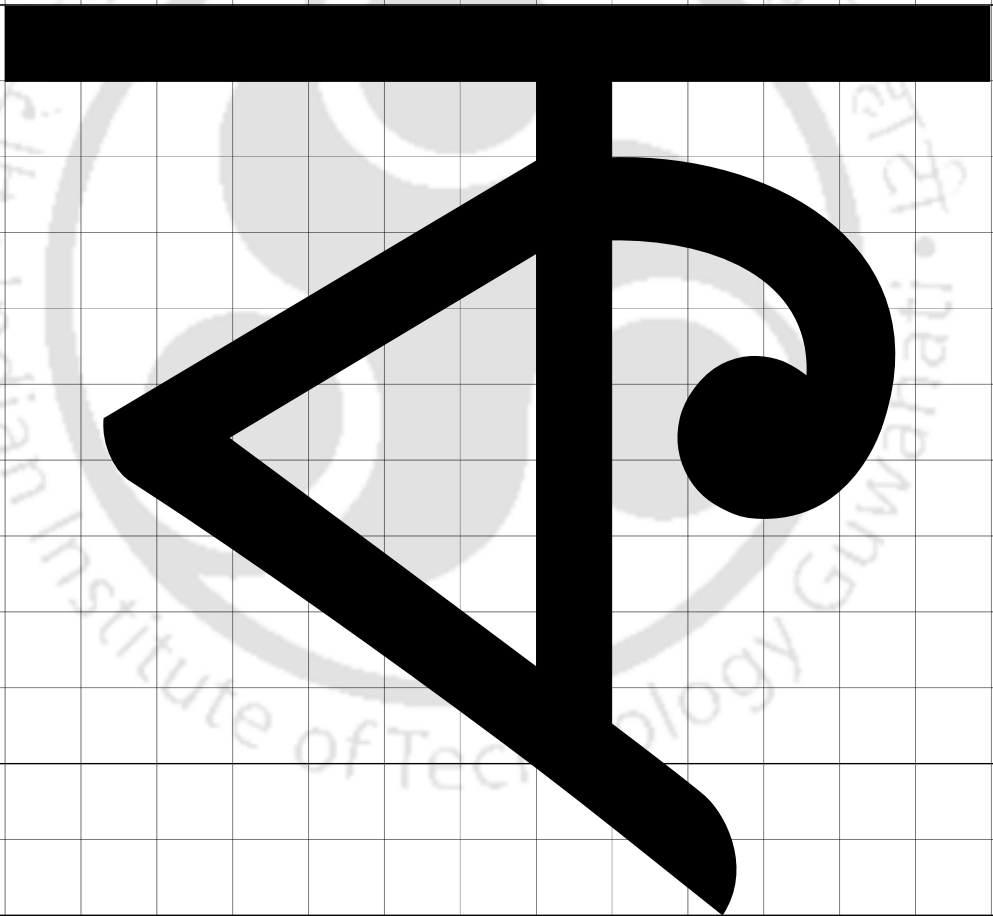
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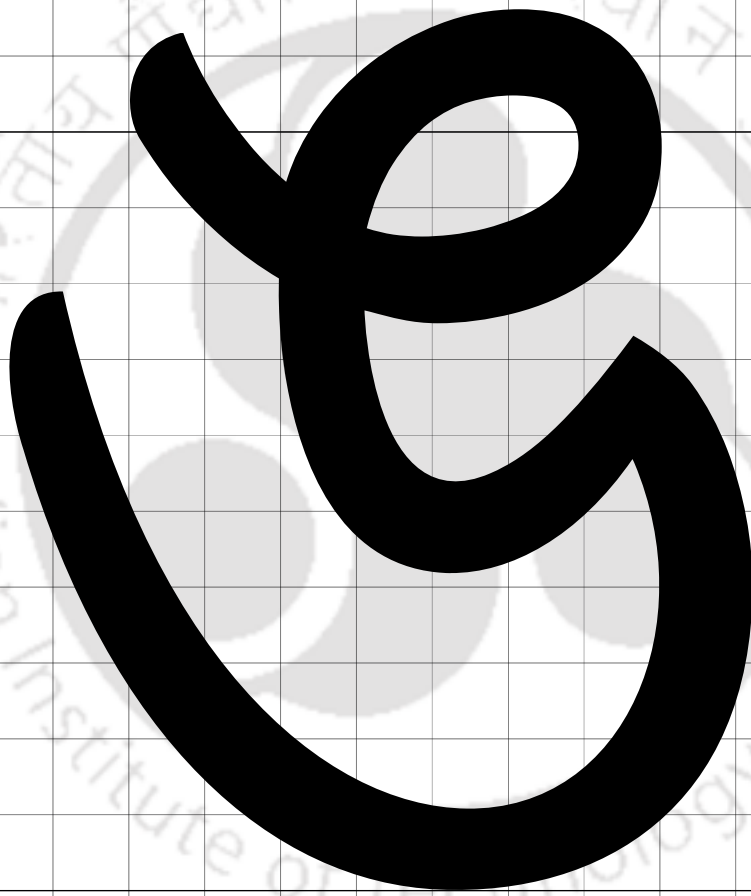
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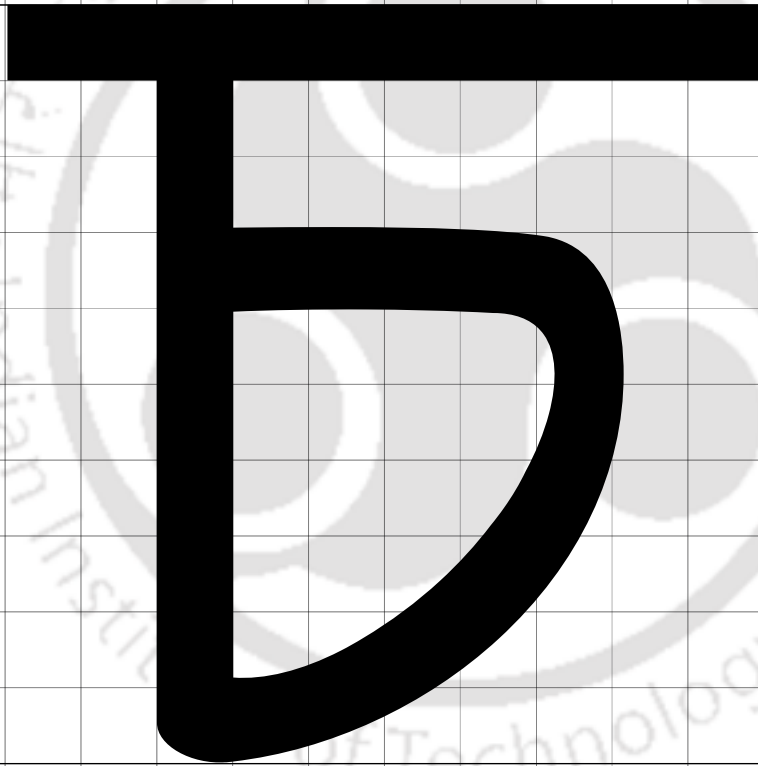
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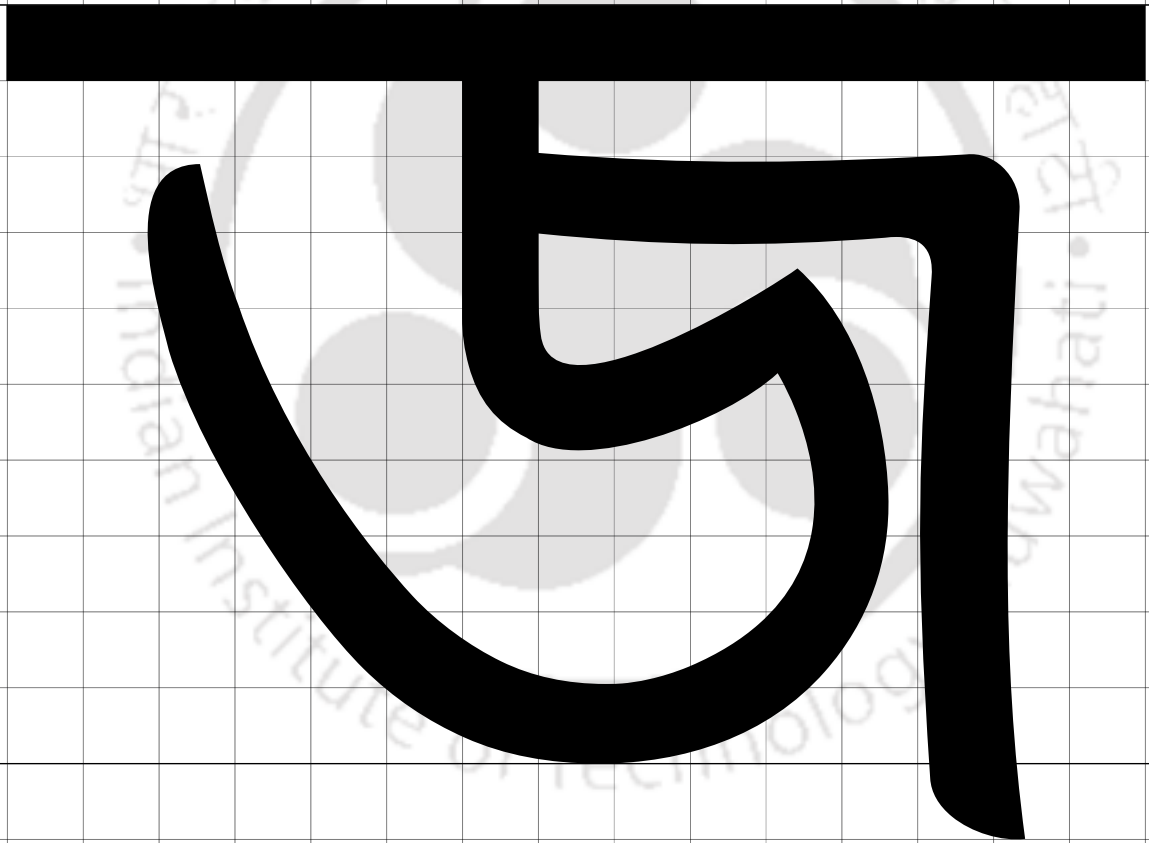
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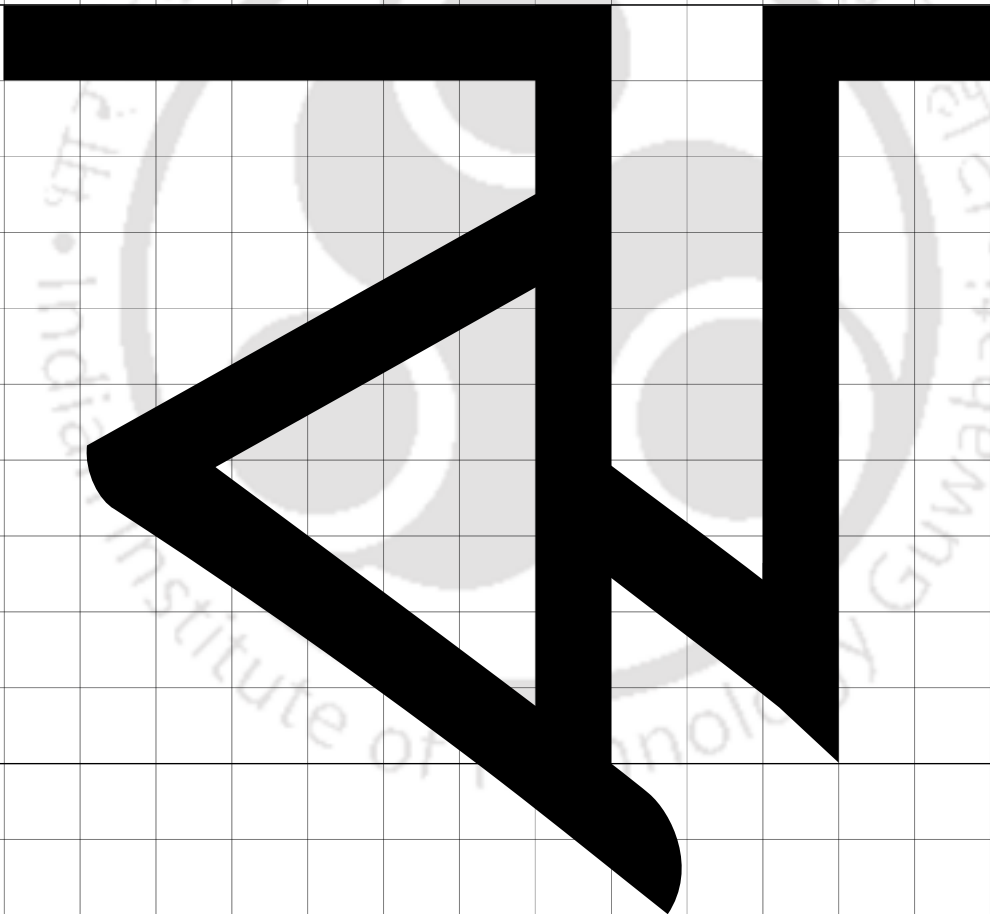
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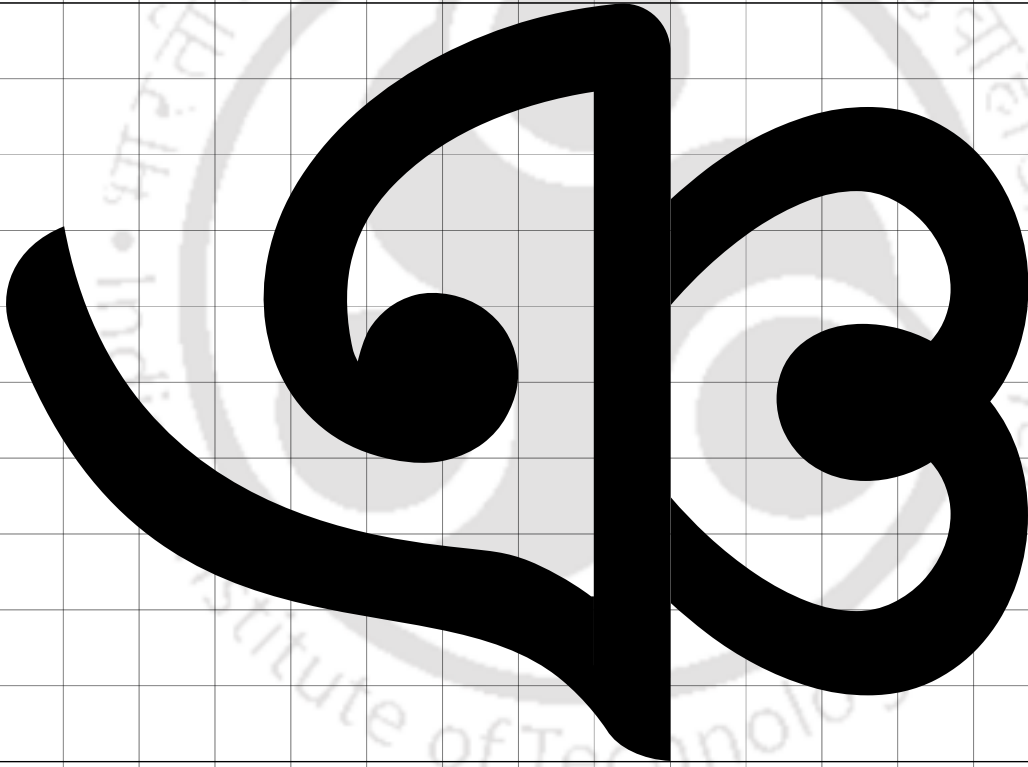
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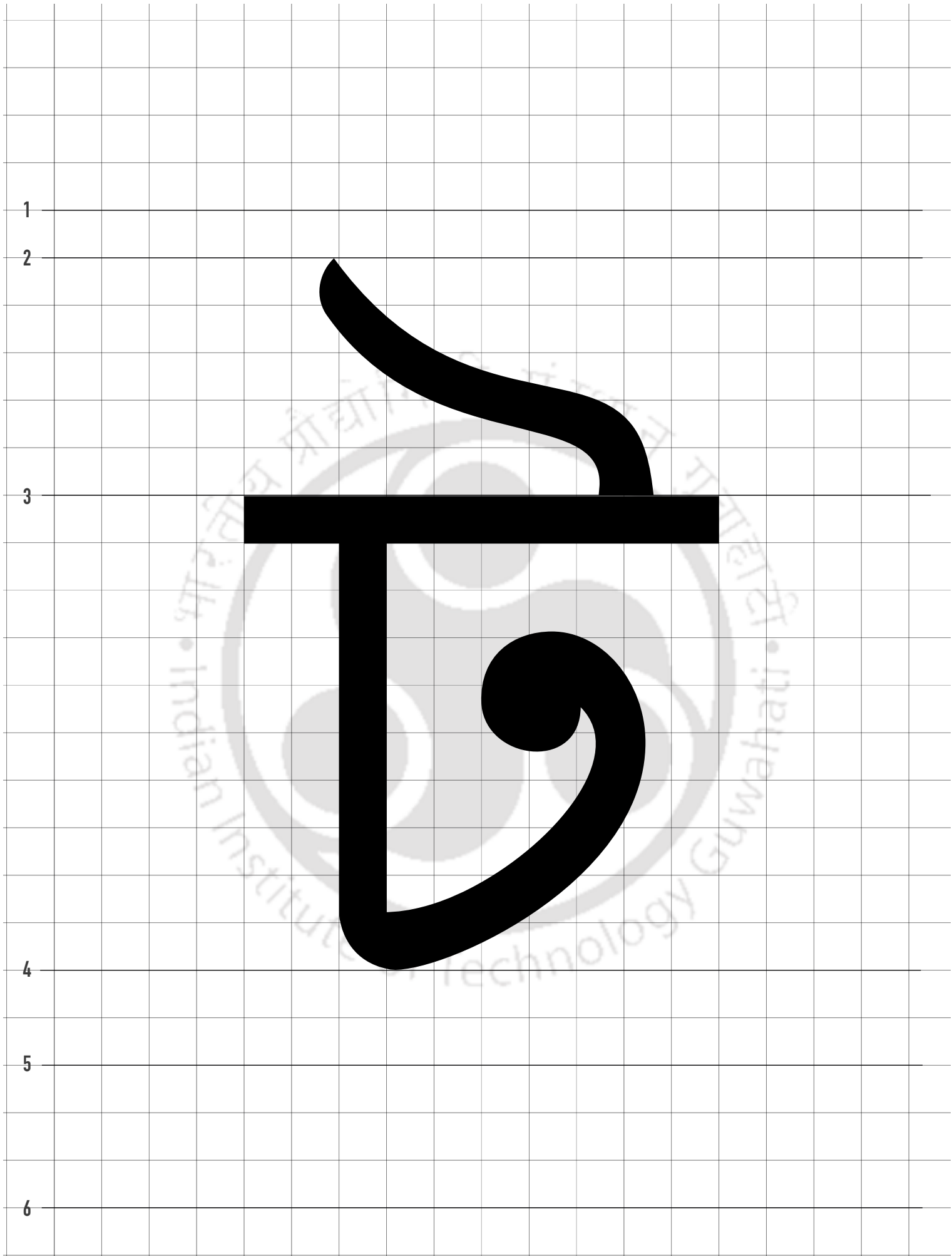
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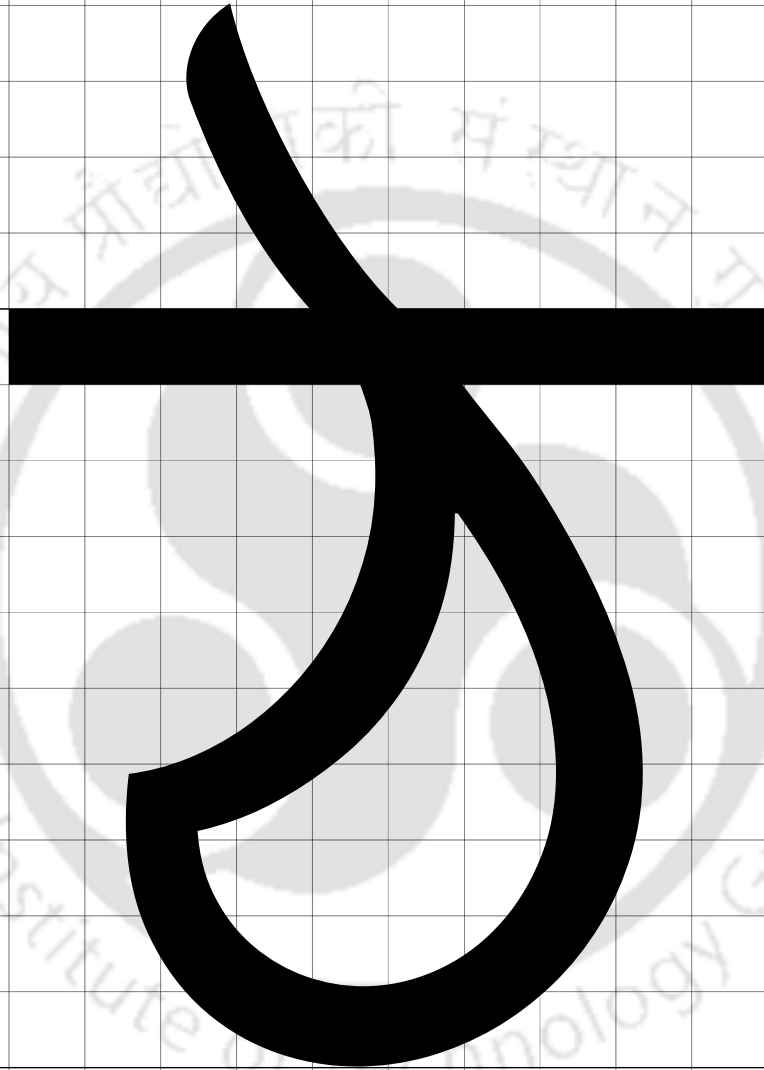
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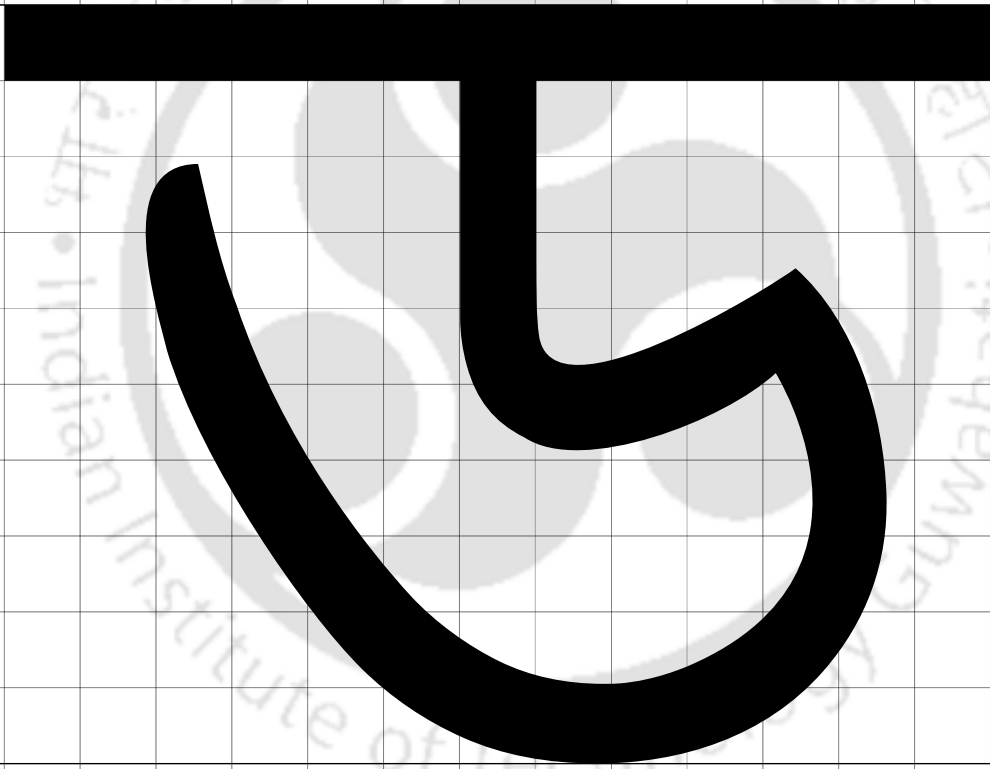
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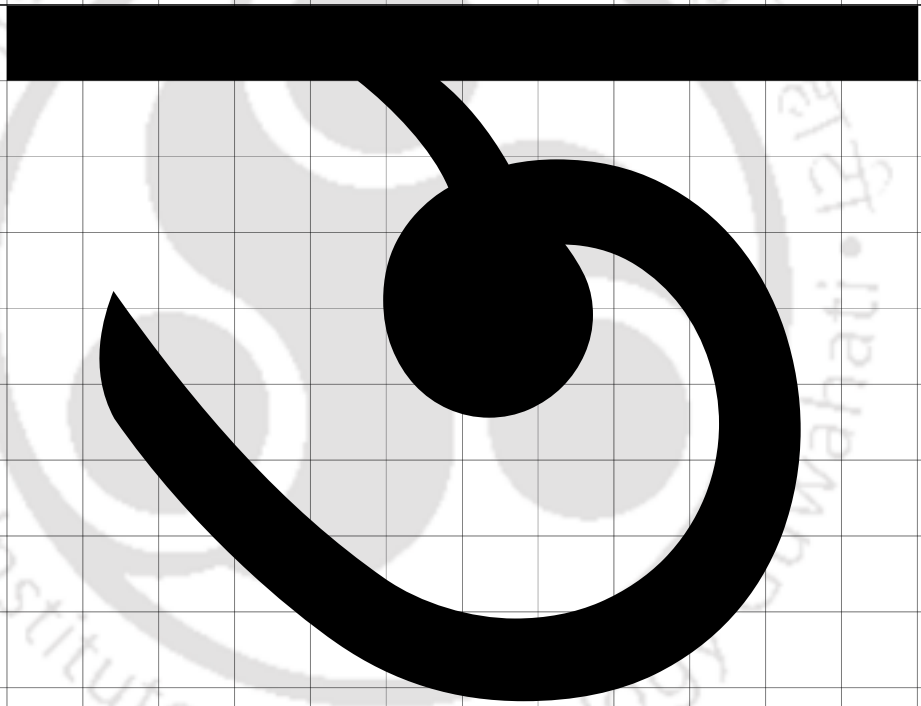
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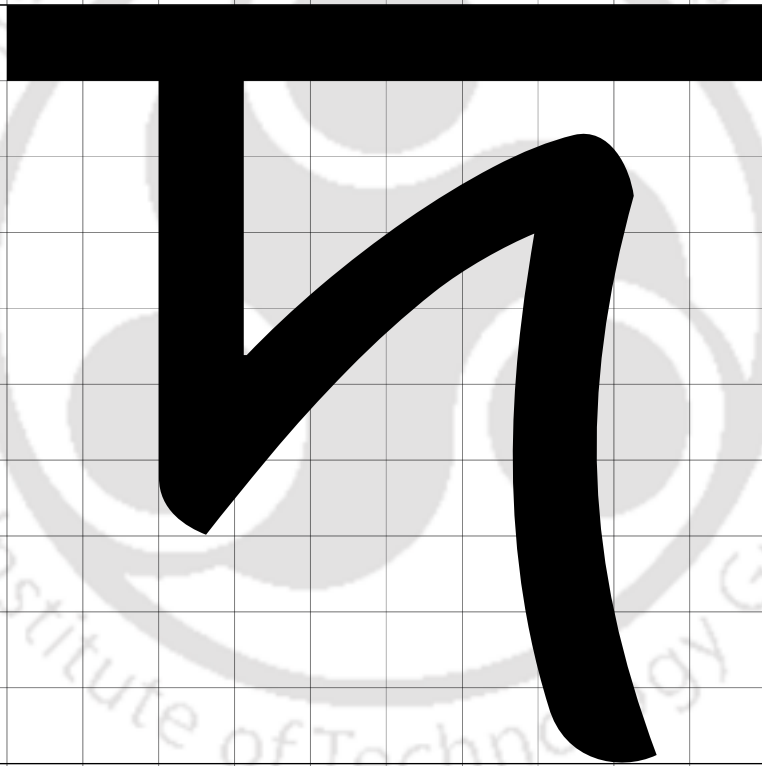
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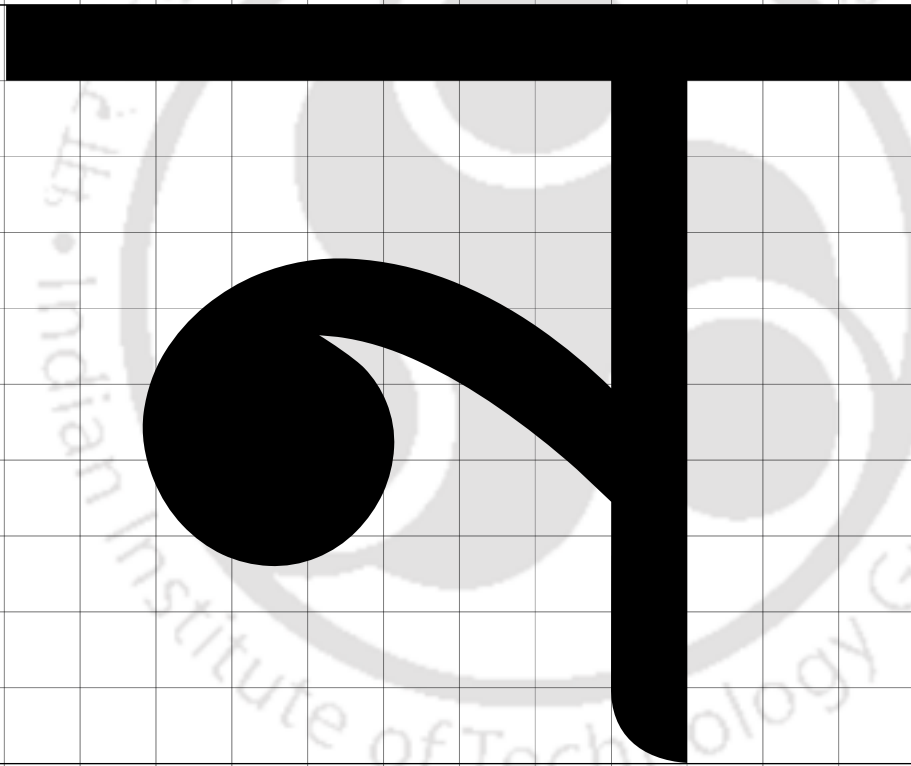
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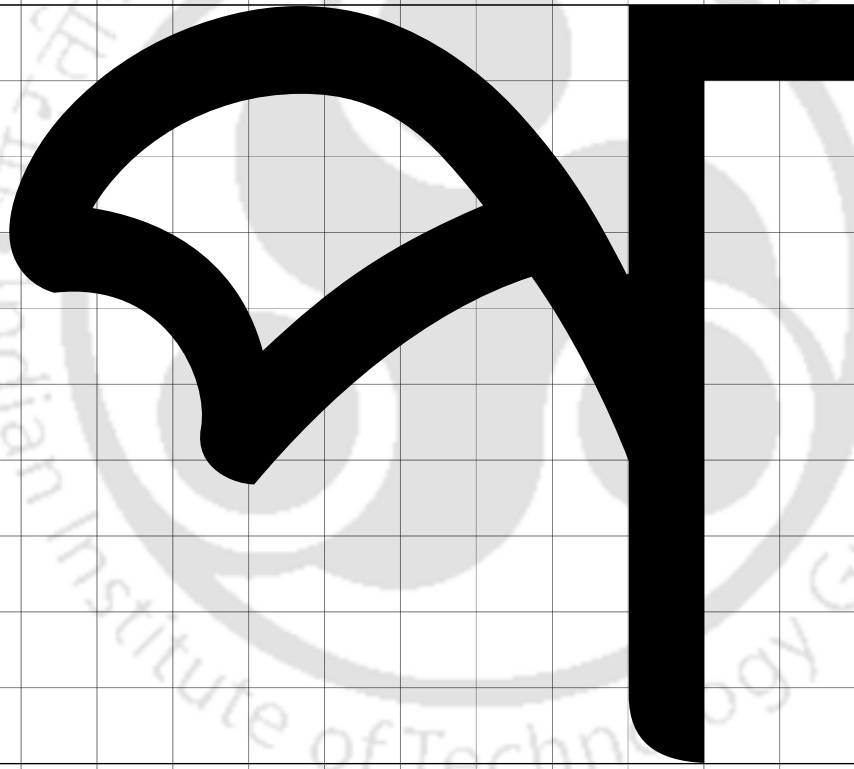
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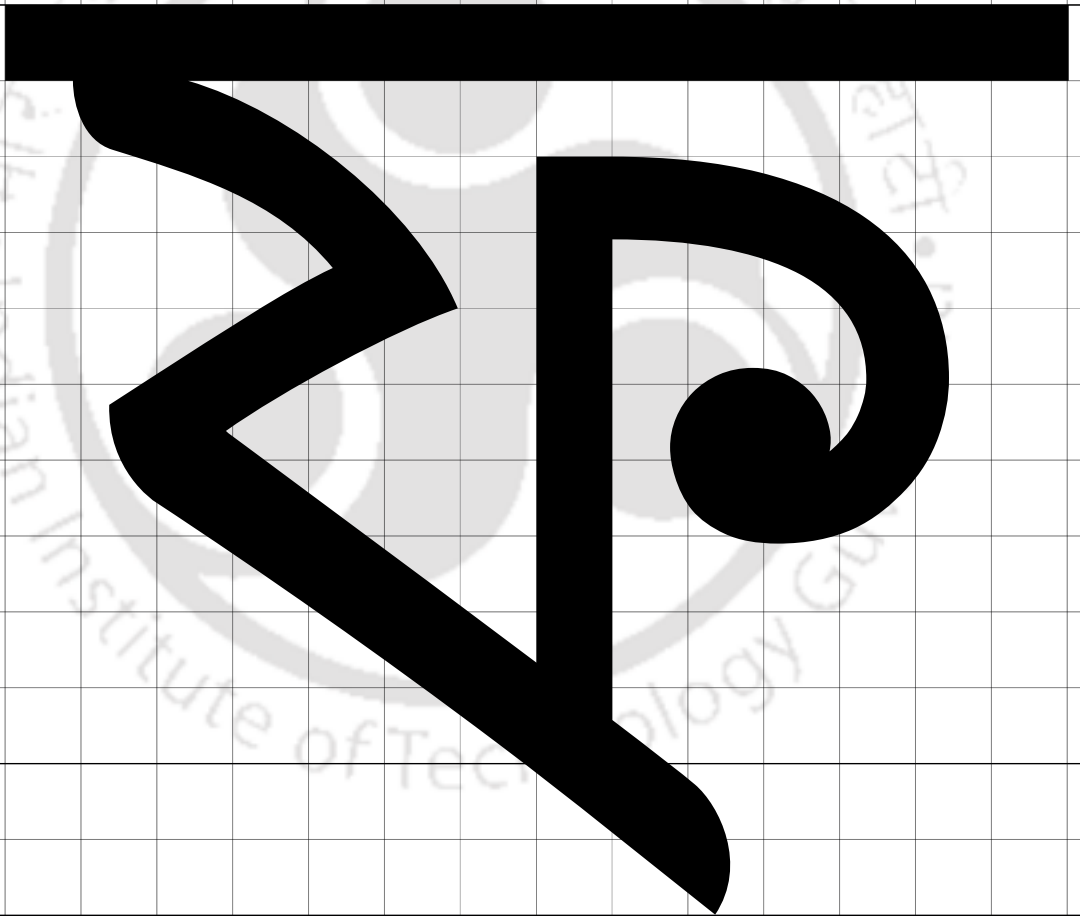
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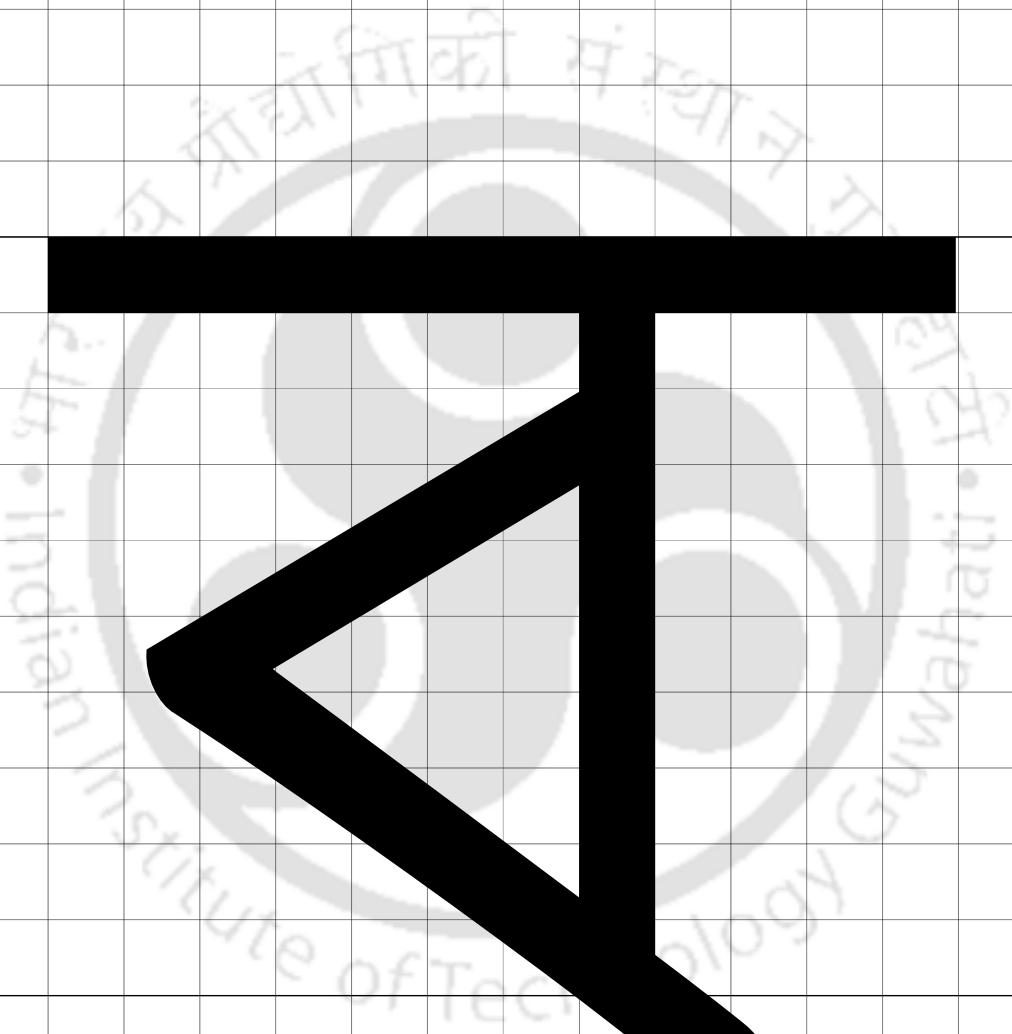
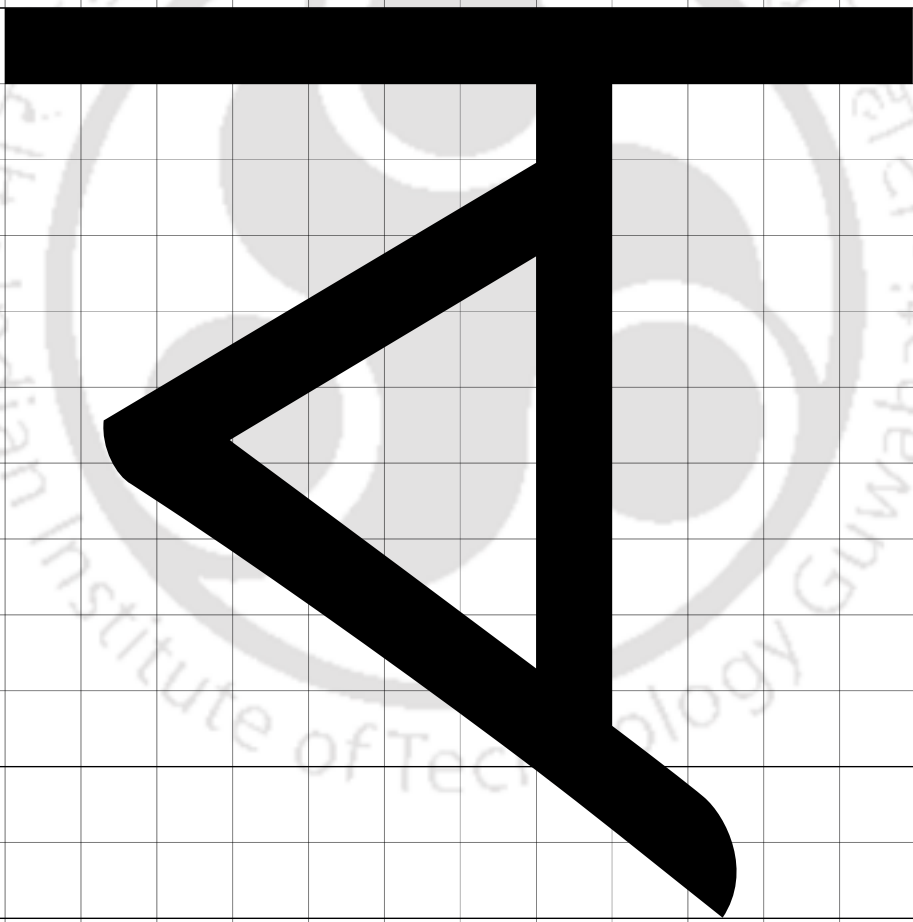
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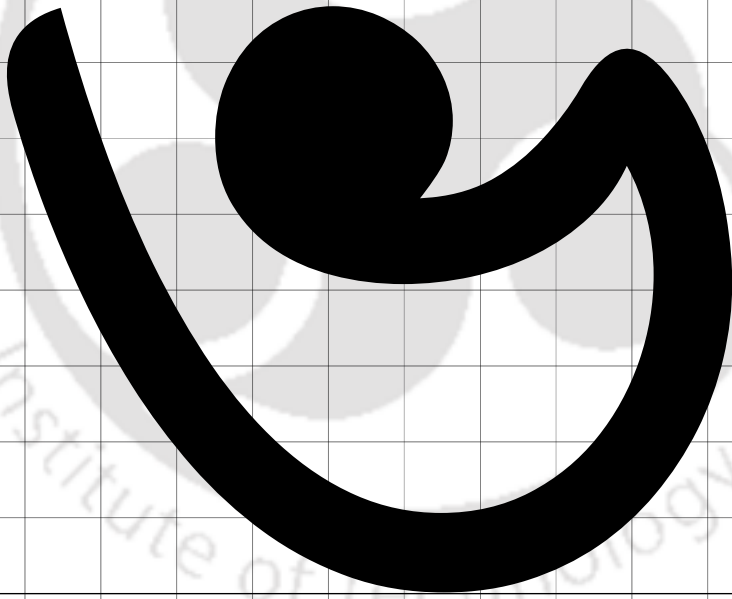
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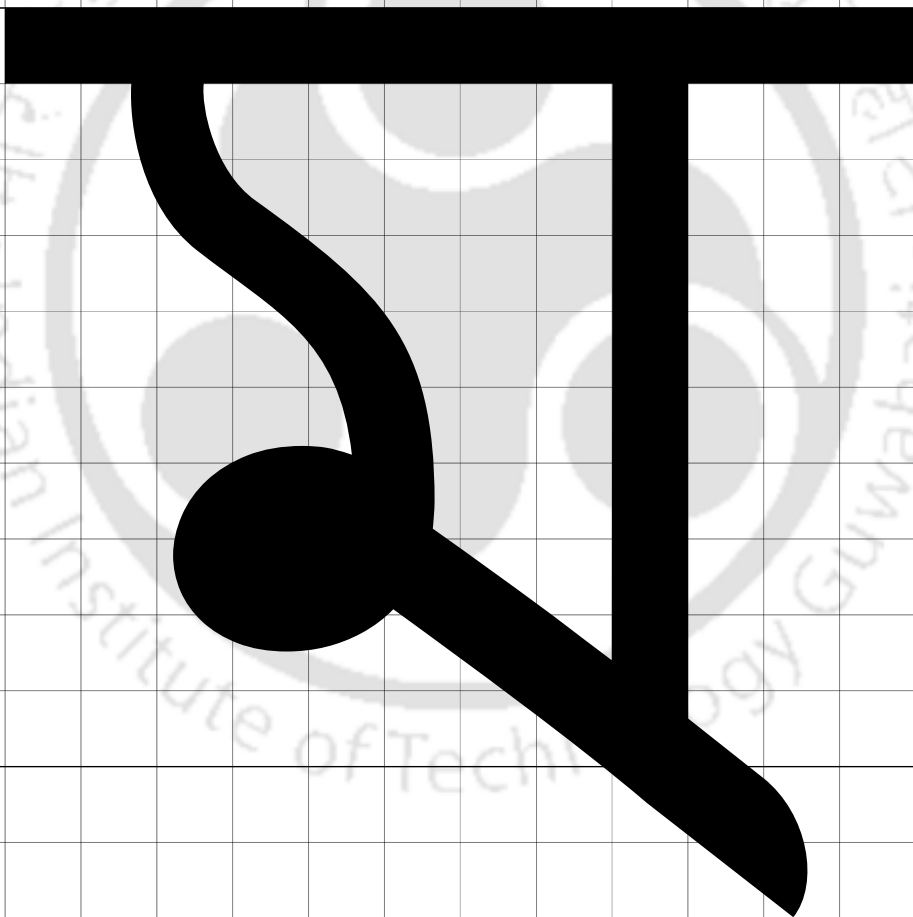
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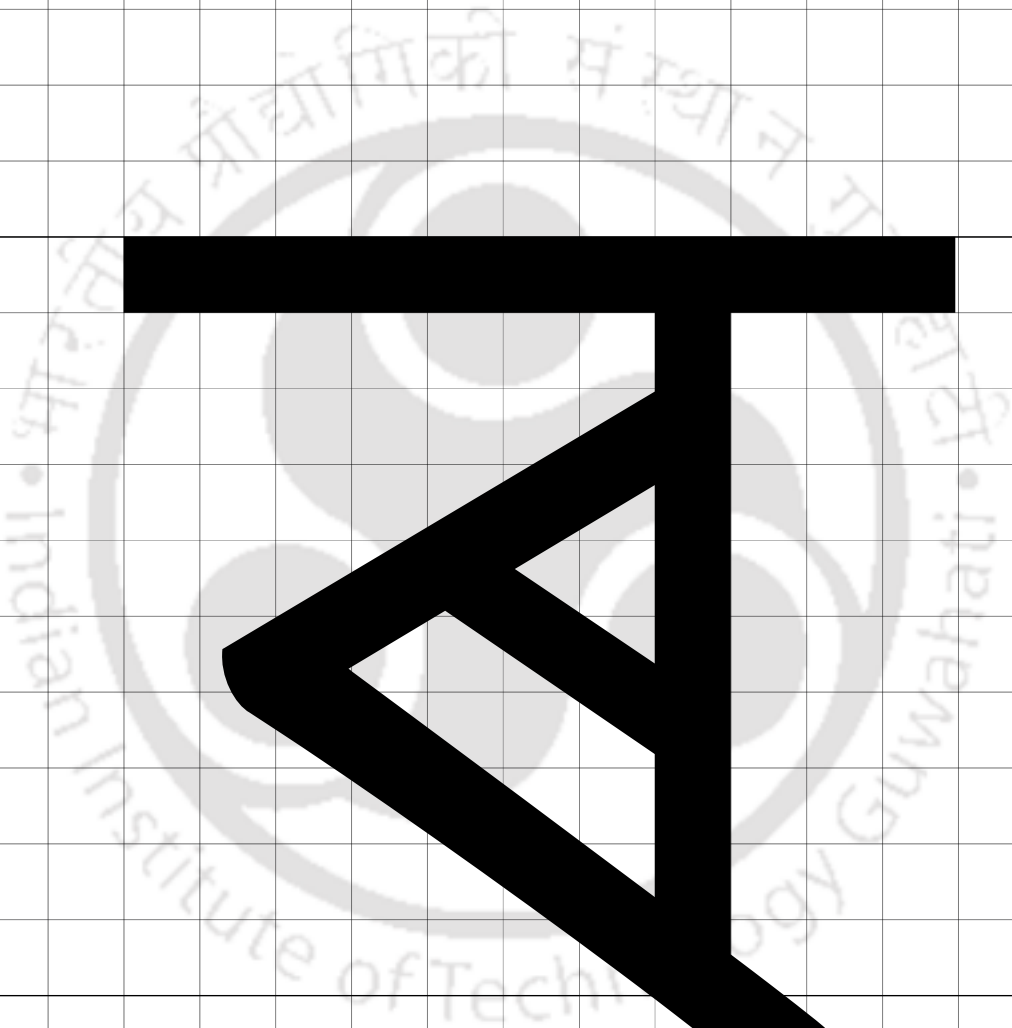
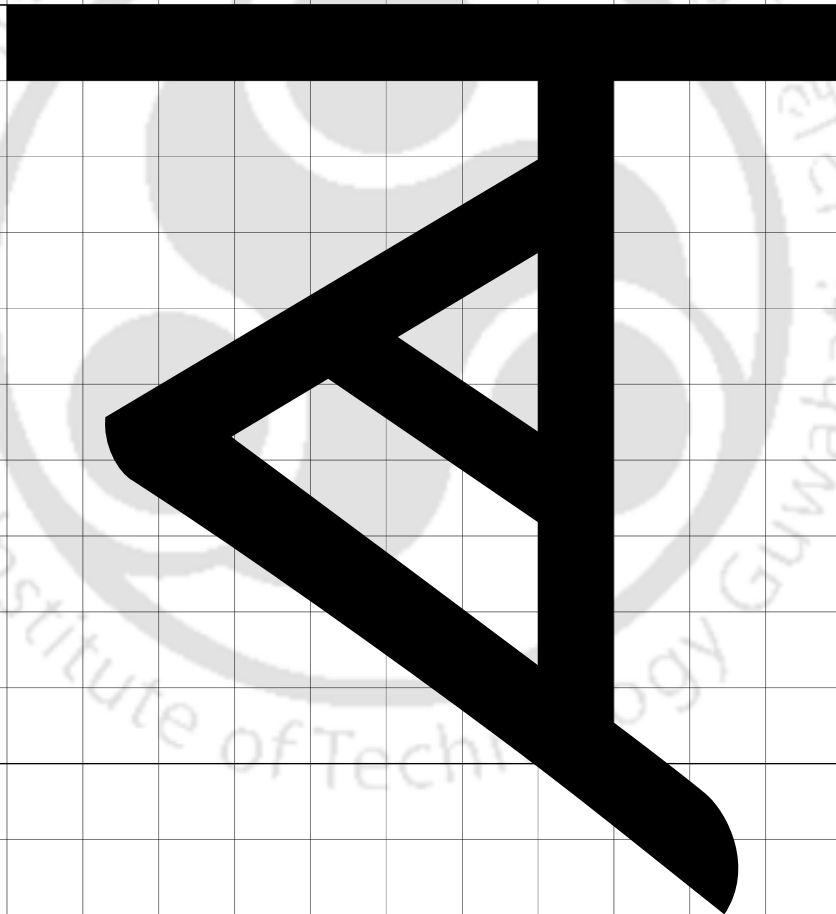
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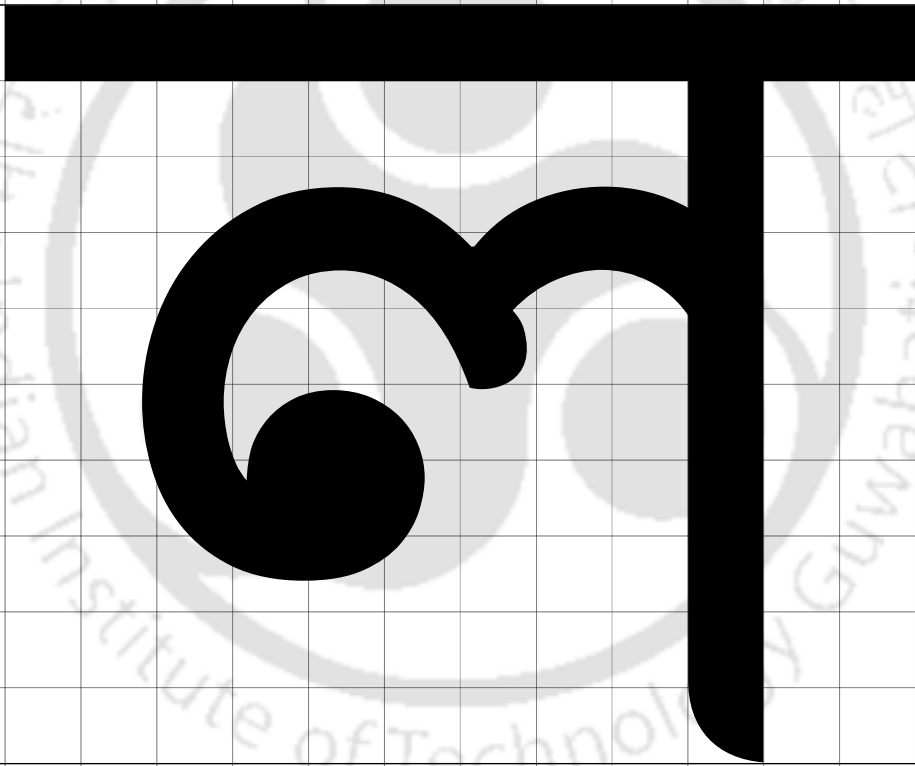
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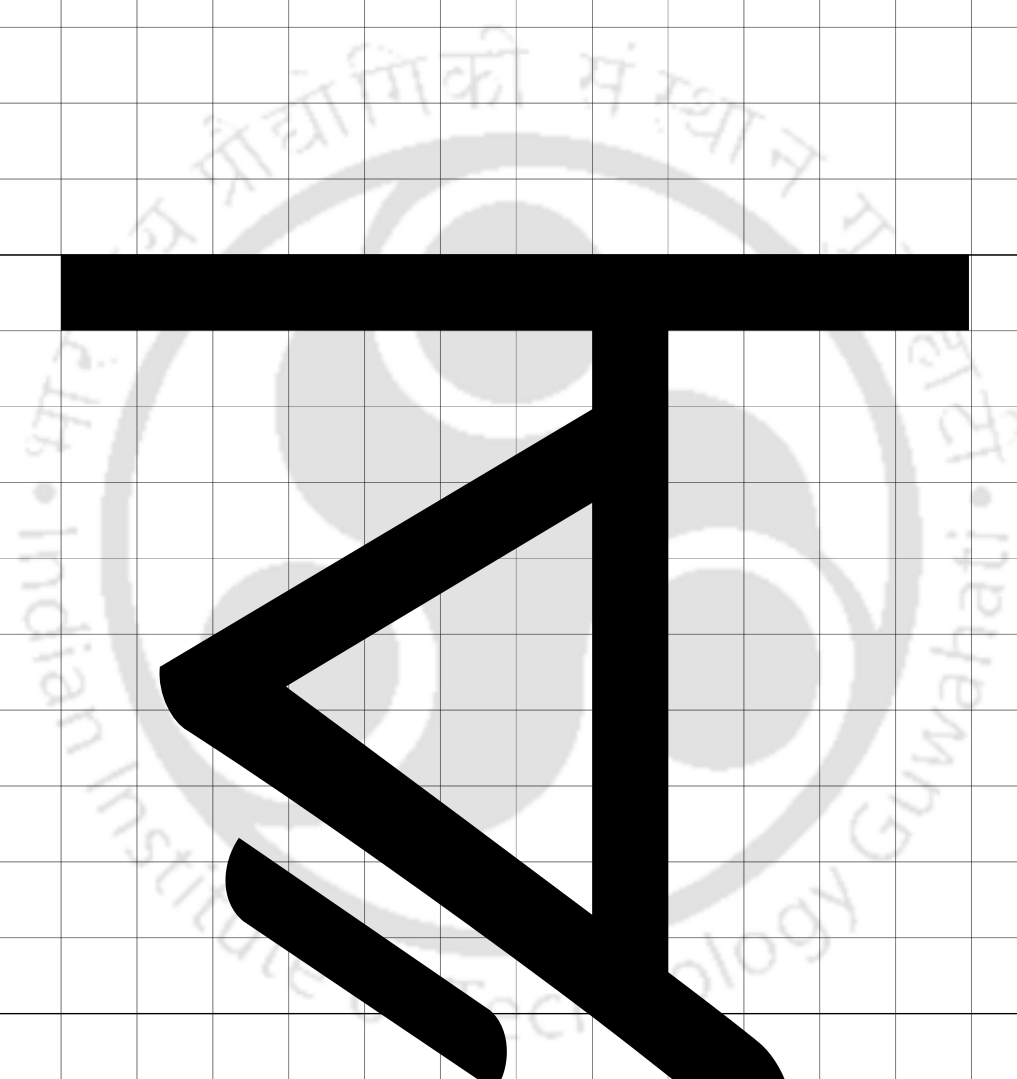
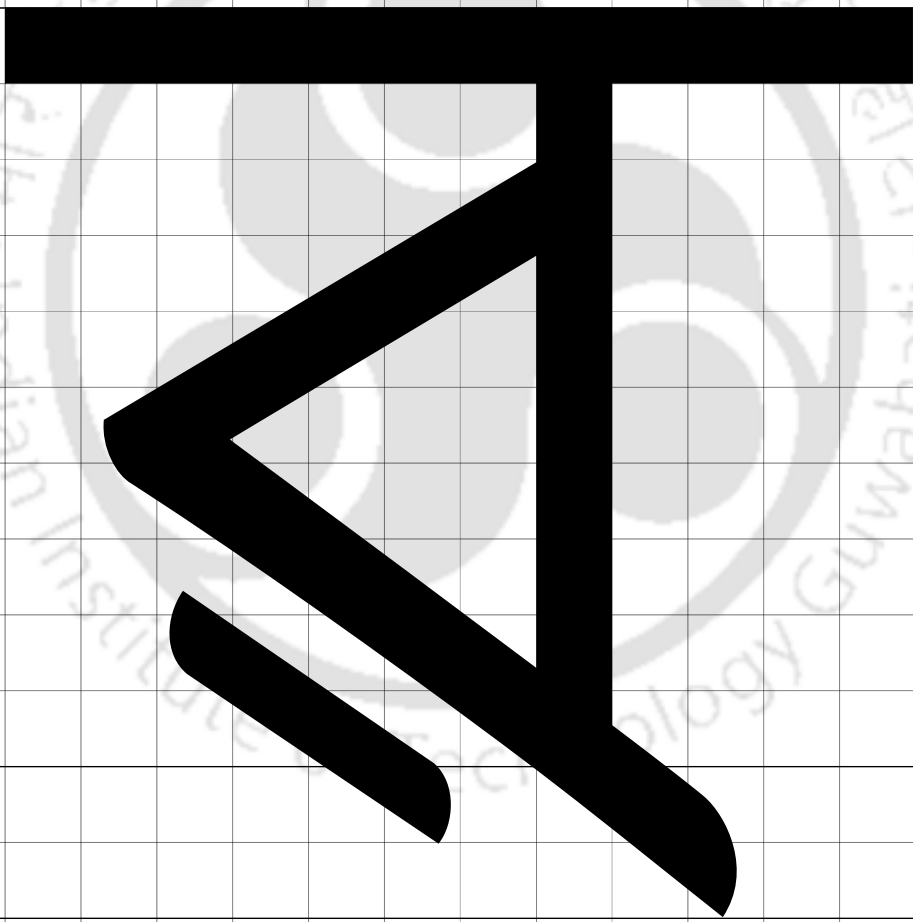
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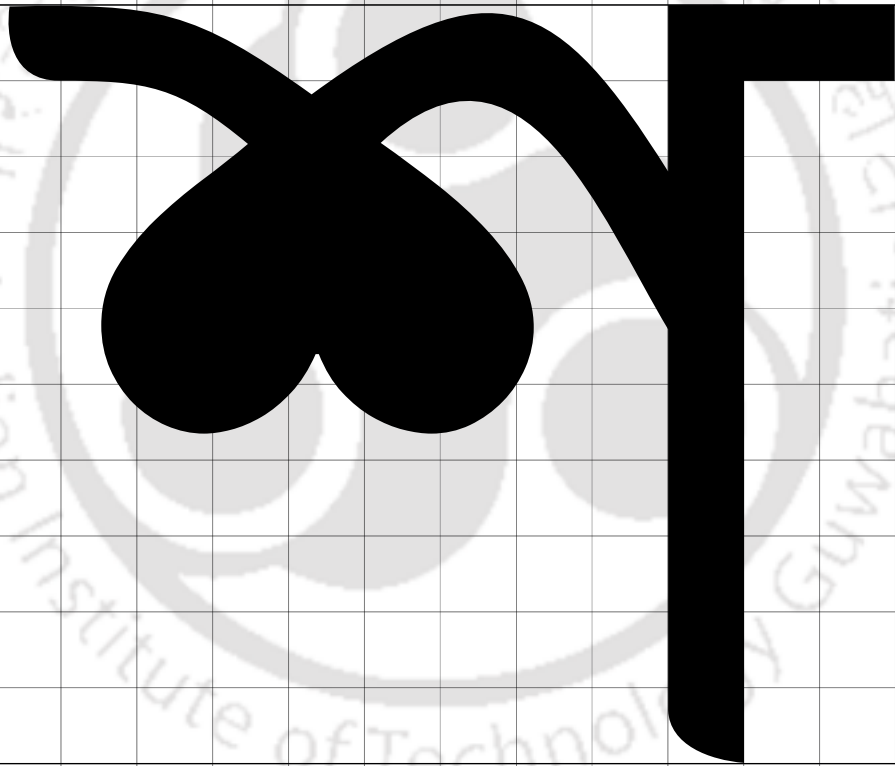
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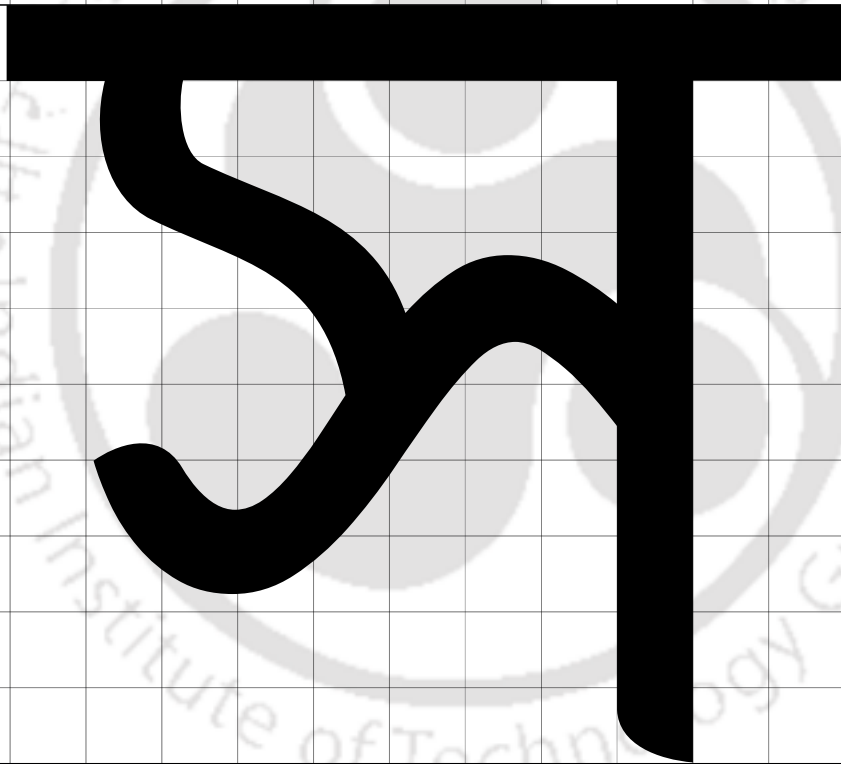
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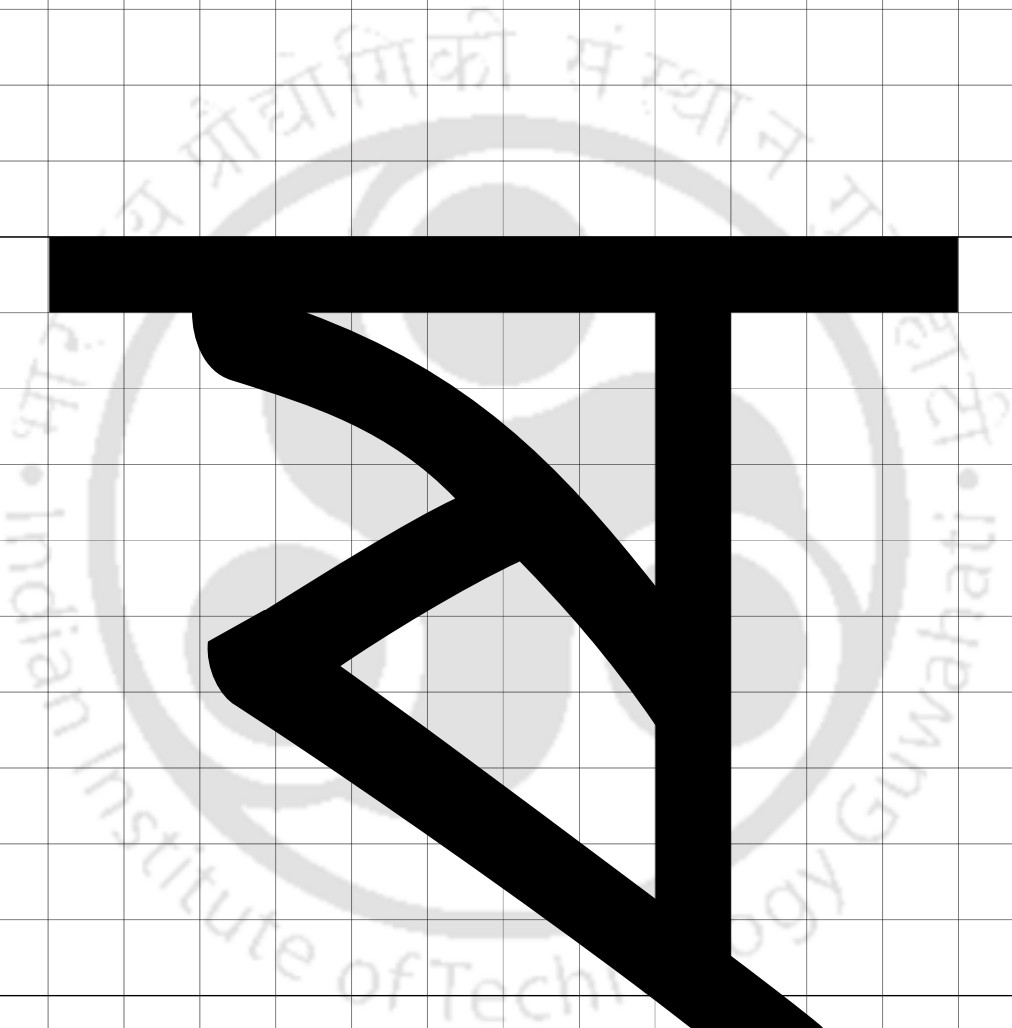
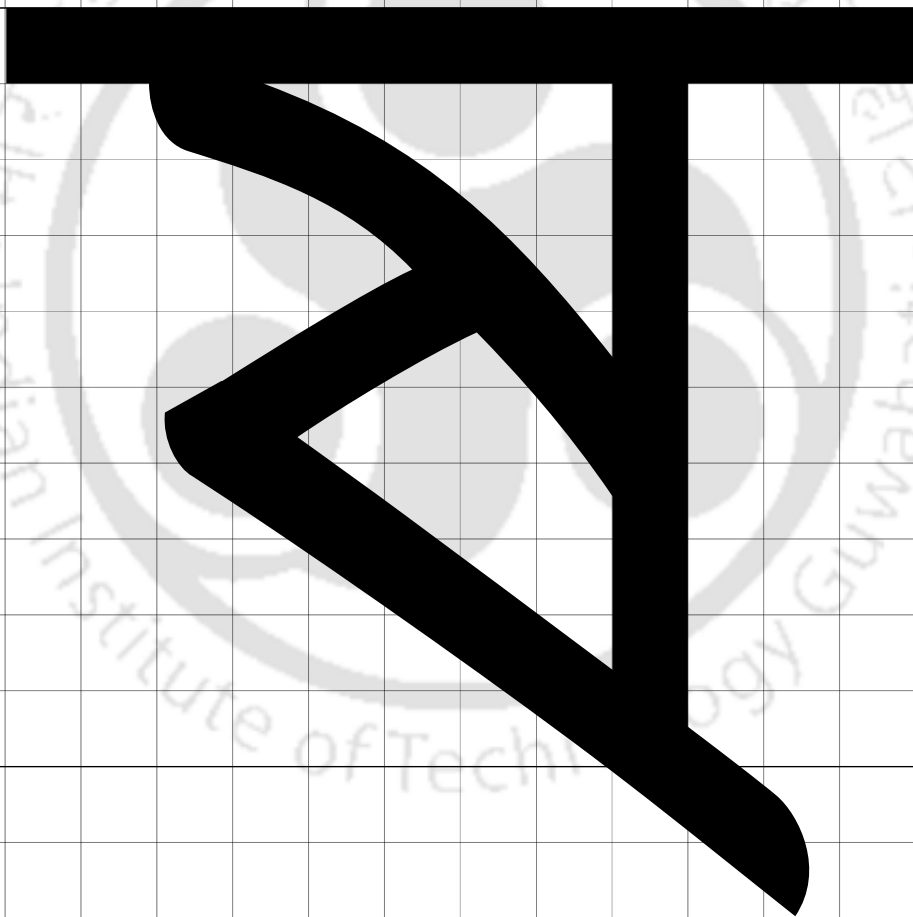
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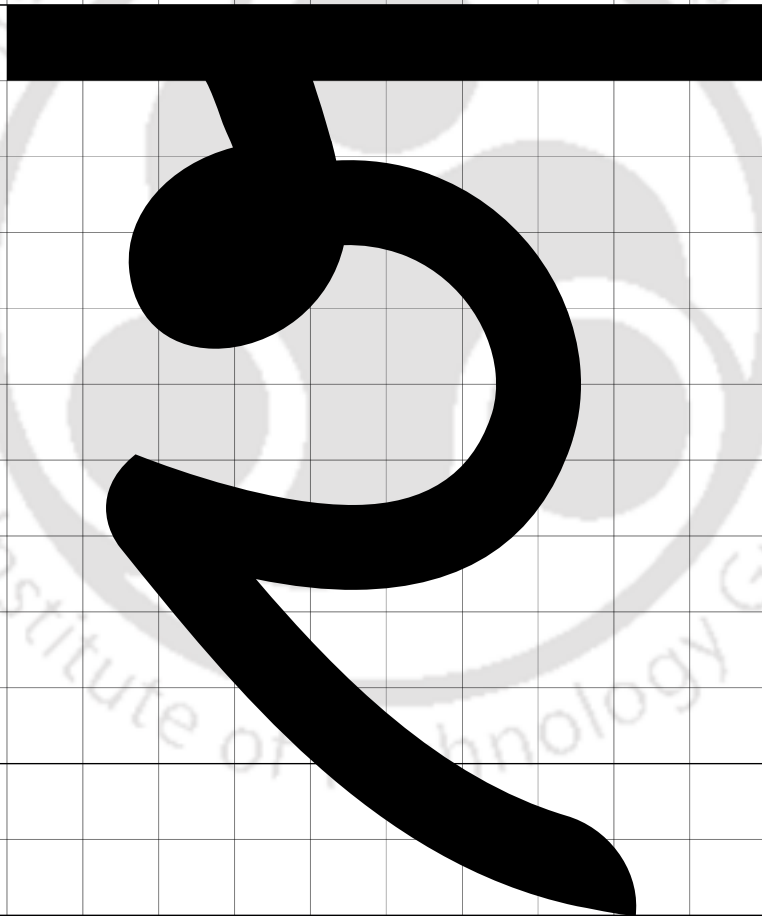
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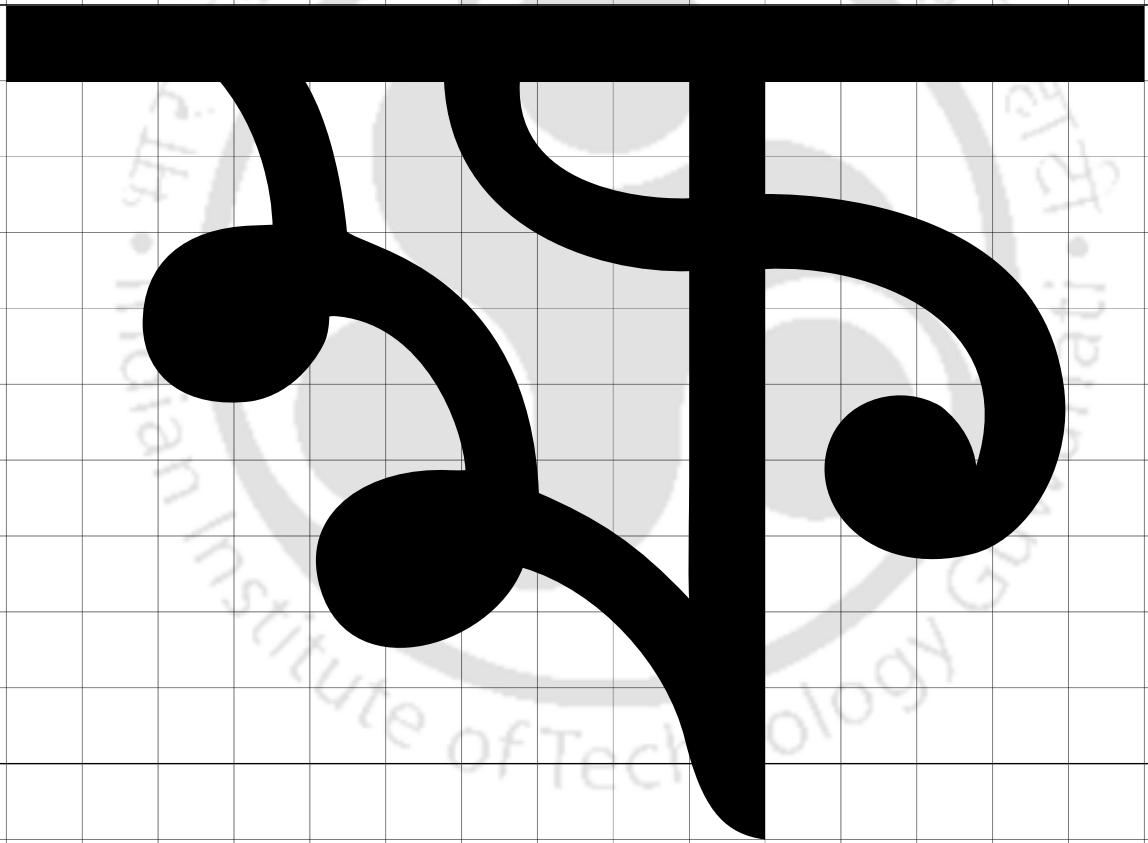
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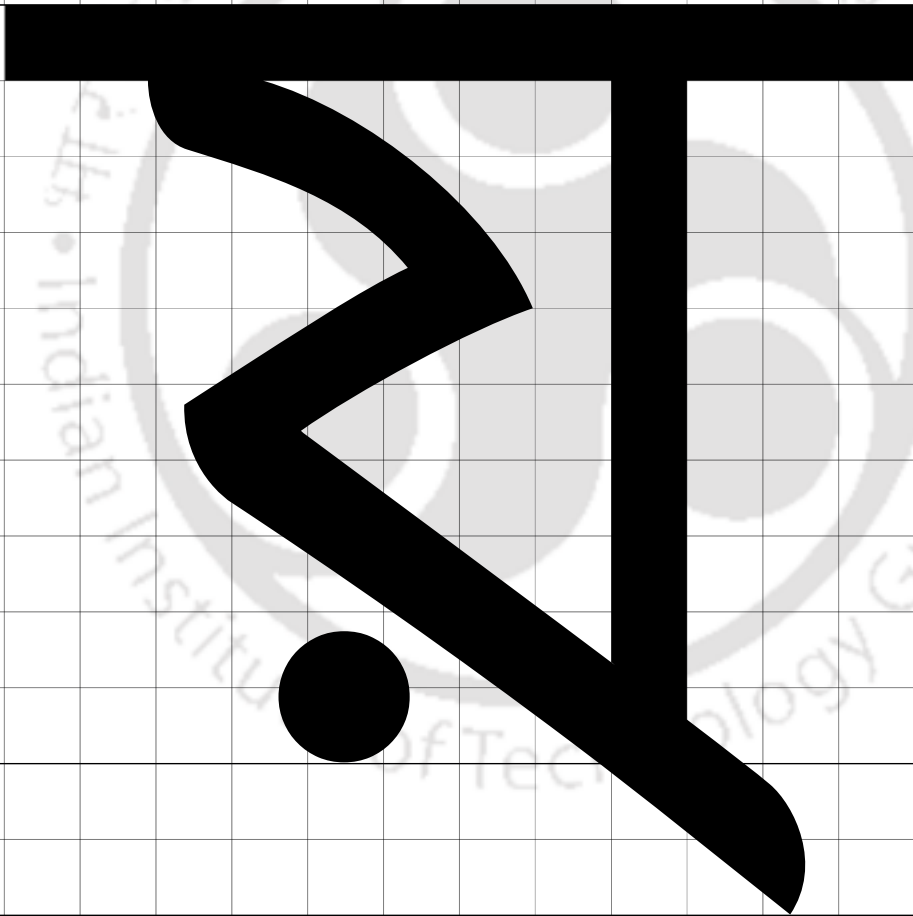
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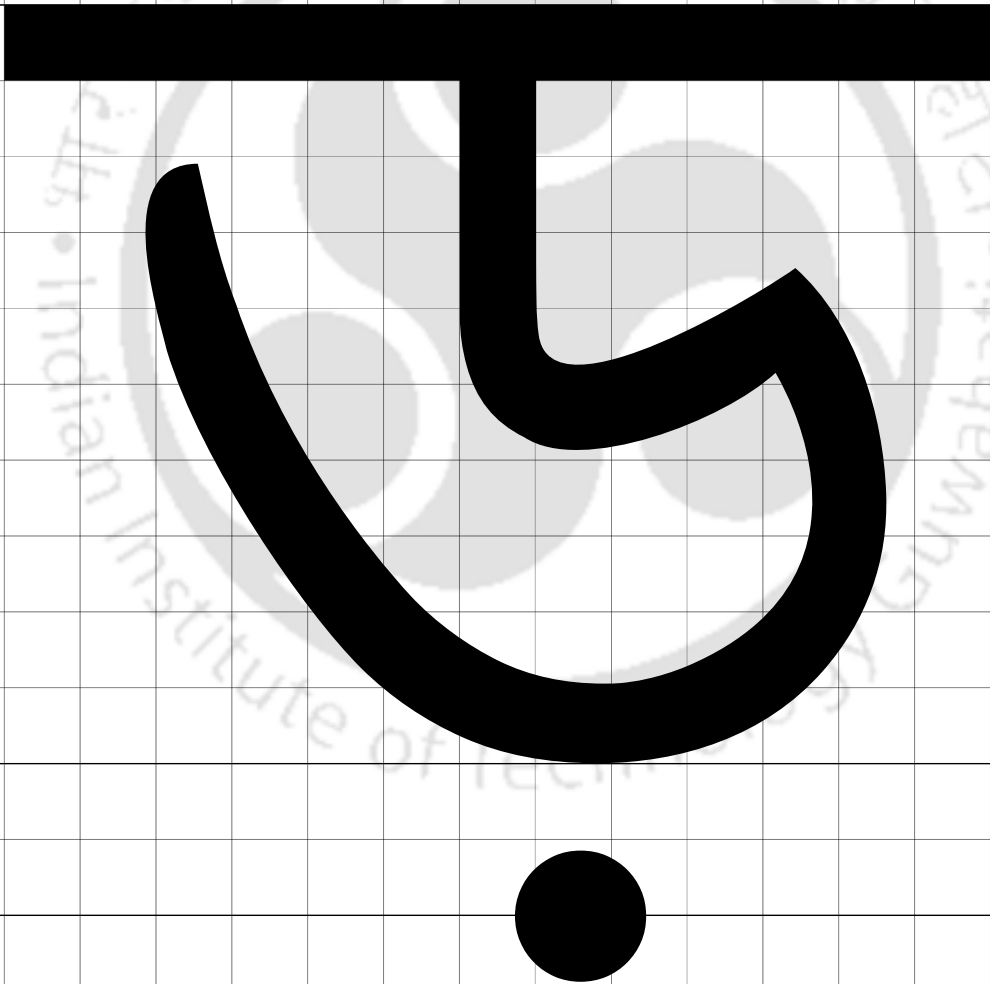
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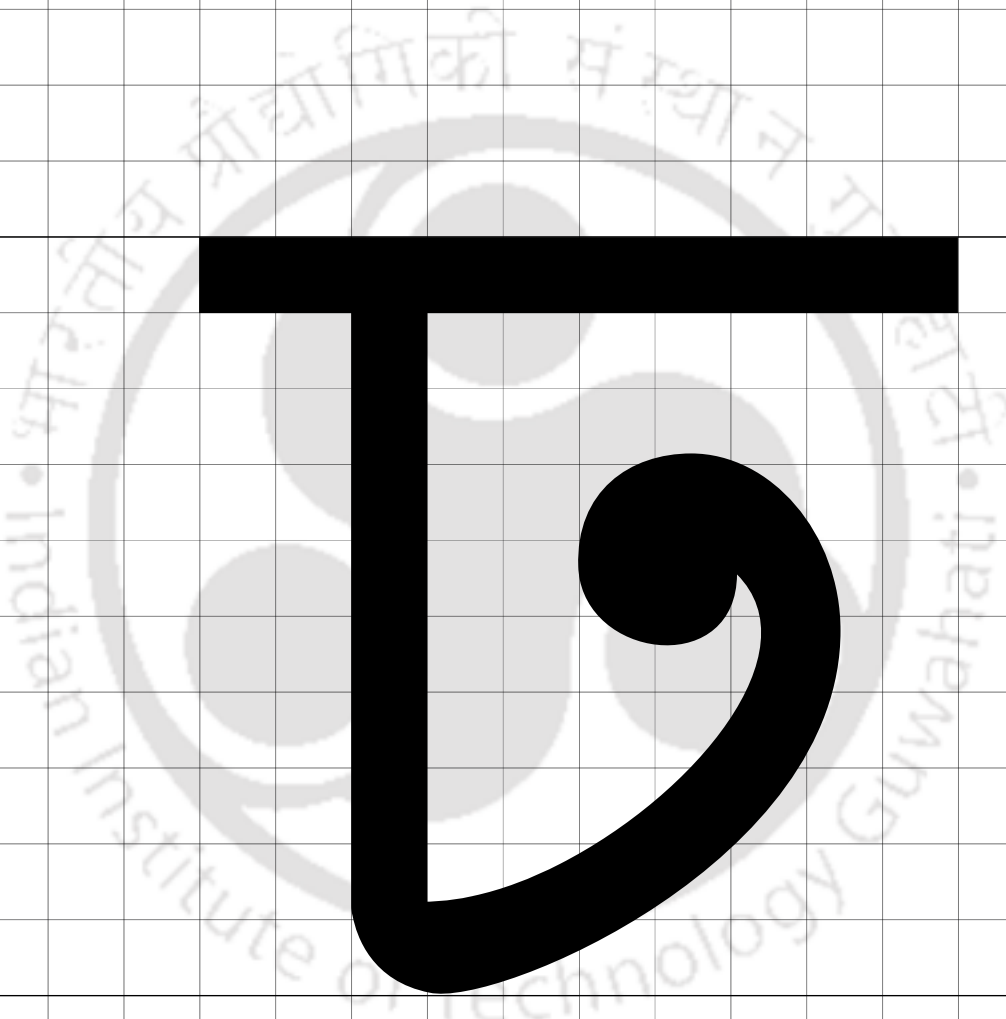
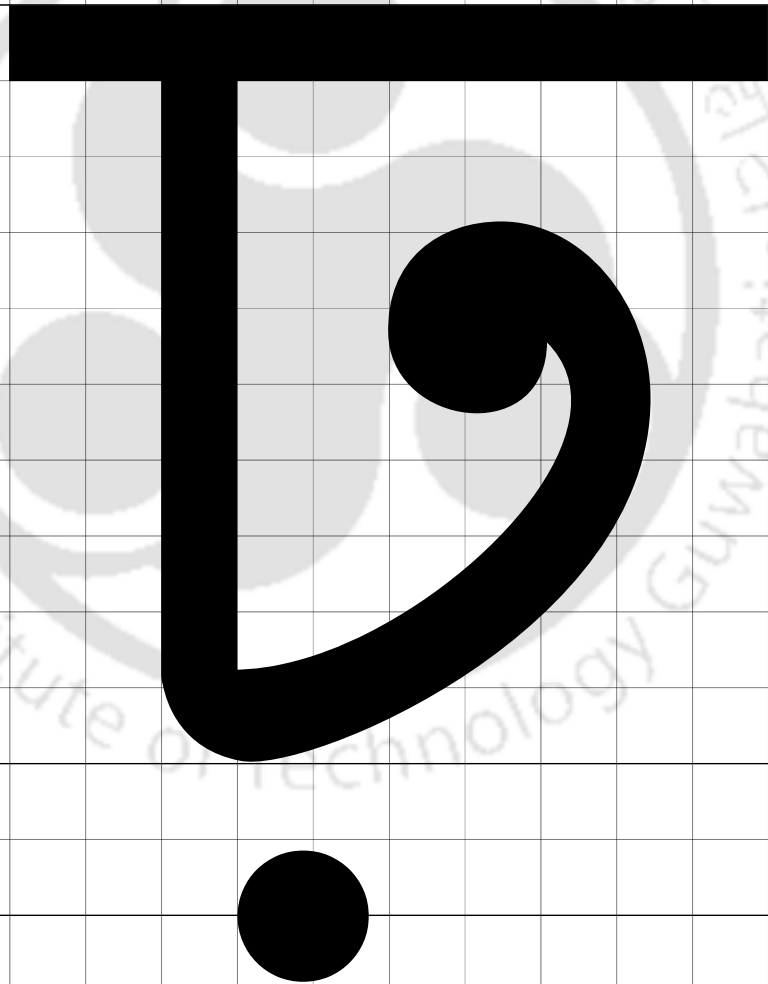
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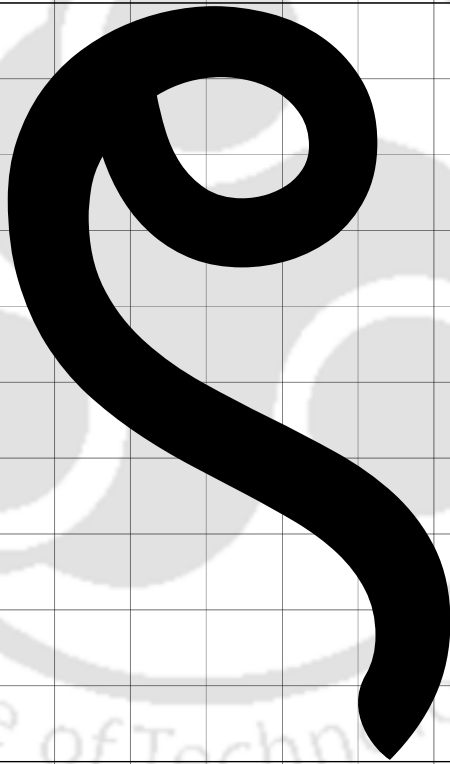
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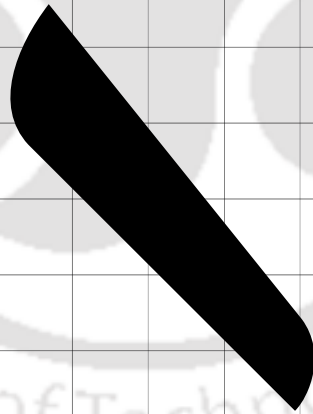
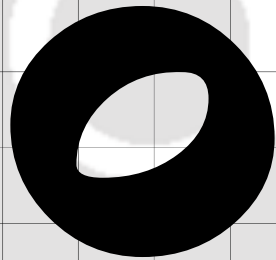
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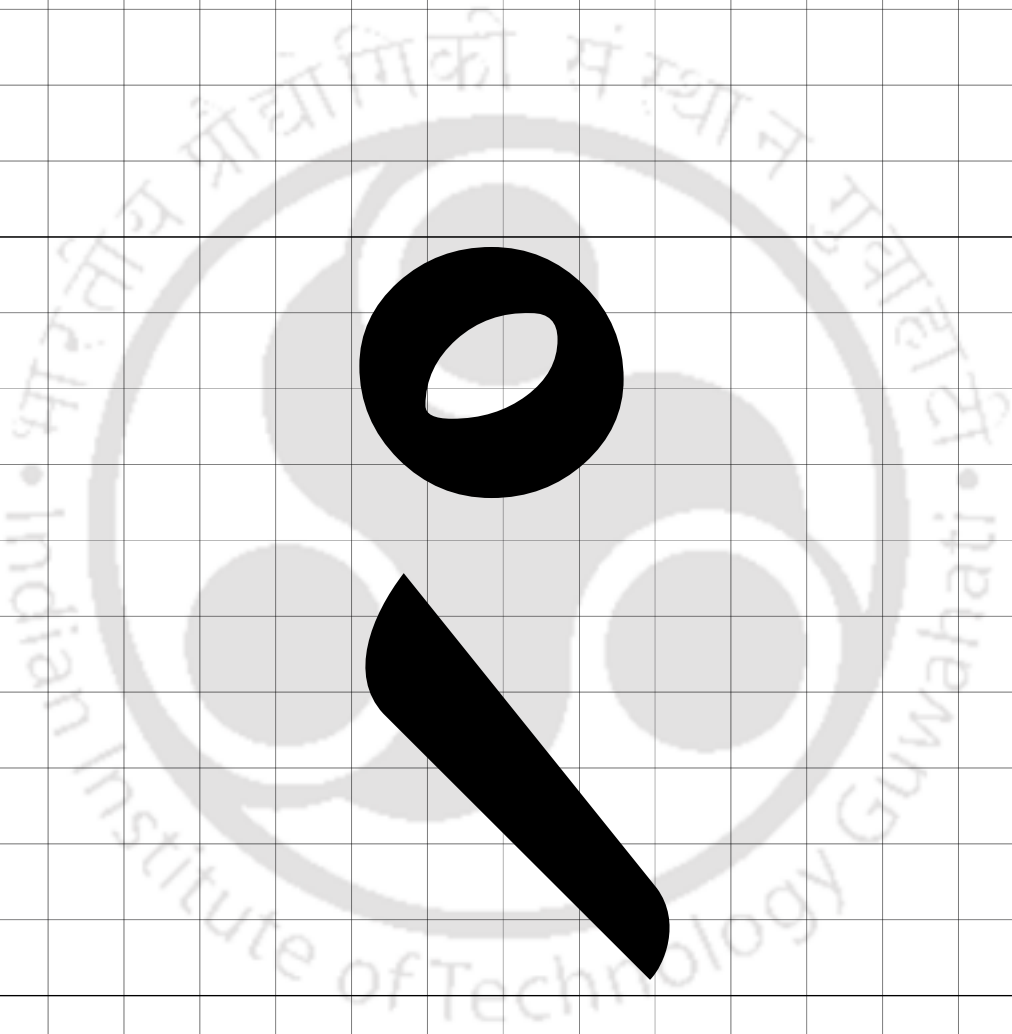
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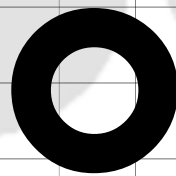
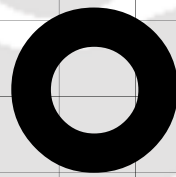
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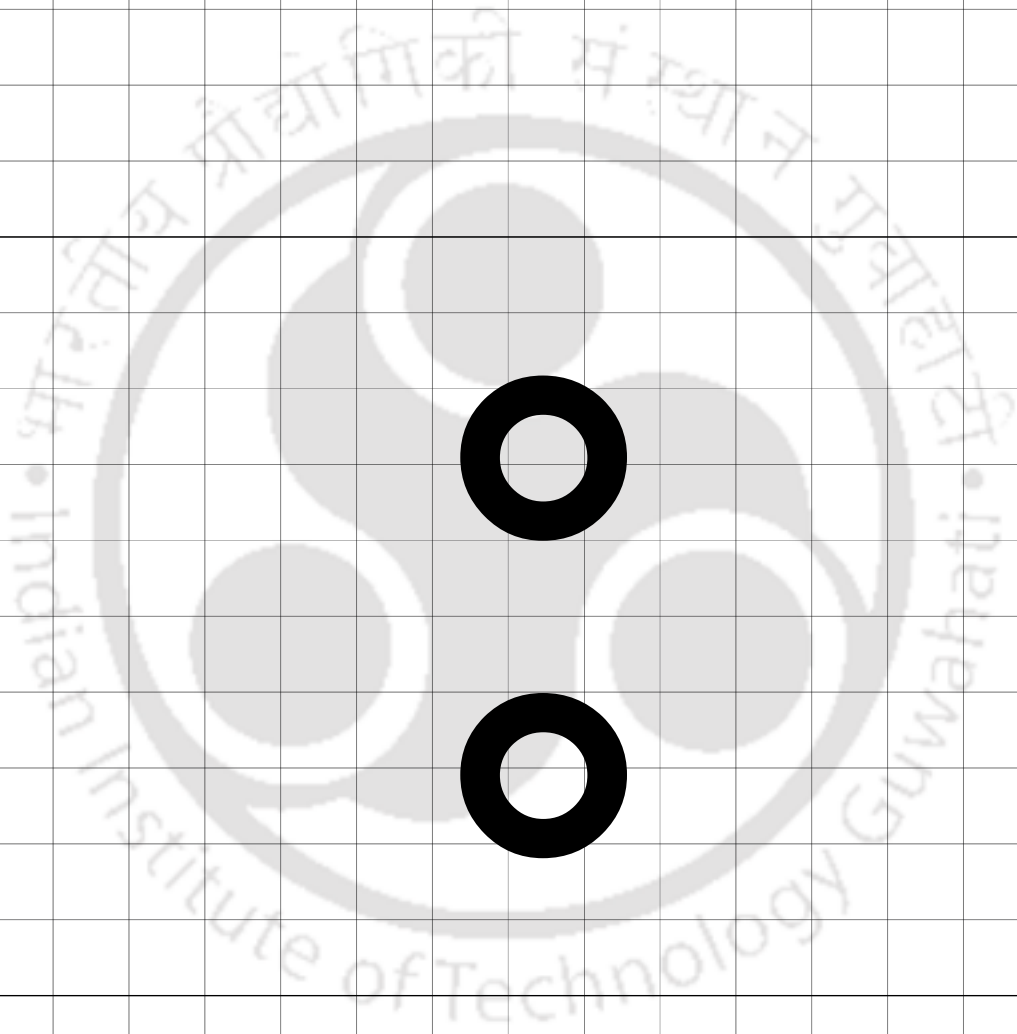
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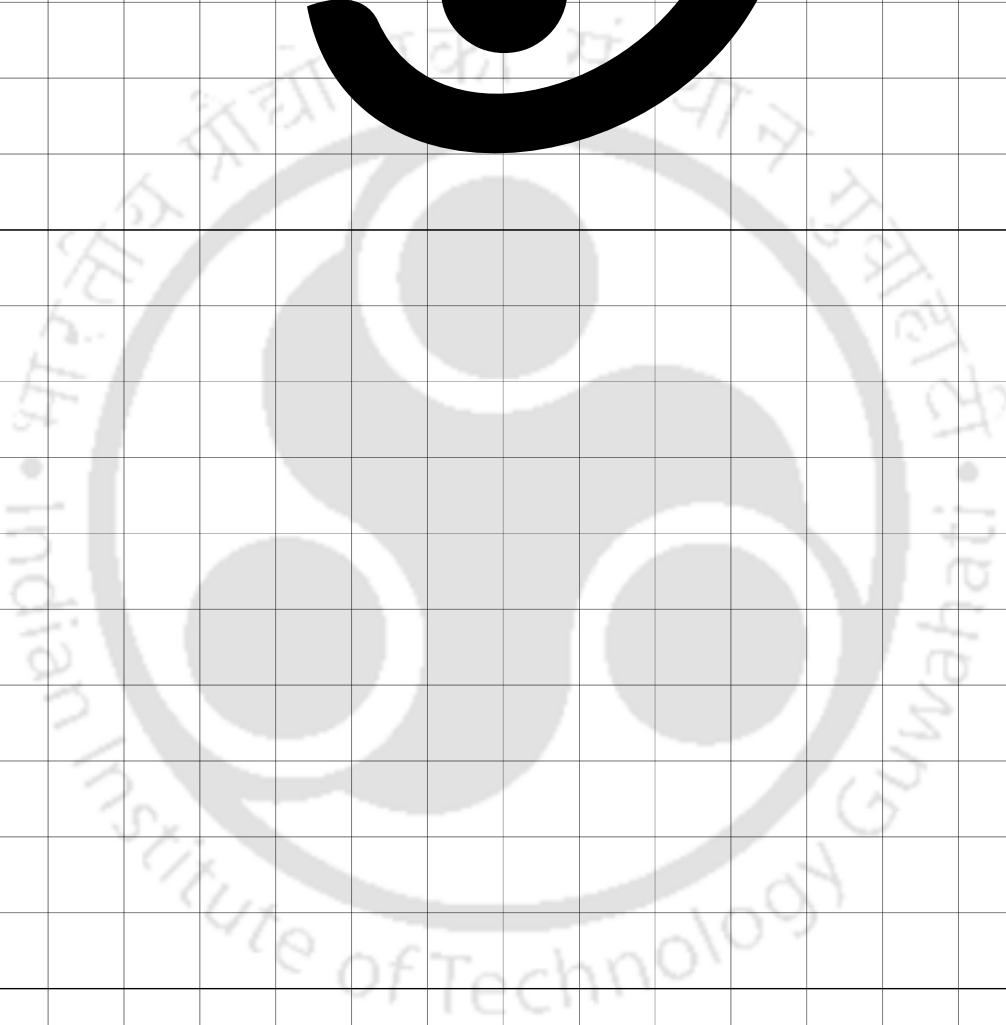
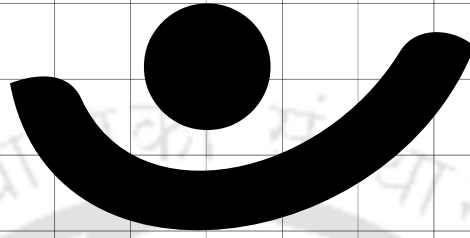
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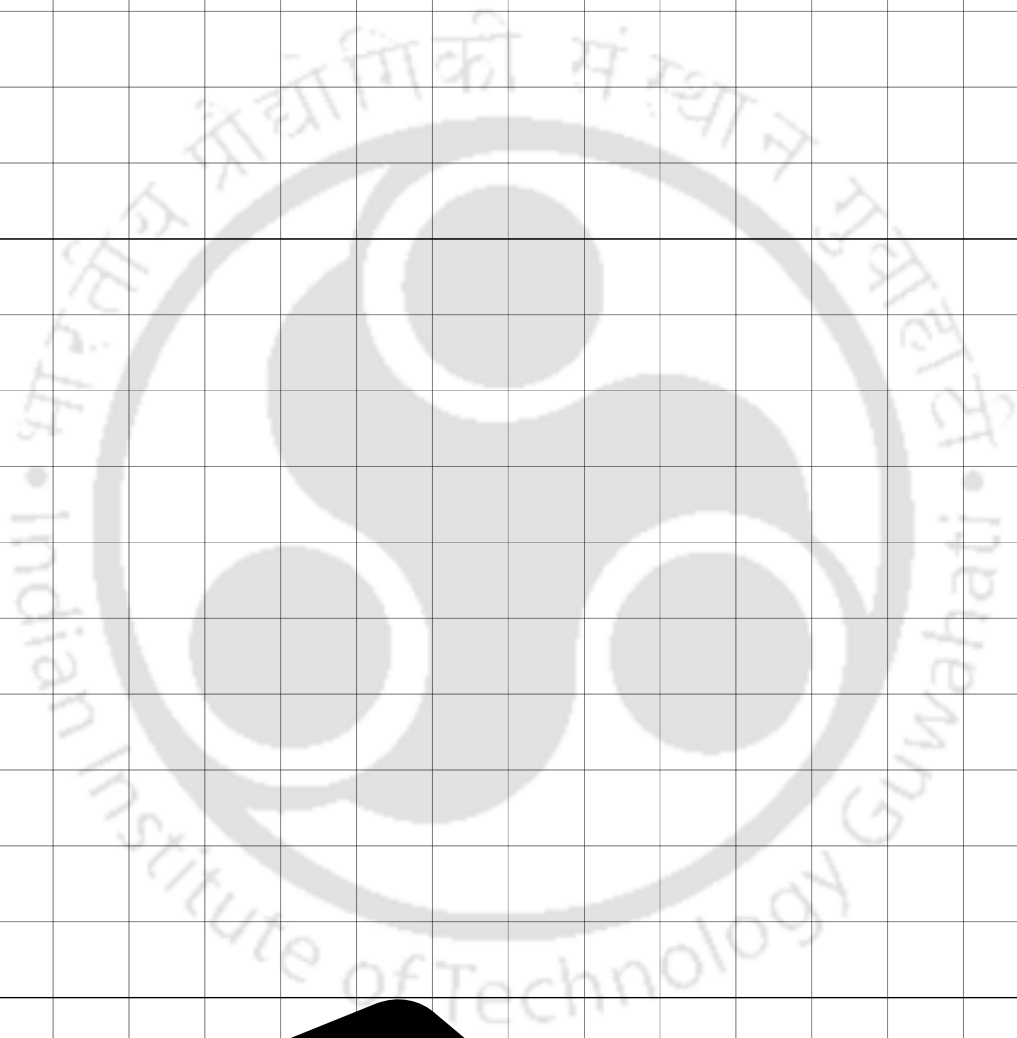
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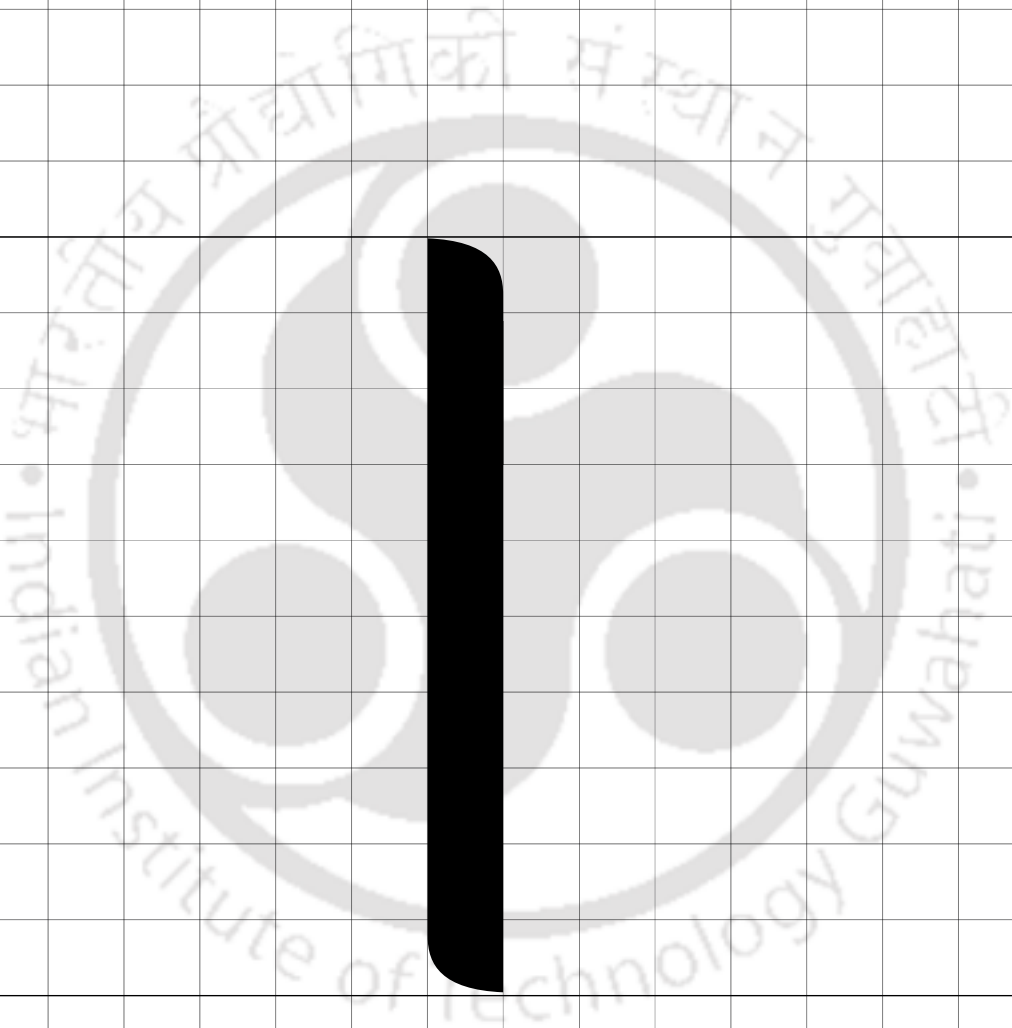
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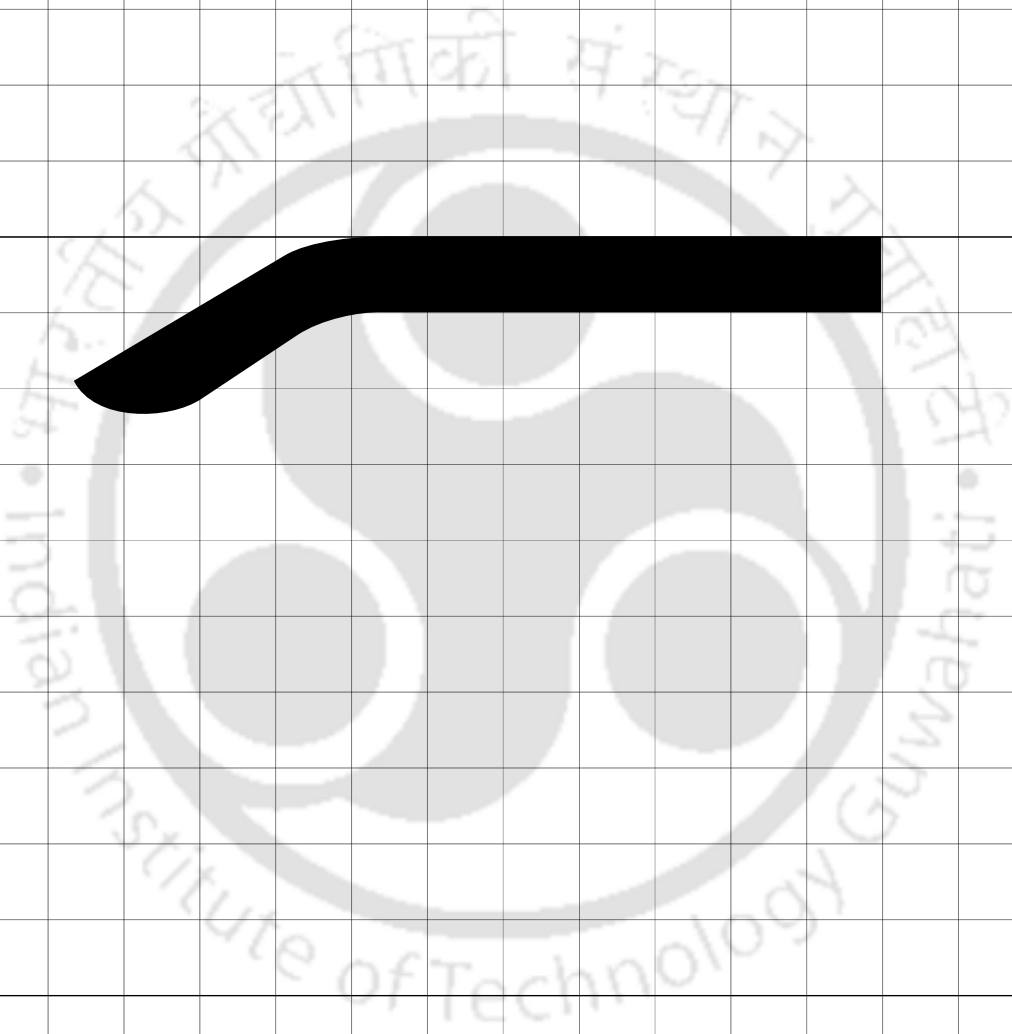
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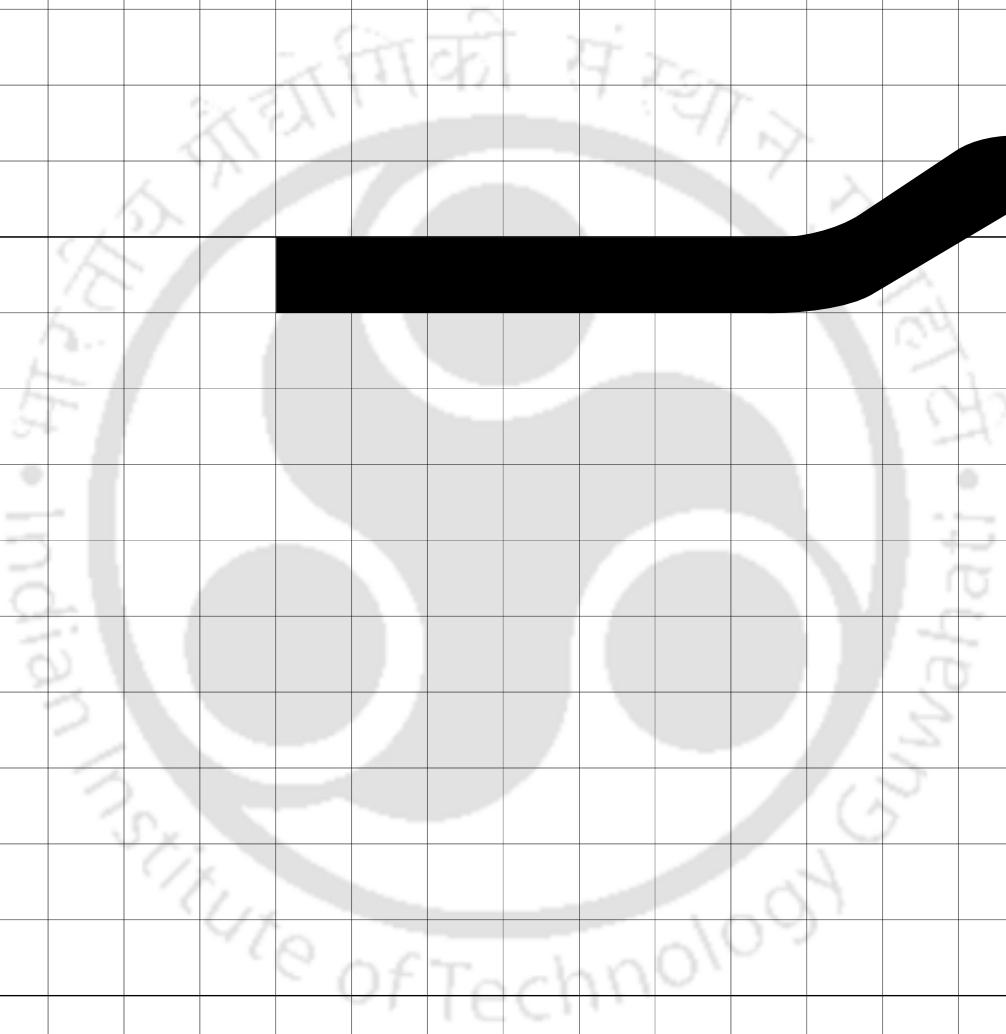
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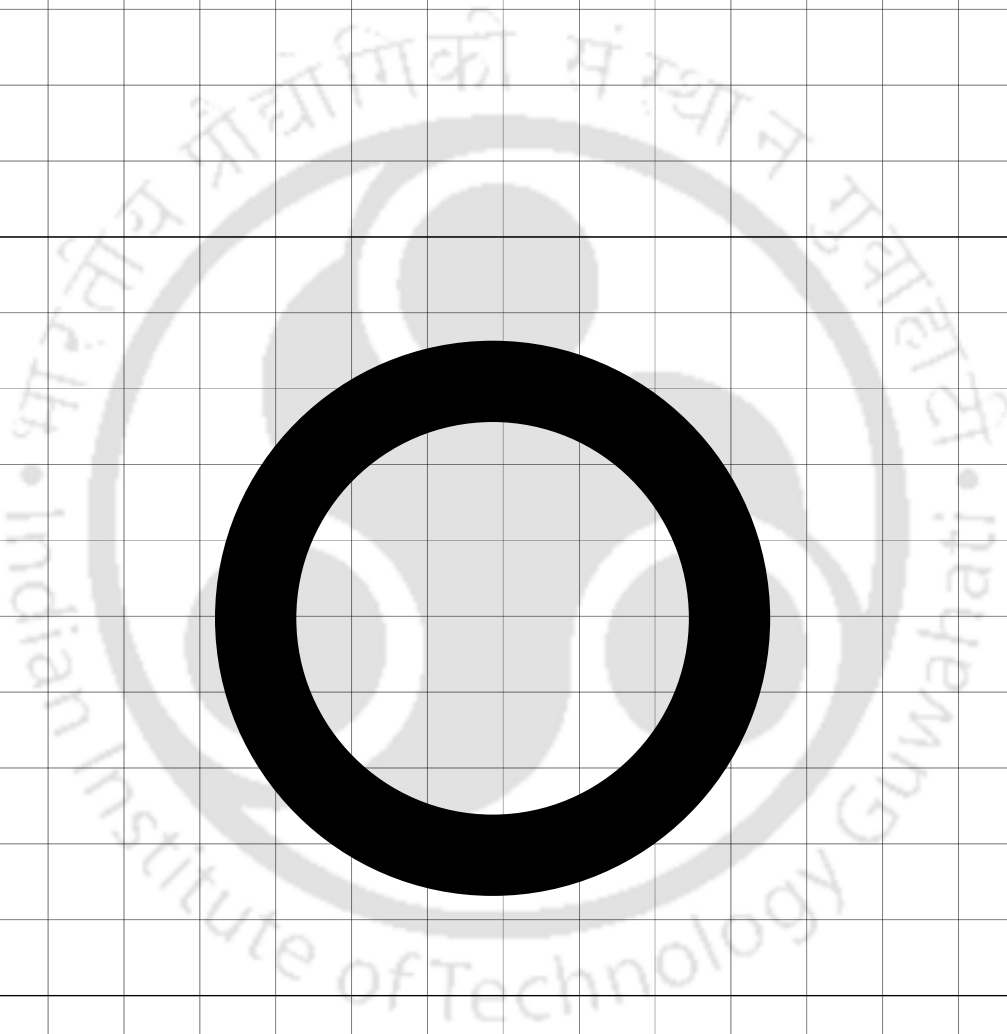
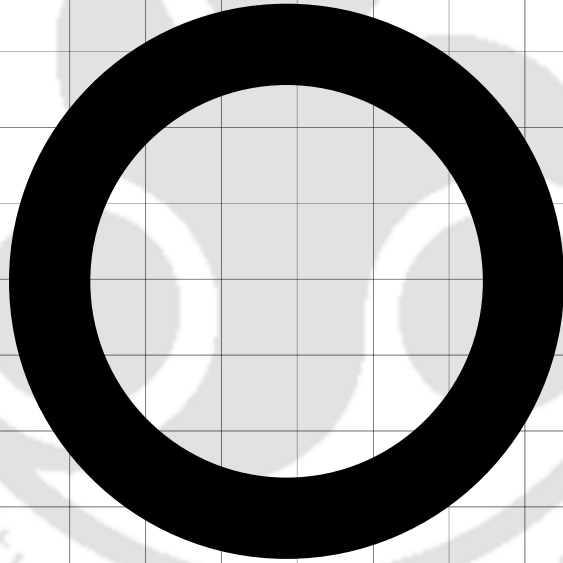
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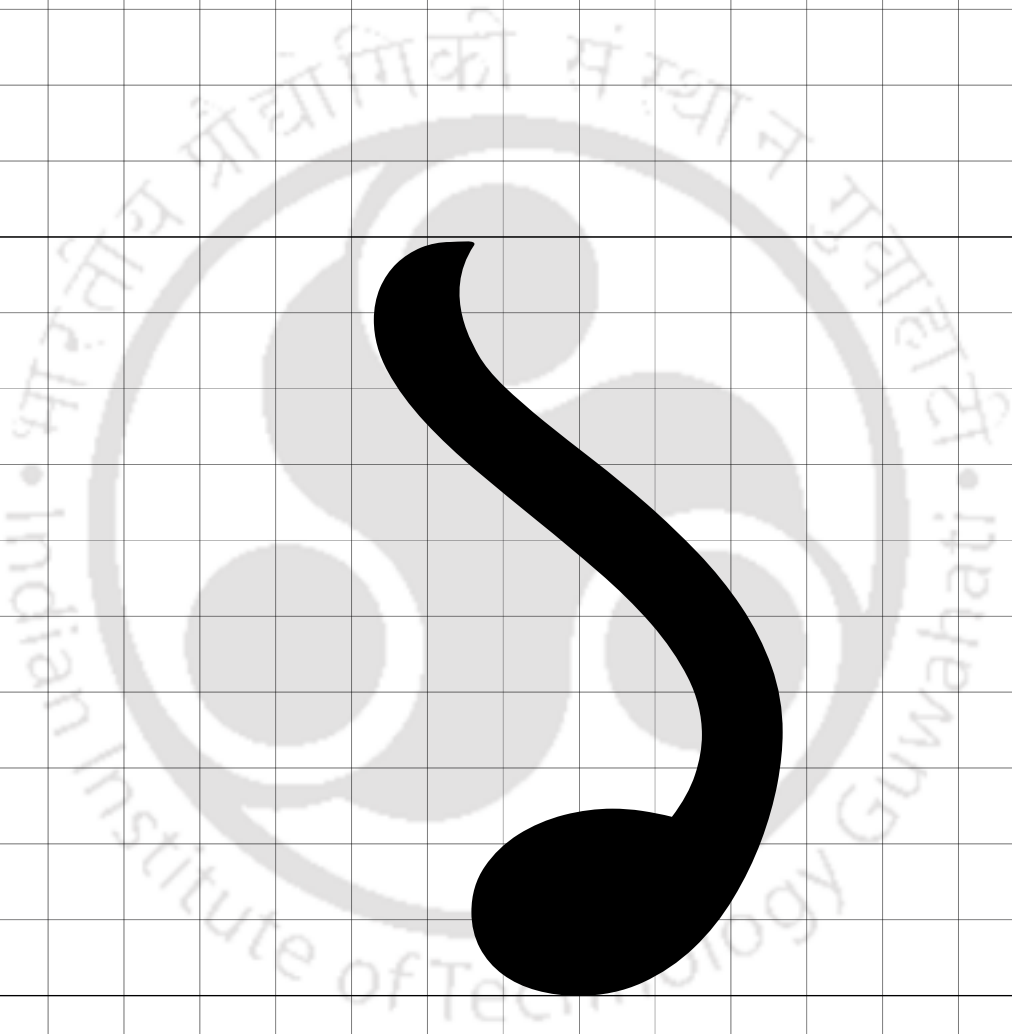
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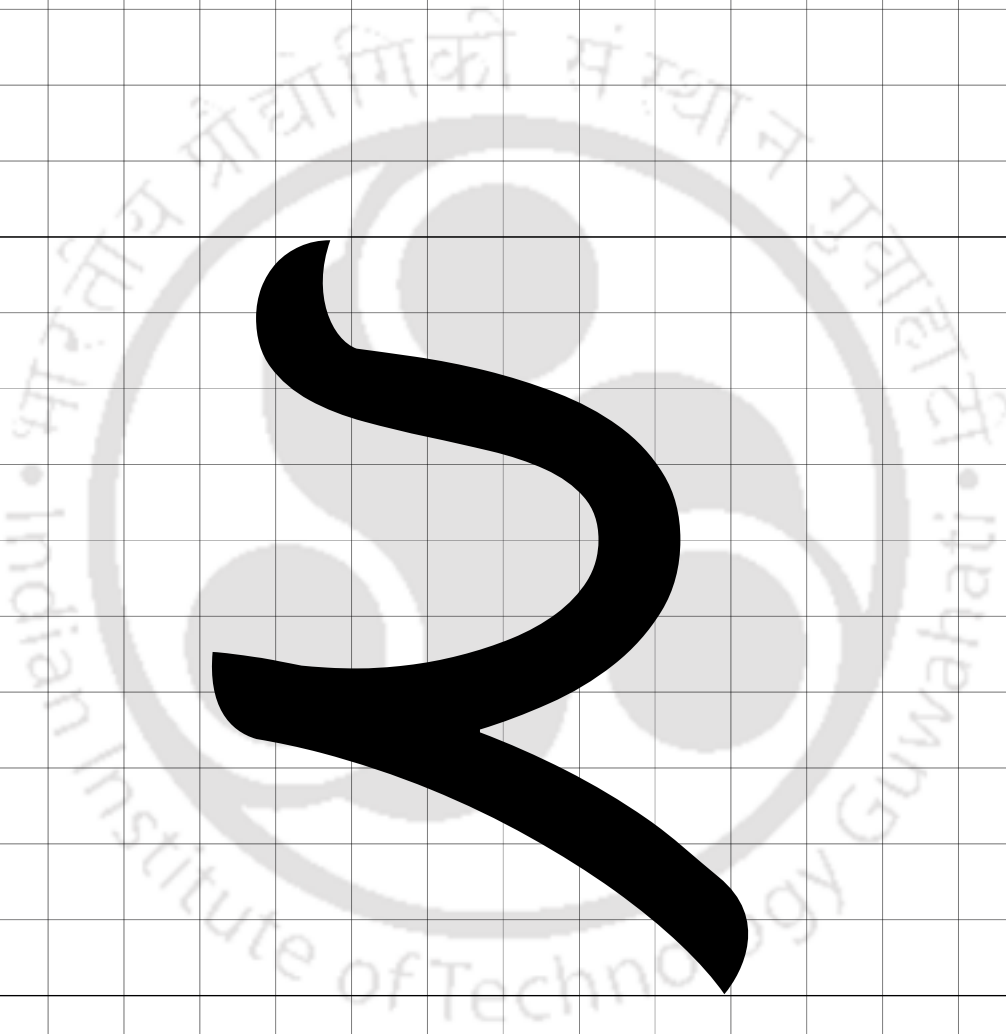
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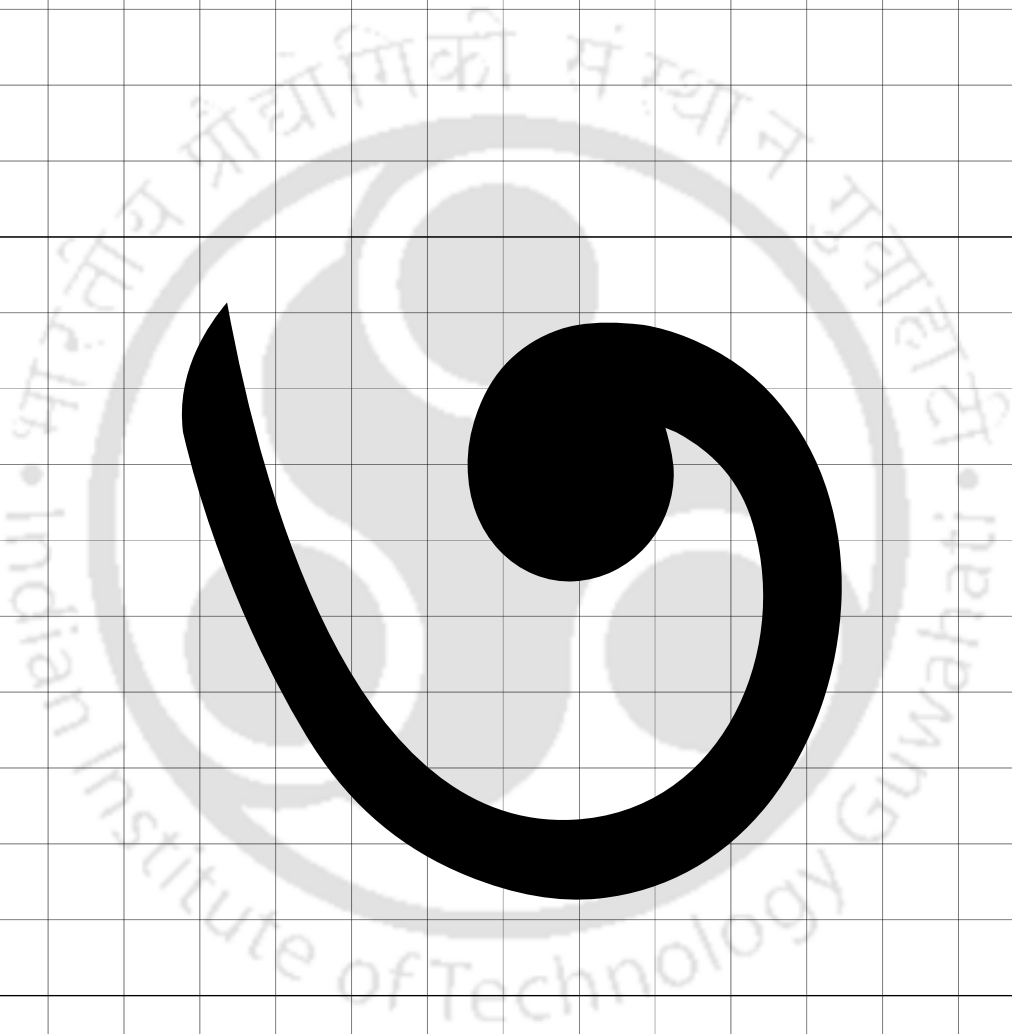
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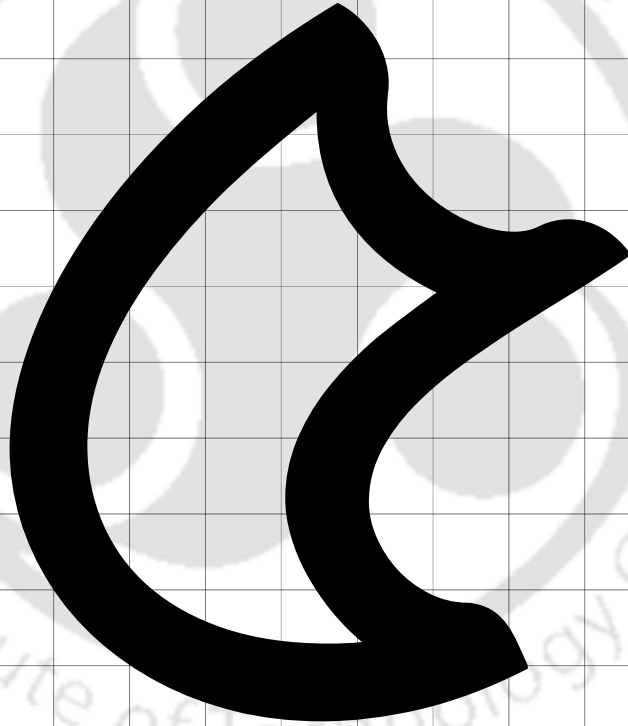
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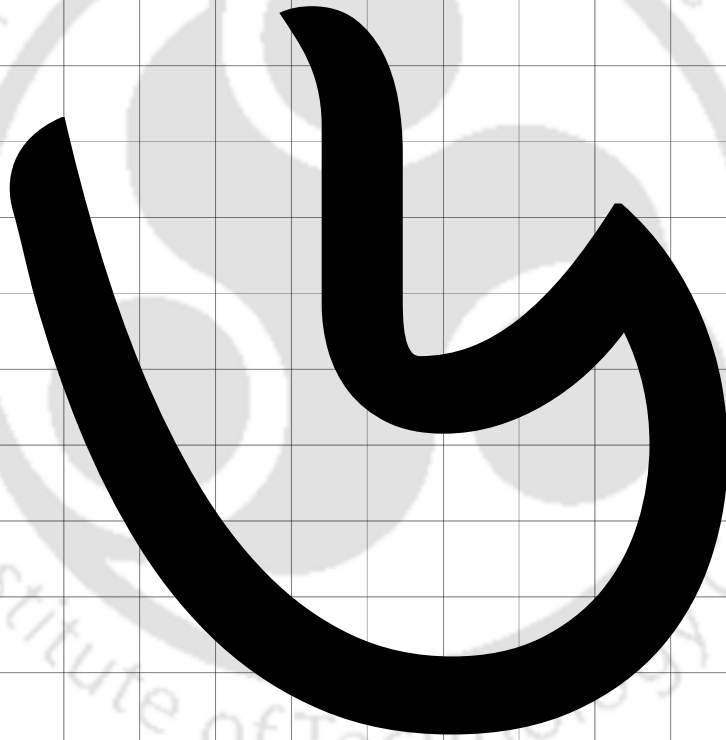
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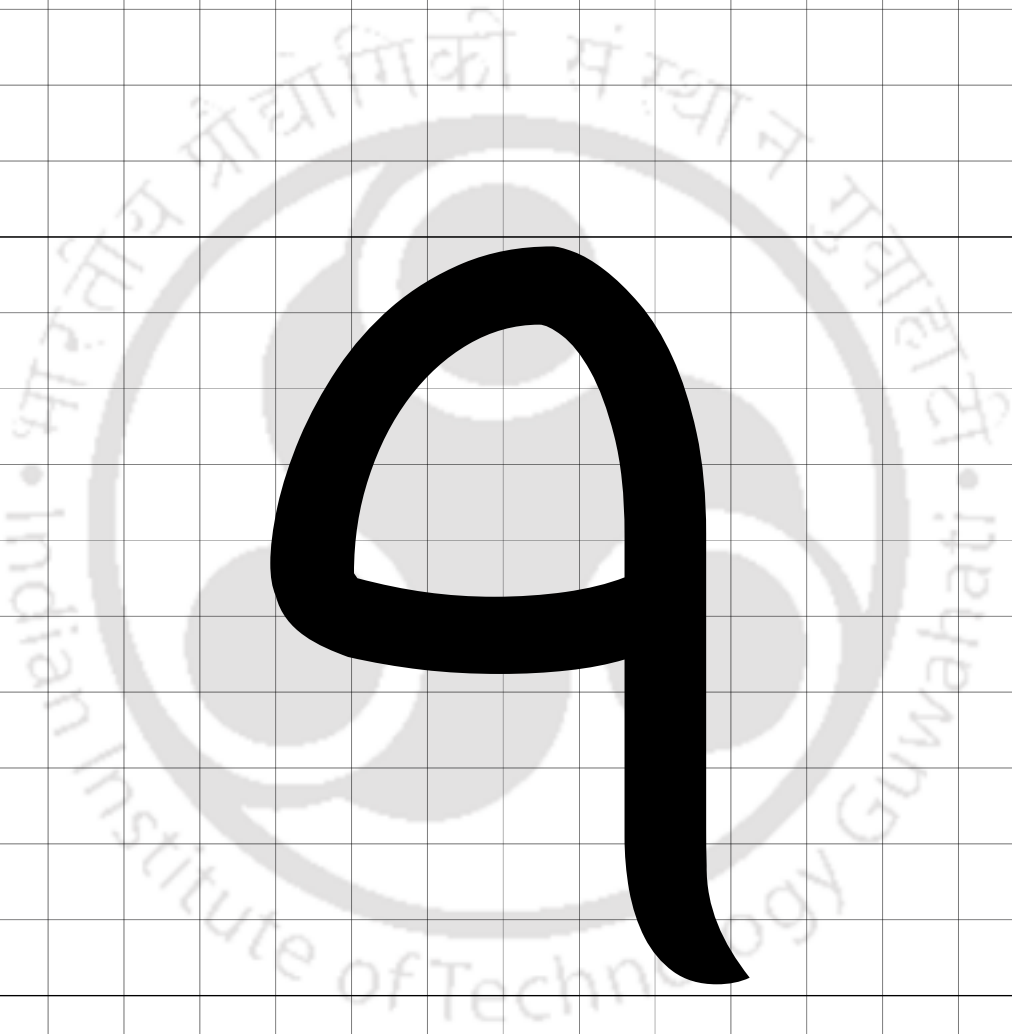
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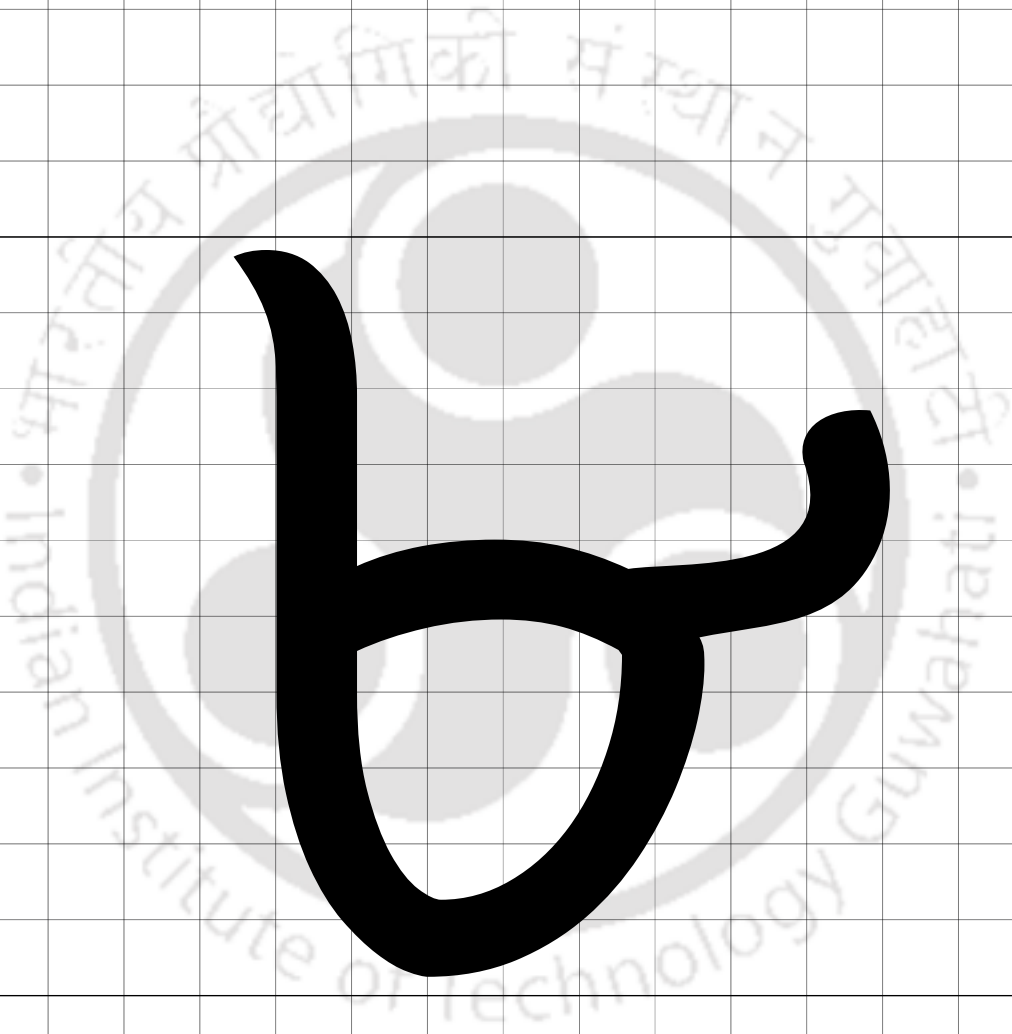
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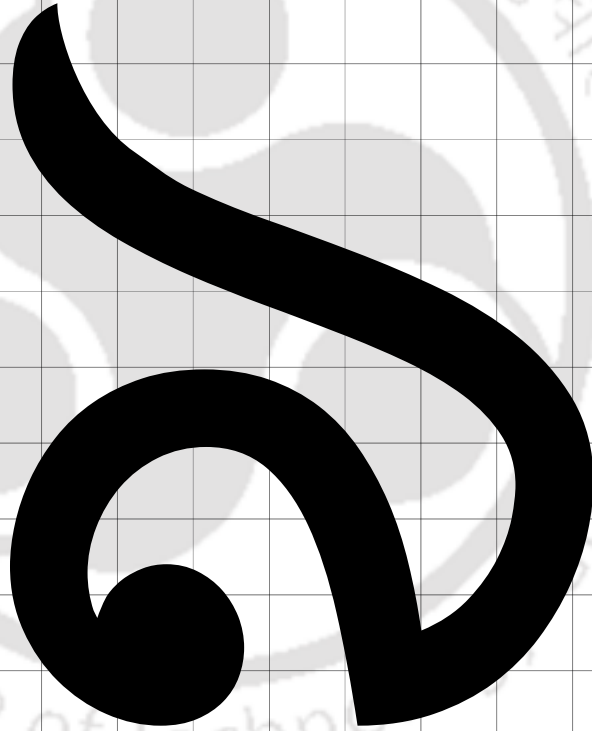
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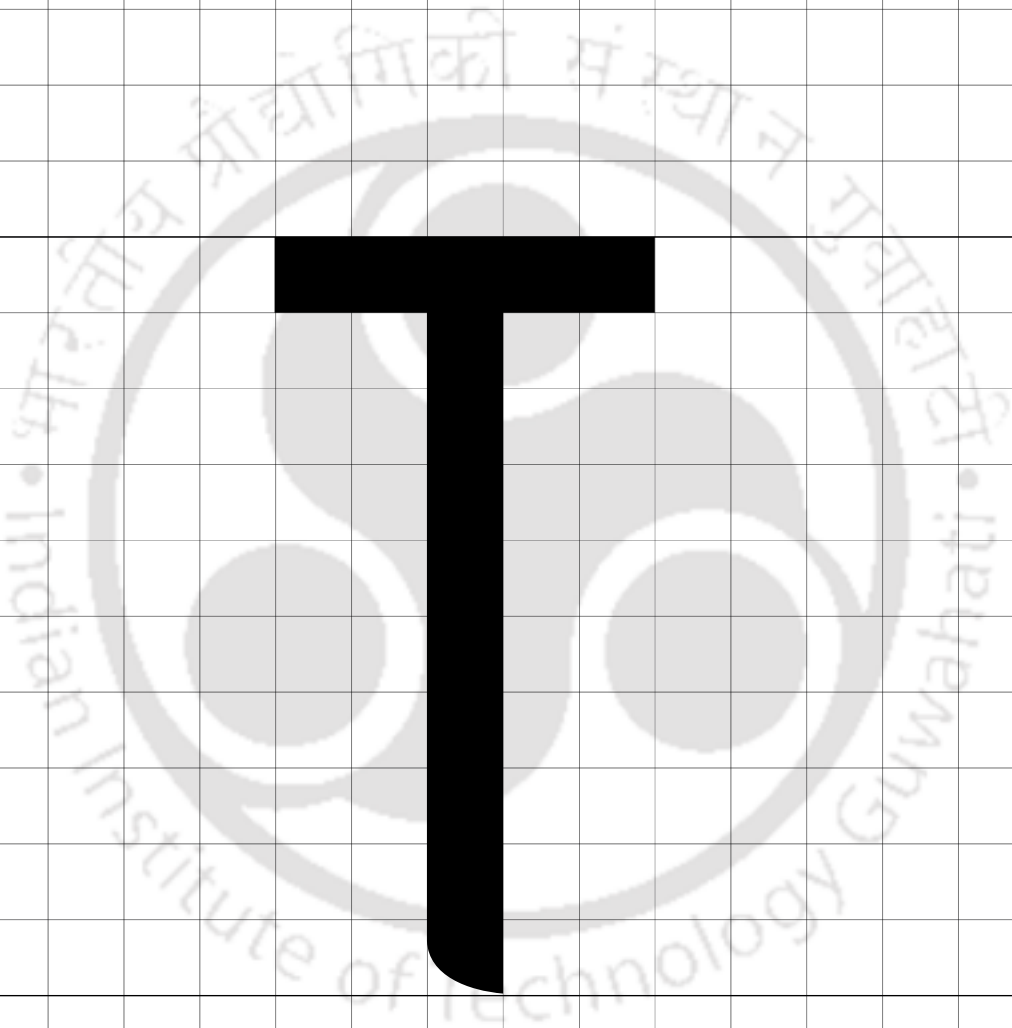
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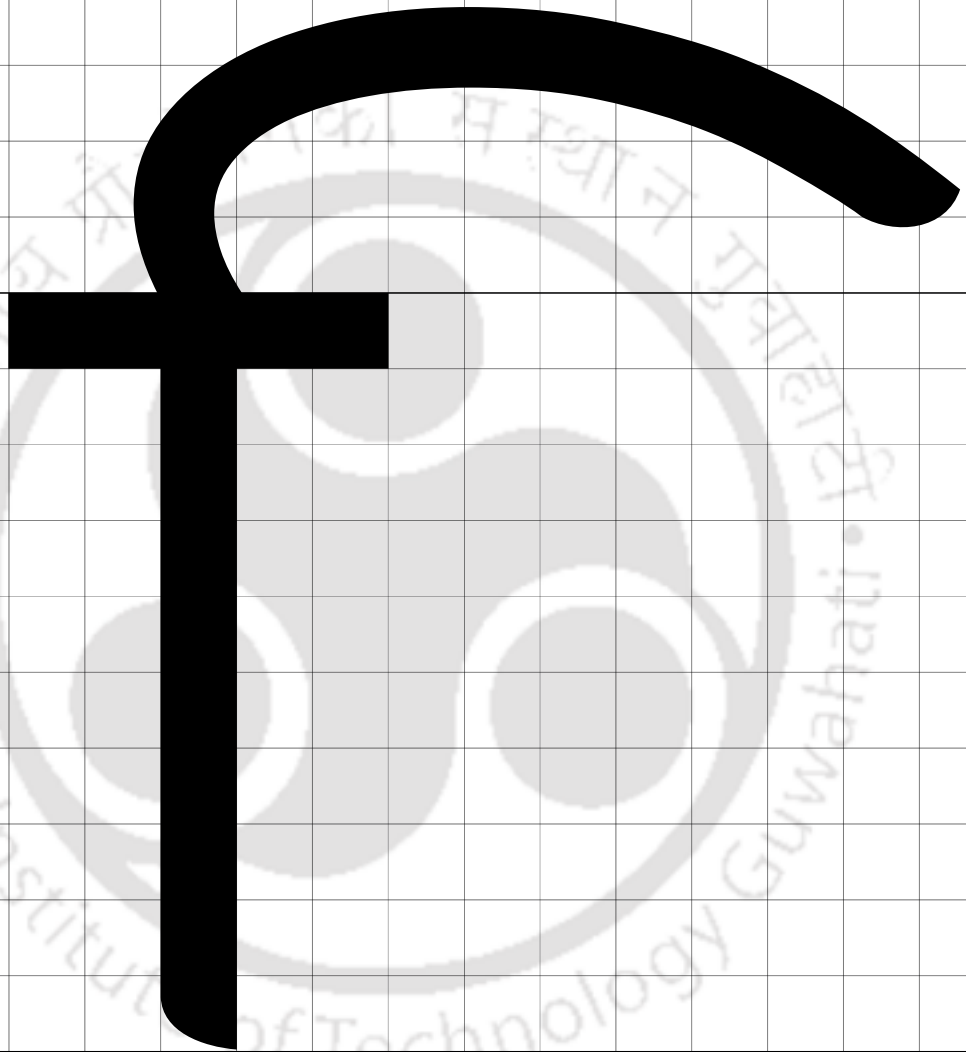
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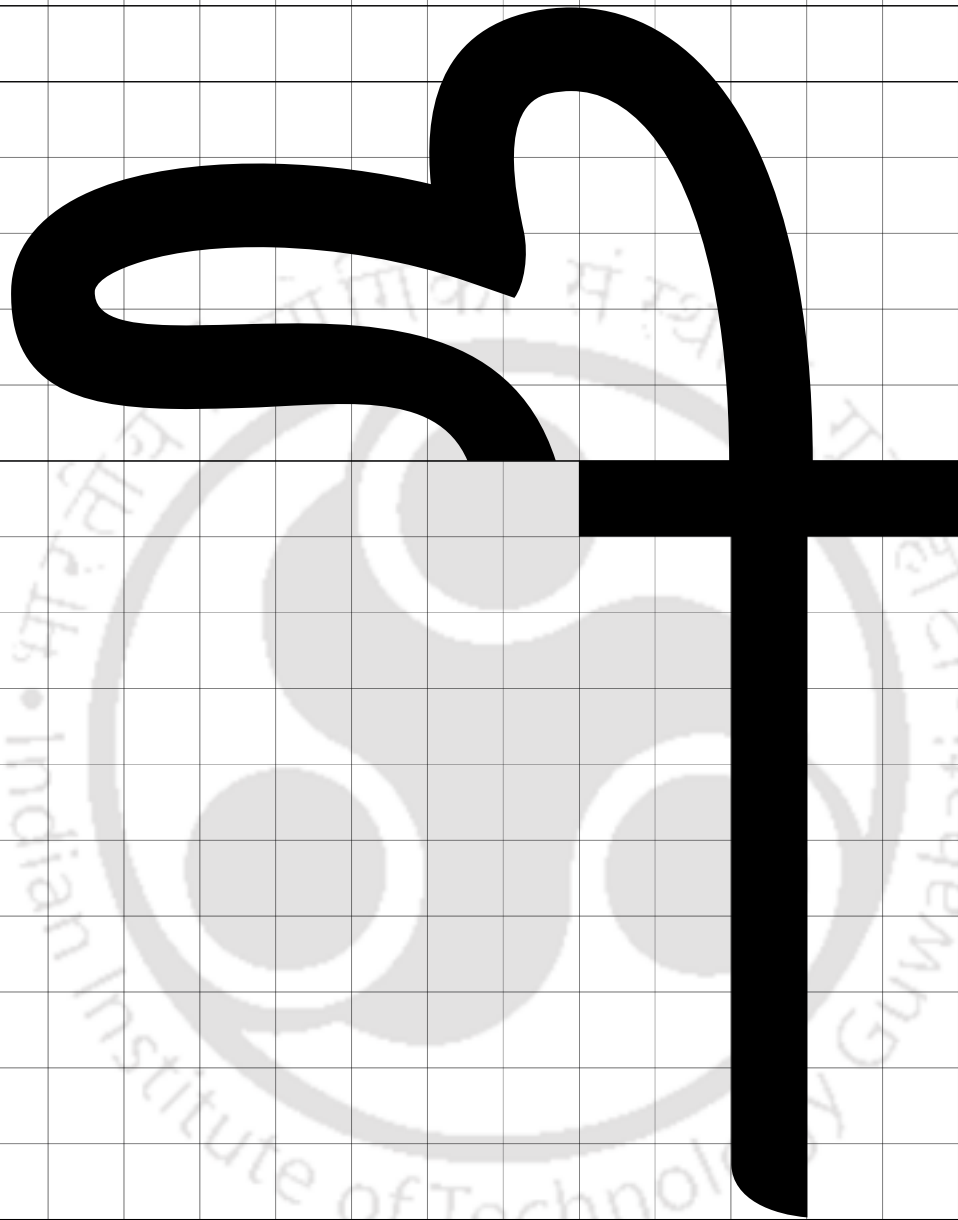
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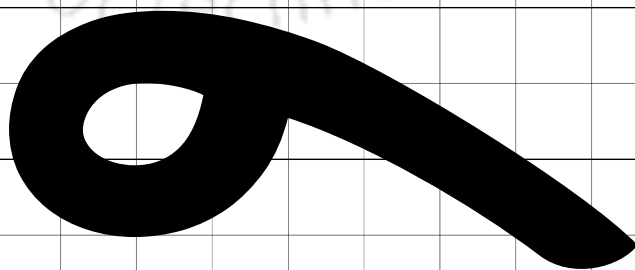
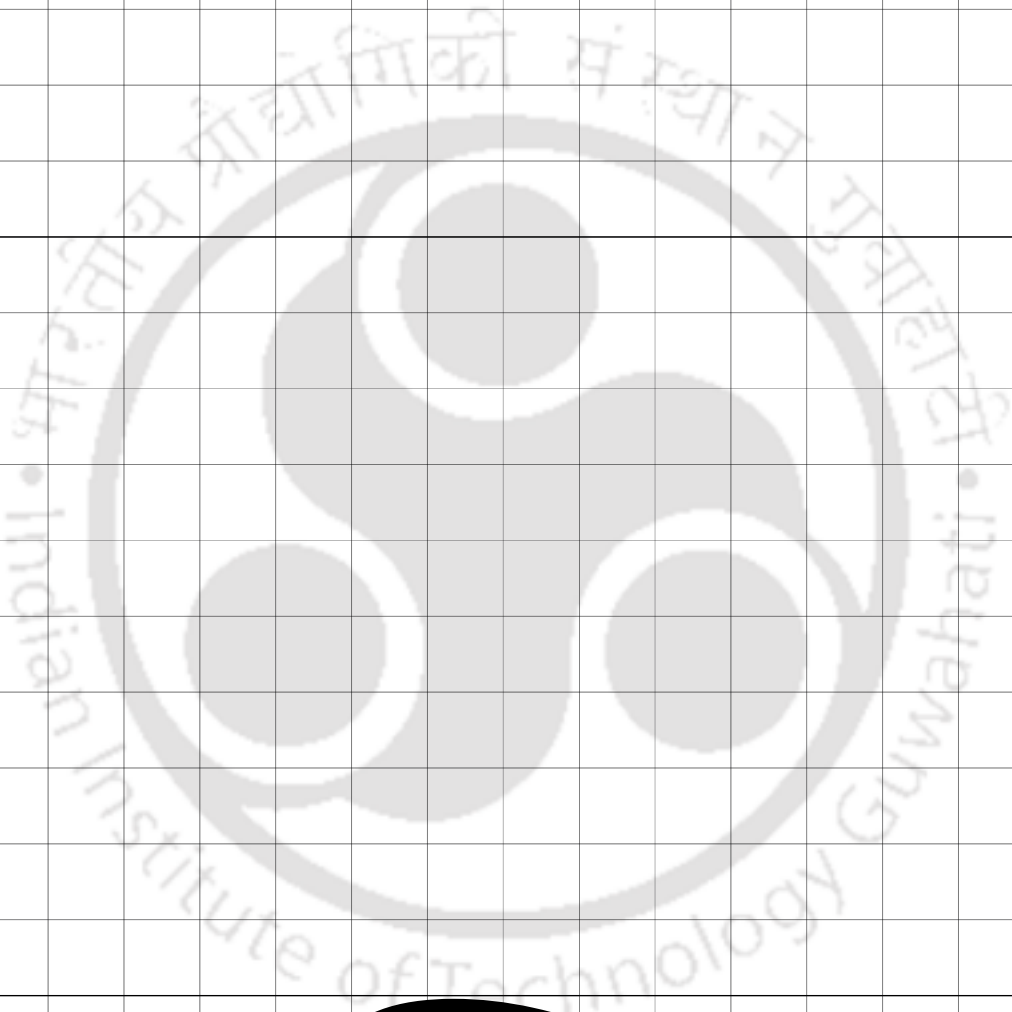
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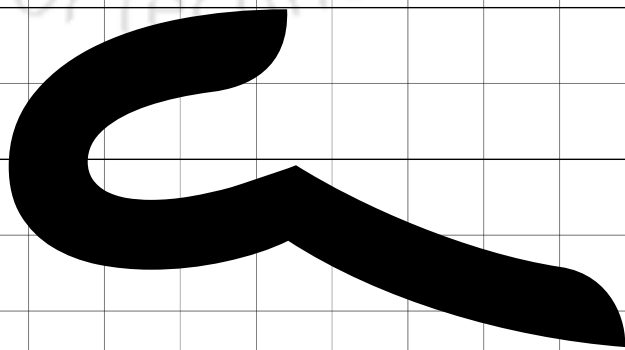
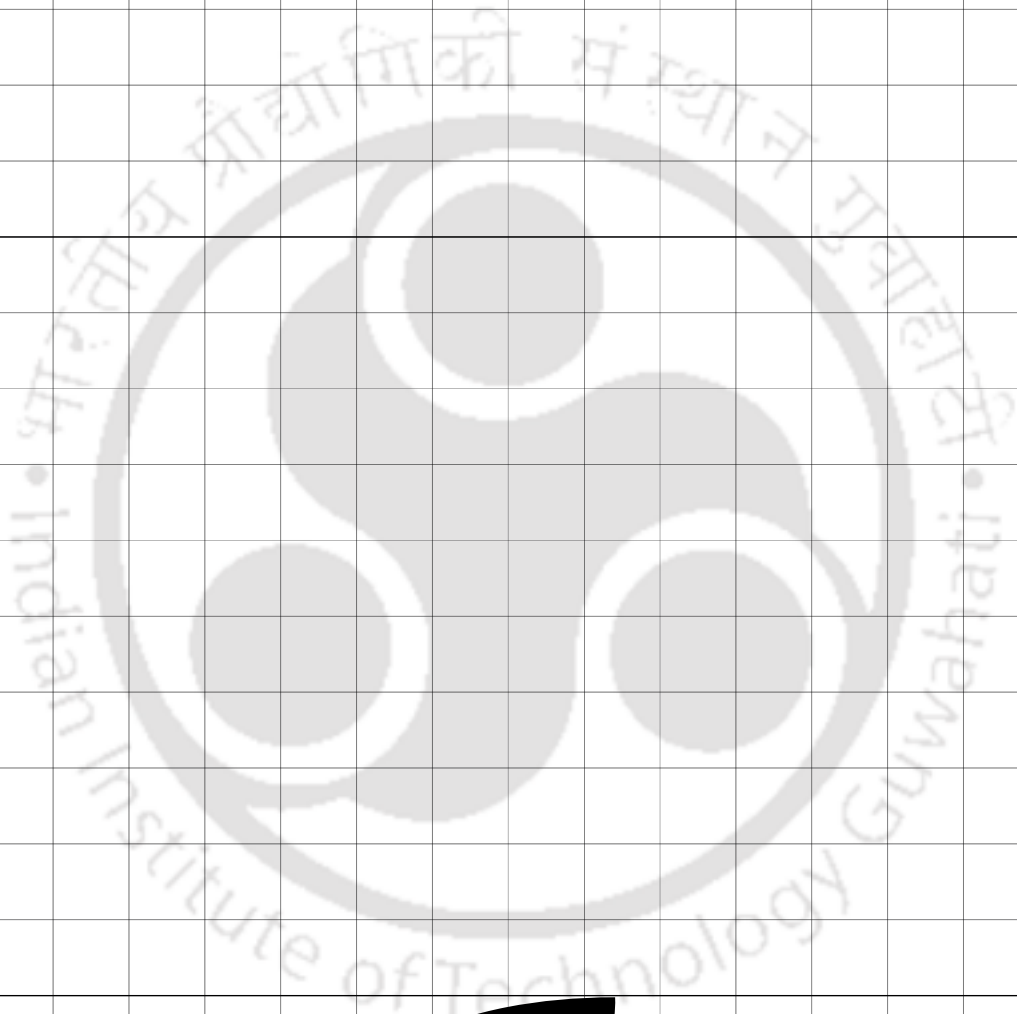
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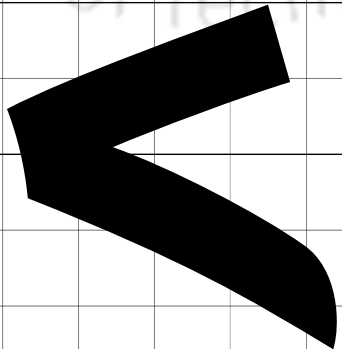
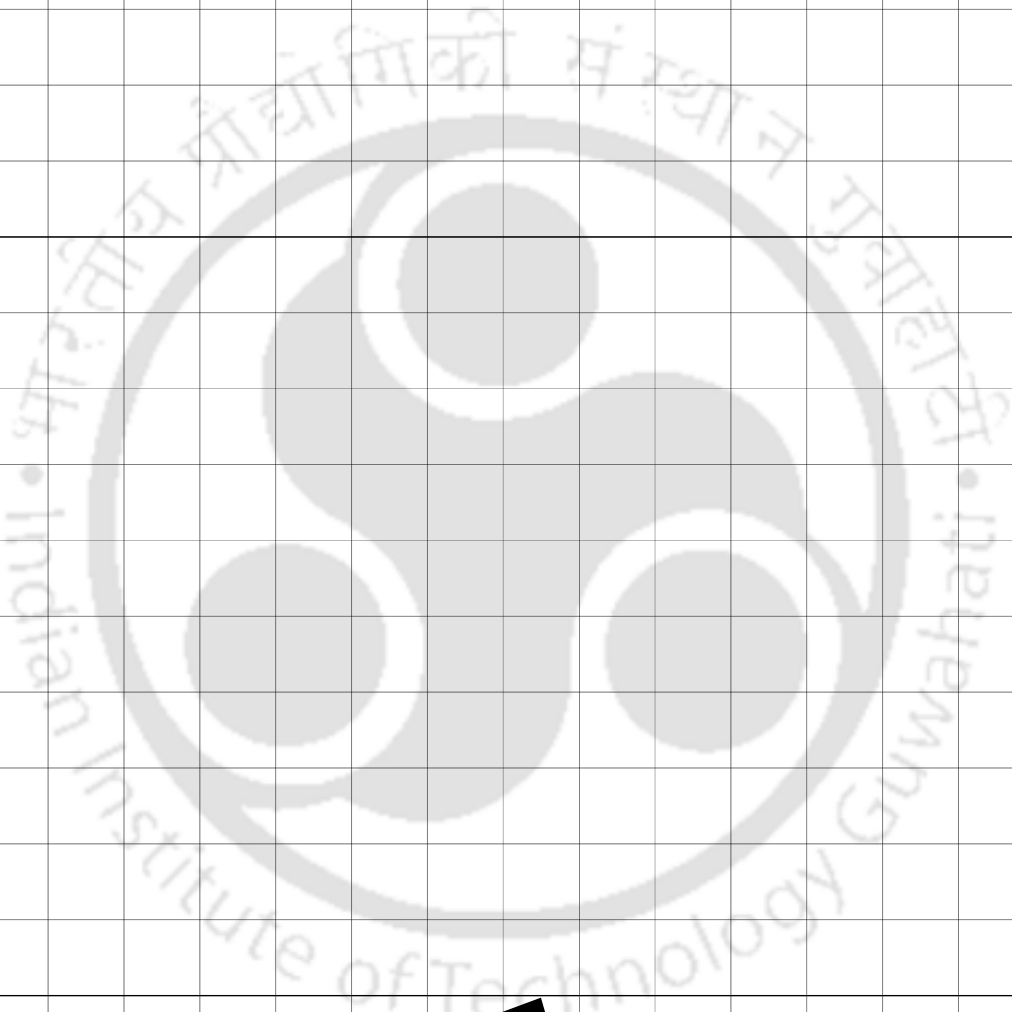
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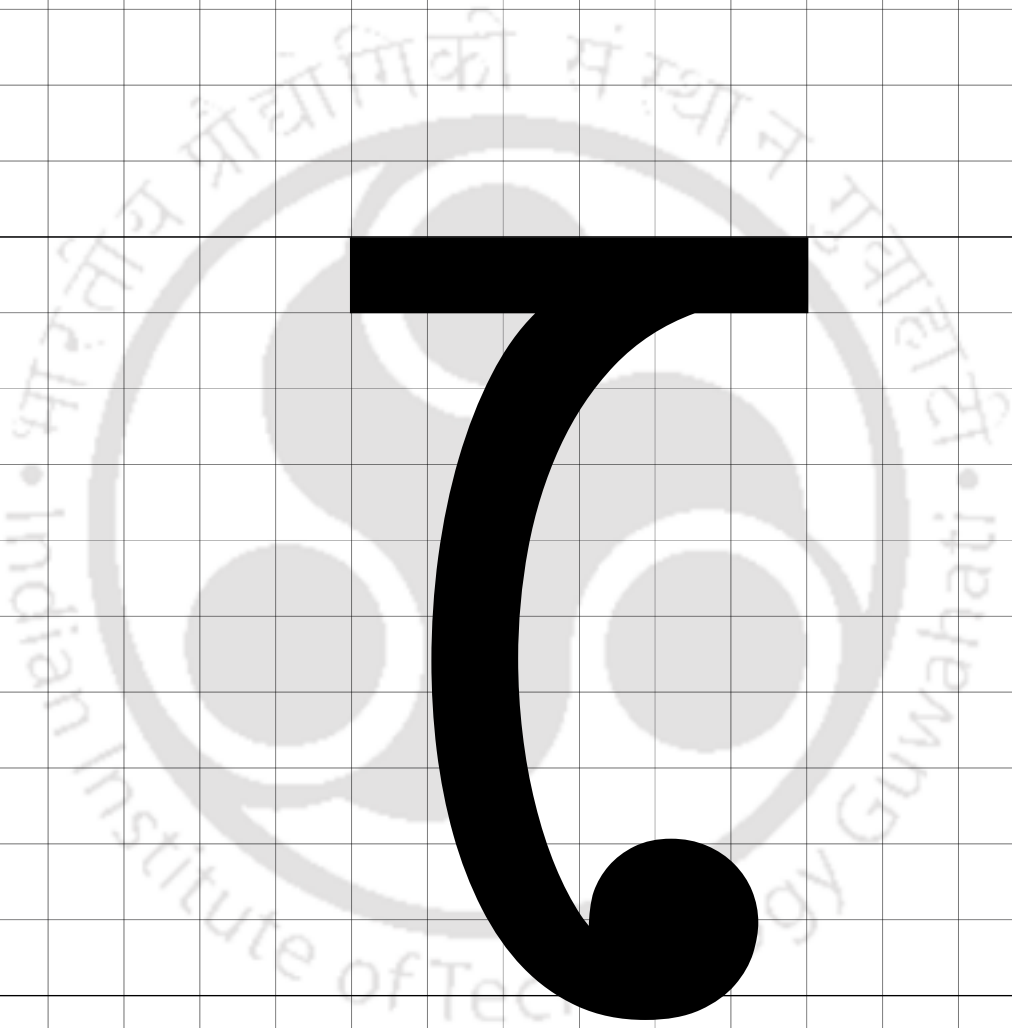
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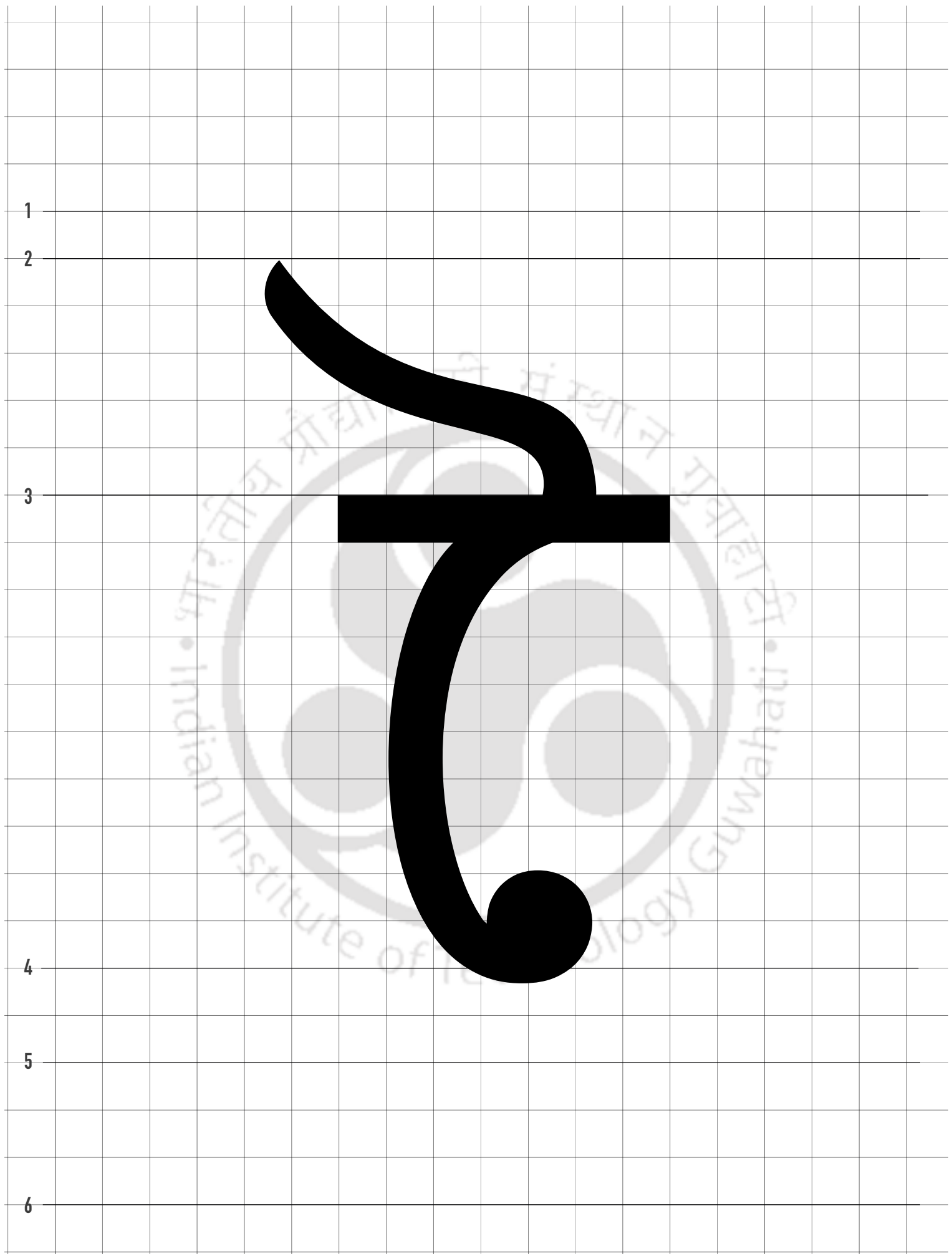
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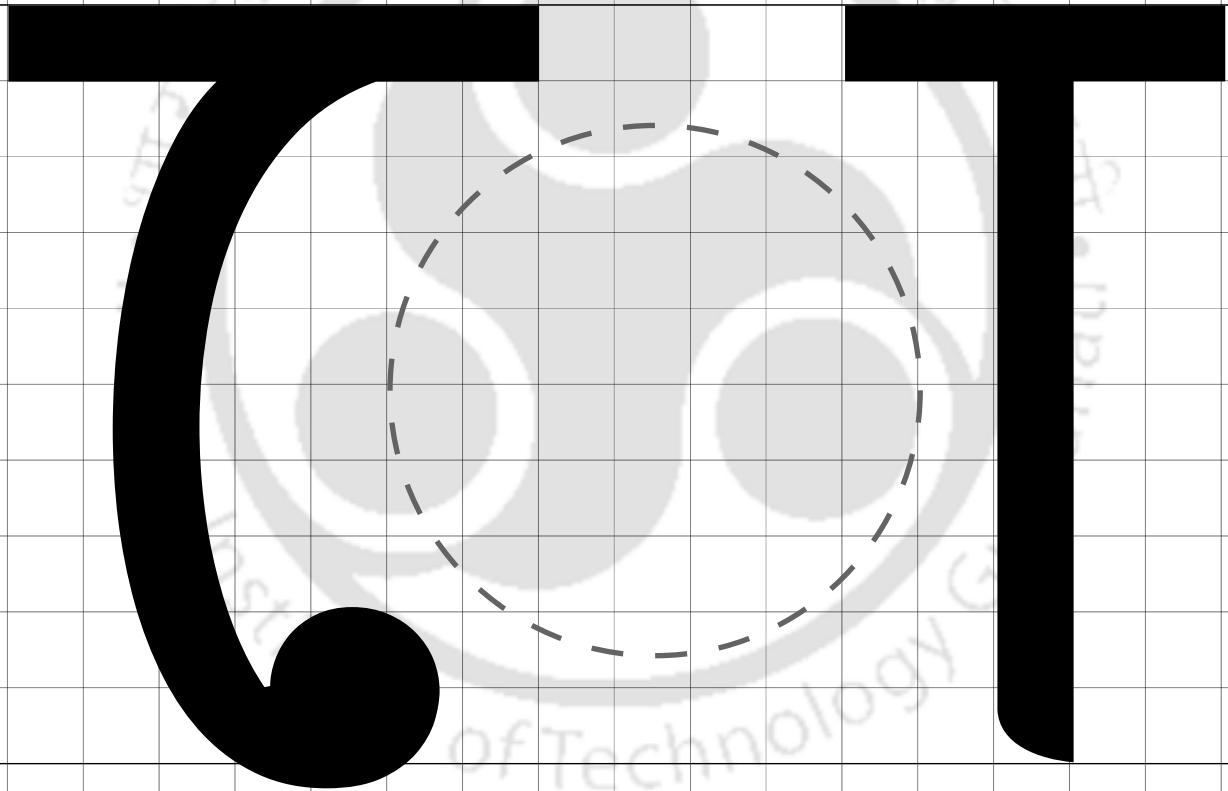
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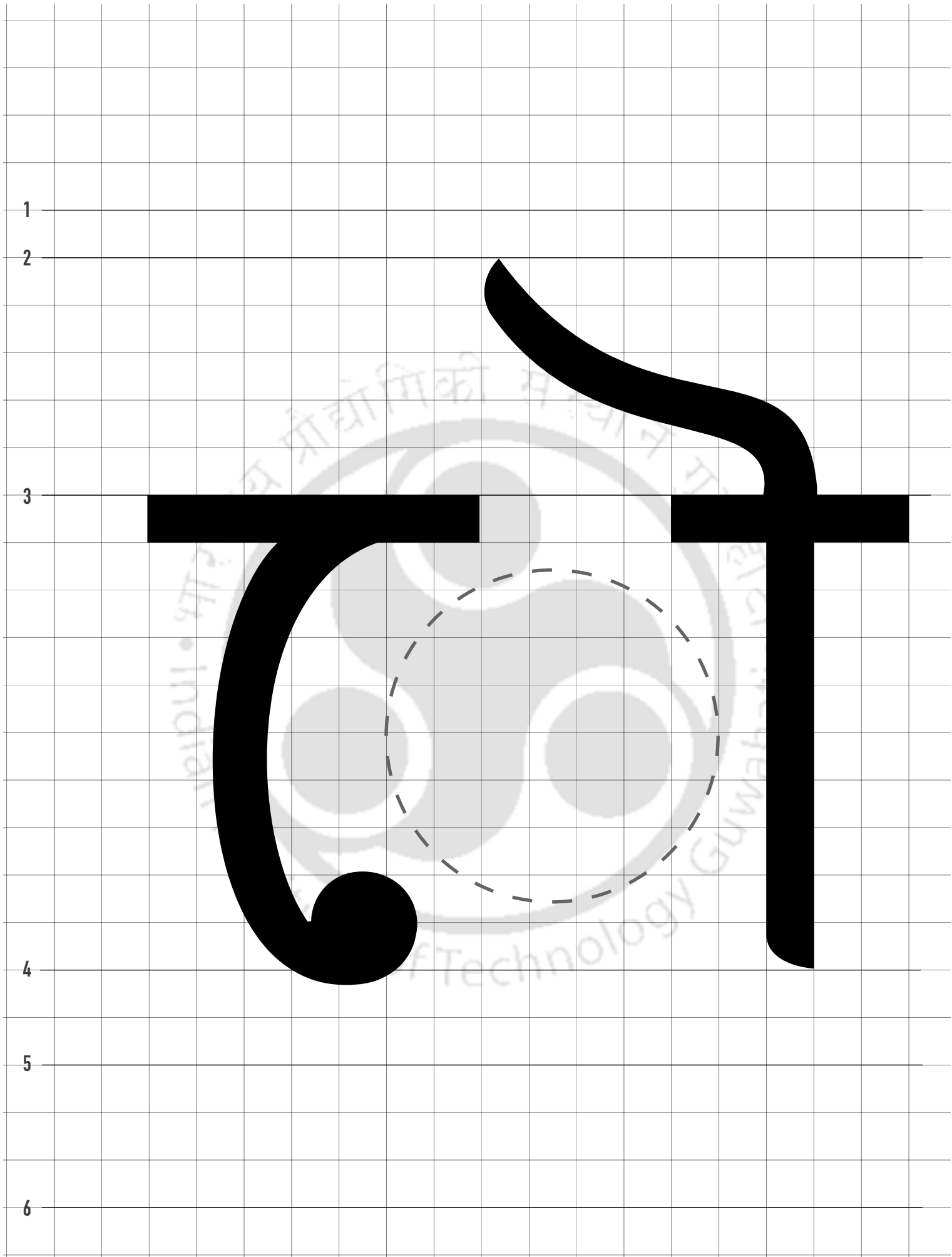
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APPENDIX – 3: INSTALLATION GUIDELINES

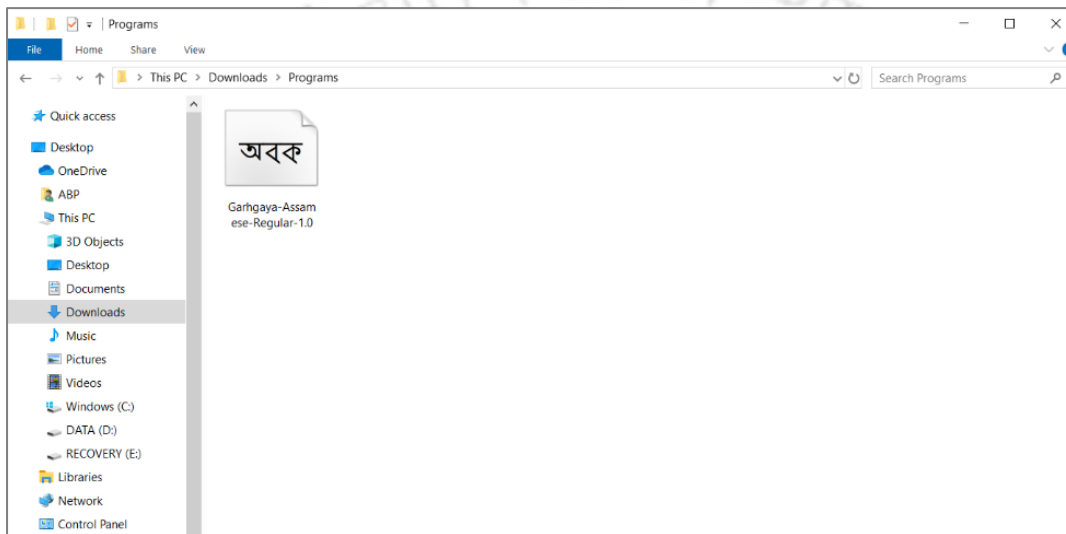
A. “Garhgayan Assamese Regular 1.0” (True Type Font file) Installation and uses guideline

Steps to follow to install the font “Garhgayan Assamese Regular 1.0”

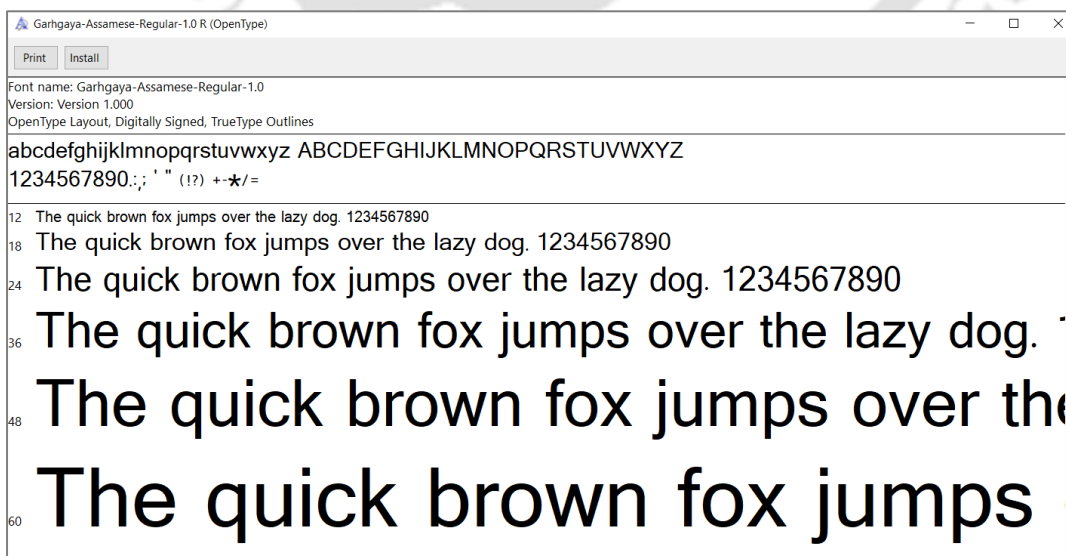
Step 1: Download the font from the link given below:

<https://drive.google.com/file/d/13oPU40o0CW8QB0RxZlavagd4SzbudQ/view?usp=sharing>

Step 2: Locate the font file on your hard drive as shown.

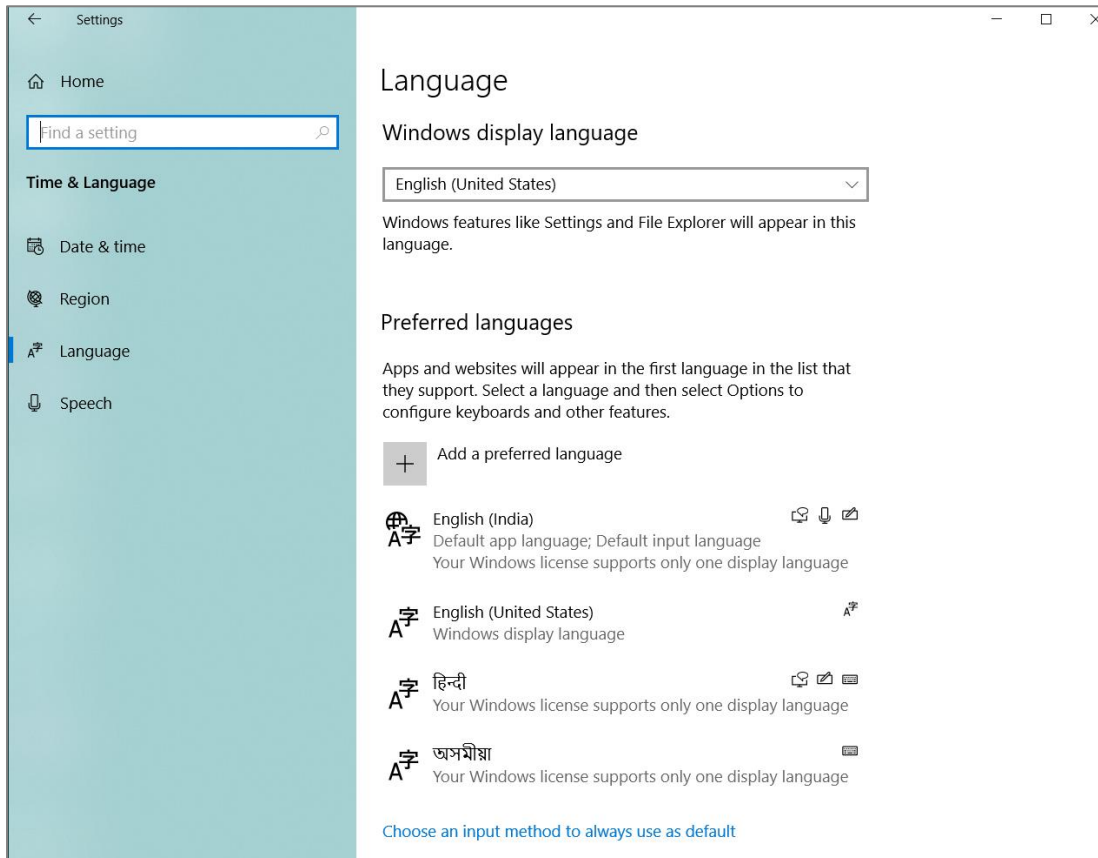


Step 3: Click on the file and select open. It will show a window as below which will ask for print or installation. Select install.



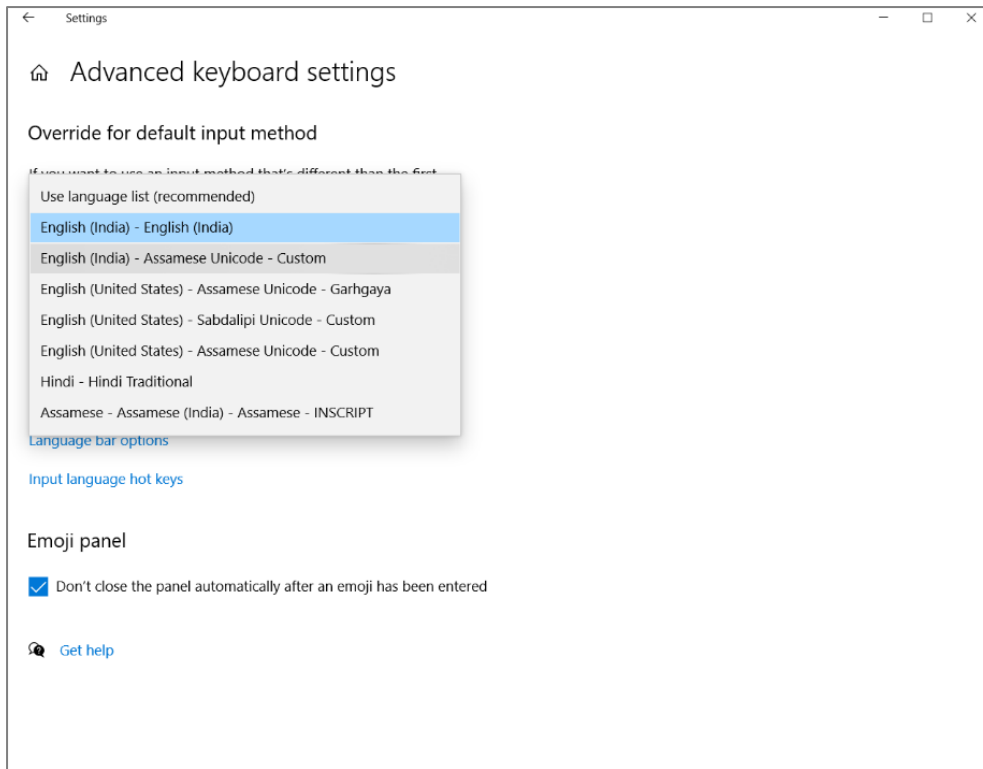
The font file will be installed in the font library of the system and ready for use.

Step 4: Before opening the font for use, the first step is to add the Assamese language in the system so that the system can detect the language its relevant script for the necessary process. For Windows systems, the language list can be added from the Microsoft server directly through the internet.



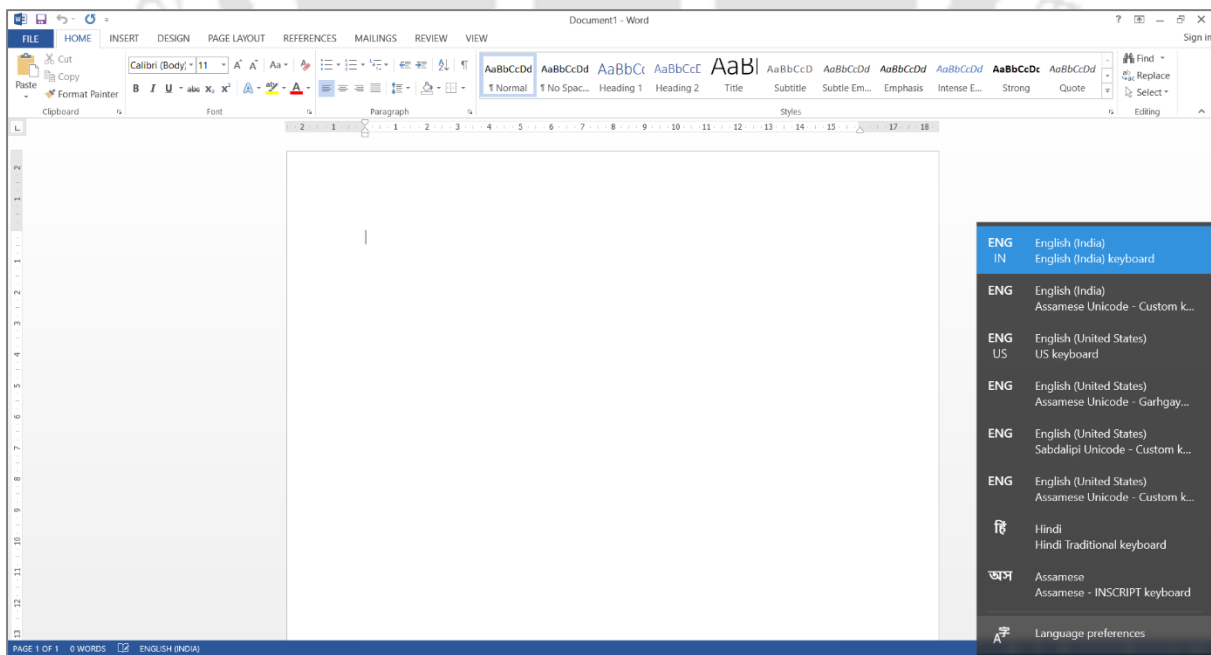
Shown above is a sample image of how a language can be added to the system language library. One has to choose the “Add a preferred languages” key with a “+” sign as shown in the figure. It connects to the internet and shows a list of Indian and other world languages. Choose the preferred language to add to the list.

Step 5: Now “Assamese” language has been added to the language list of the system. Next is to choose an input method for typing in Assamese. As shown in the previous figure, at the bottom there is an option given to choose an input method for default use. By clicking this option will lead to choosing the default keyboard option for typing. For typing in the Assamese language, a variety of keyboards are available such as Unicode keyboard, Assamese In-script, Shabdaliipi, etc. Initially, the Unicode Assamese keyboard should be selected for typing as the font is Unicode compliant following Unicode standard typing methods.



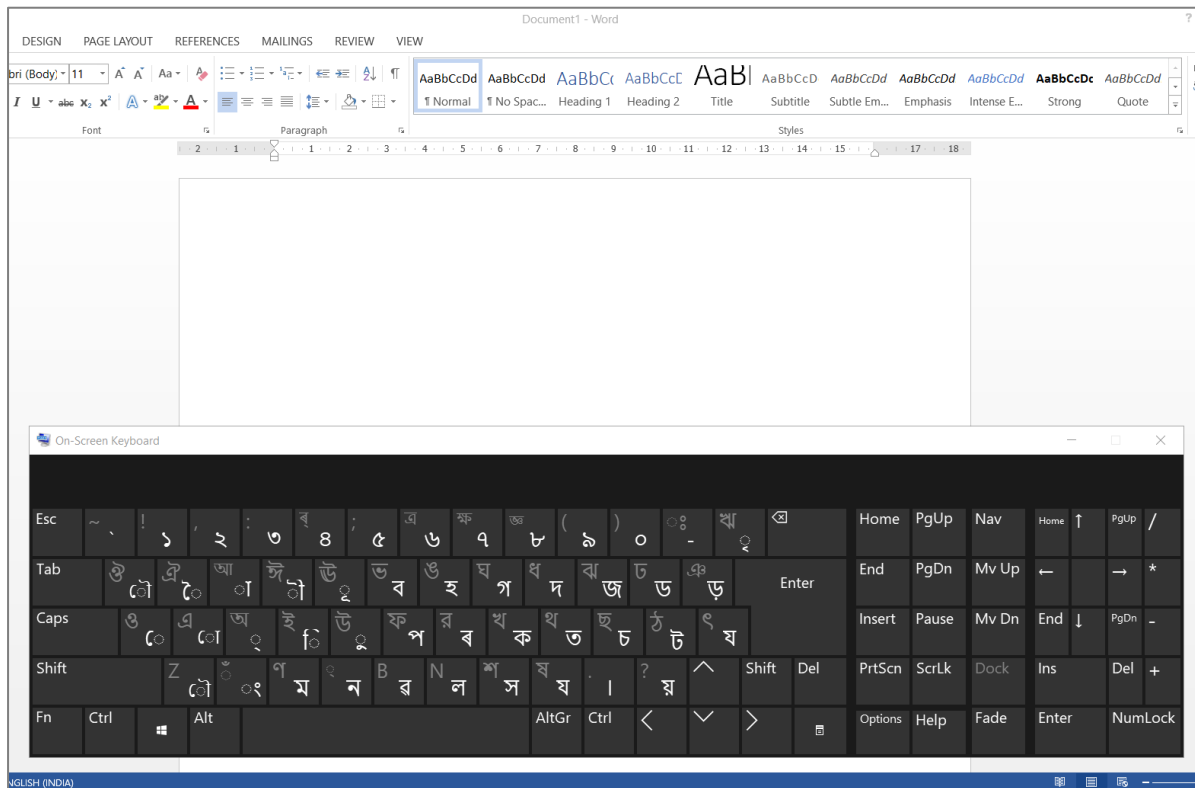
Shown above is a reference figure to locate the Unicode Assamese keyboard. Now the font is ready for use on any documents.

Step 6: Open MS word for typing check. Then go to the bottom right corner to select the preferred language option as shown below.



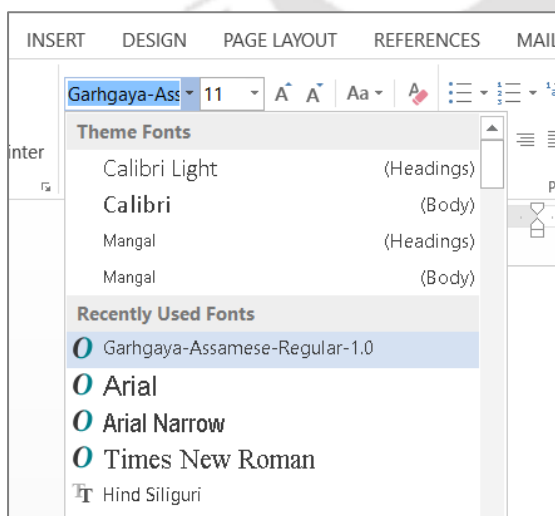
Select Assamese Unicode custom keyboard as the input method. Now open the virtual keyboard for typing check.

Step 7: Selecting Assamese Unicode custom keyboard will convert the input method to Assamese. Open the virtual keyboard and it will show an in-script Assamese keyboard with Unicode standards as shown below.



Now the font is ready for typing with an in-script Assamese Unicode keyboard.

Step 8: Before start, typing select the font to “Garhgayan Assamese Regular 1.0” for typing process as shown below.



That’s it. The font is ready for typing on MS Word. One can easily type for any document processing in the Assamese language with the new font.

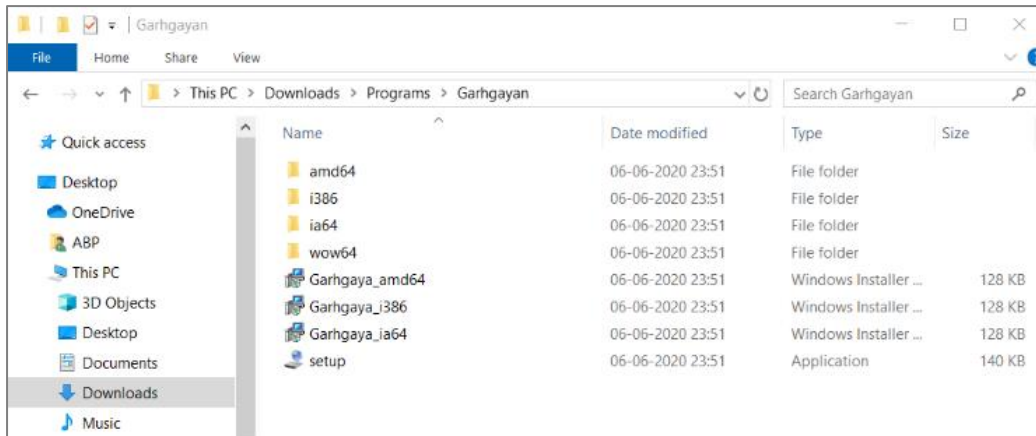
B. Custom keyboard “Garhgayan” installation and uses guidelines.

Steps to follow to install and use the custom-designed “Garhgayan” keyboard.

Step 1: Download the installation folder of the Garhgayan keyboard from the following link –

<https://drive.google.com/drive/folders/1jbkifblwSITk15wu2vNIG9tK7yntj7DF?usp=sharing>

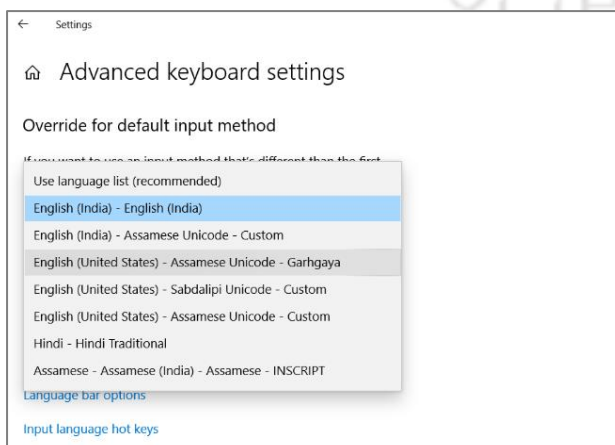
Step 2: Locate the folder on the system hard drive. See reference figure below.



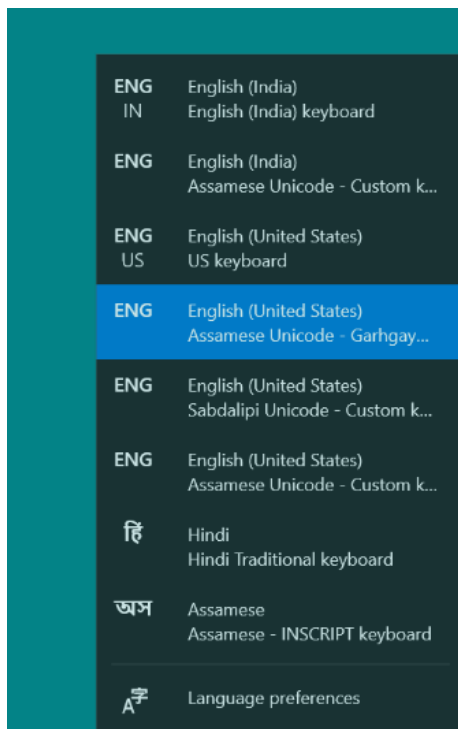
Step 3: Right-click on the “setup” file and select run as administrator. A dialogue box will open up and ask for installation. Follow the steps to complete the installation process.

Step 4: After installation over, go to settings of the system and select language. Go to add preferred language and choose Assamese. Once Assamese has been added to the list of languages in the system then choose the default input method. This will lead to a keyboard selection option.

Step 5: Since the Garhgayan keyboard has been already installed, it will be in the list of input method options of the system. Then select the default input method as Assamese Unicode Garhgayan as shown below.

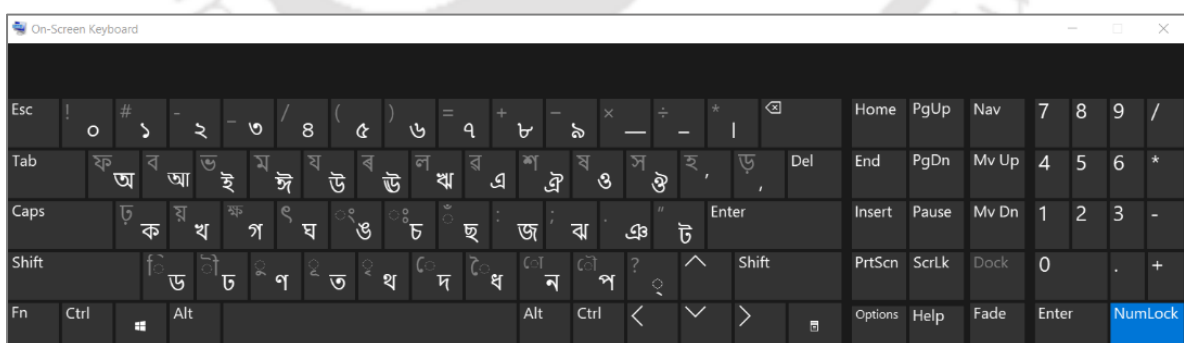


Step 6: System is now ready for Garhgayan keyboard as default input method. Open MS word for testing of the keyboard. The go to bottom right corner to select the Garhgayan keyboard as shown below.



It will convert the default English keyboard to the Garhgayan Assamese keyboard as an input method.

Step 7: Open the virtual keyboard for testing. It will open with the Garhgayan Assamese keyboard layout. See reference figure below.



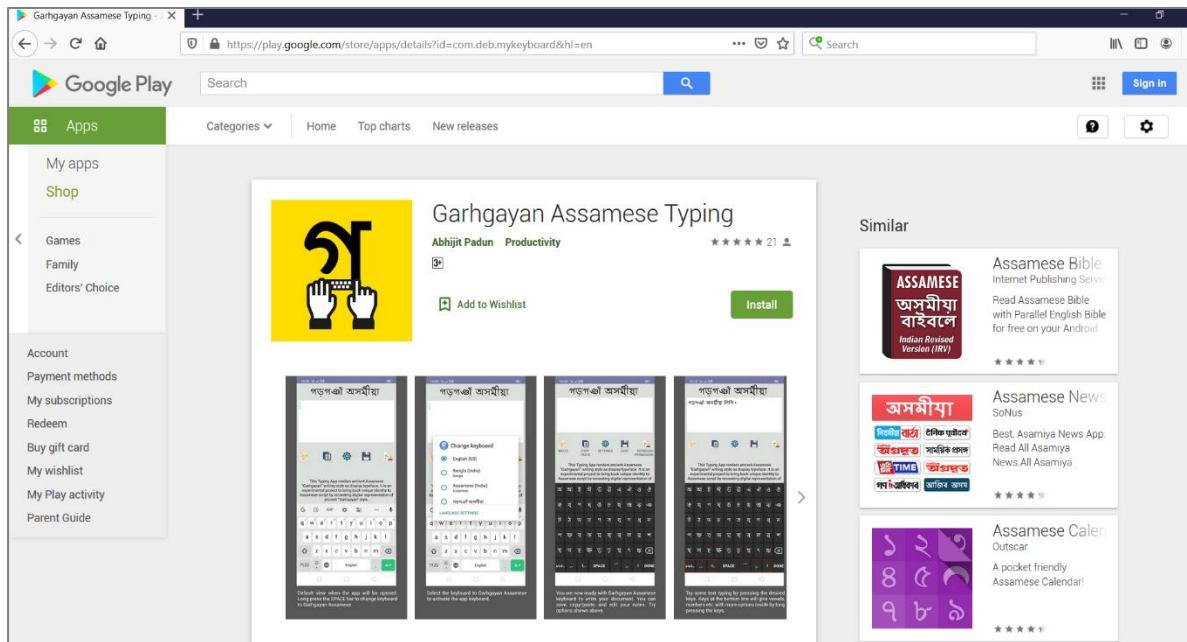
Step 8: The in-script Garhgayan Assamese keyboard is ready for use. The keyboard has been designed to address the amateur people who like to try typing in Assamese script. The keys are placed in a serial order to easily detect instead of the standard Unicode keyboard. It has three modes with normal, shift, and Alt+Ctrl. All the modes are shown different key layers in a serial order. Typing conjunct letters will follow standard Unicode methods.

C. Typing app “Garhgayan Axomia” for Android devices - installation, features and uses guideline

Steps to follow to install and use the typing app “Garhgayan Axomia” for android devices.

Step 1: Download the typing app from the following link.

<https://play.google.com/store/apps/details?id=com.deb.mykeyboard&hl=en>



Step 2: Install it on android devices – mobile phone or tablet with android version 4.4 or above. Once installed, the Garhgayan Assamese typing app logo will appear on the device screen for use. Click on the logo to open the app. It will run with an introduction screen to guide about the application uses. The introduction screen will run only when the app will start for the first time.

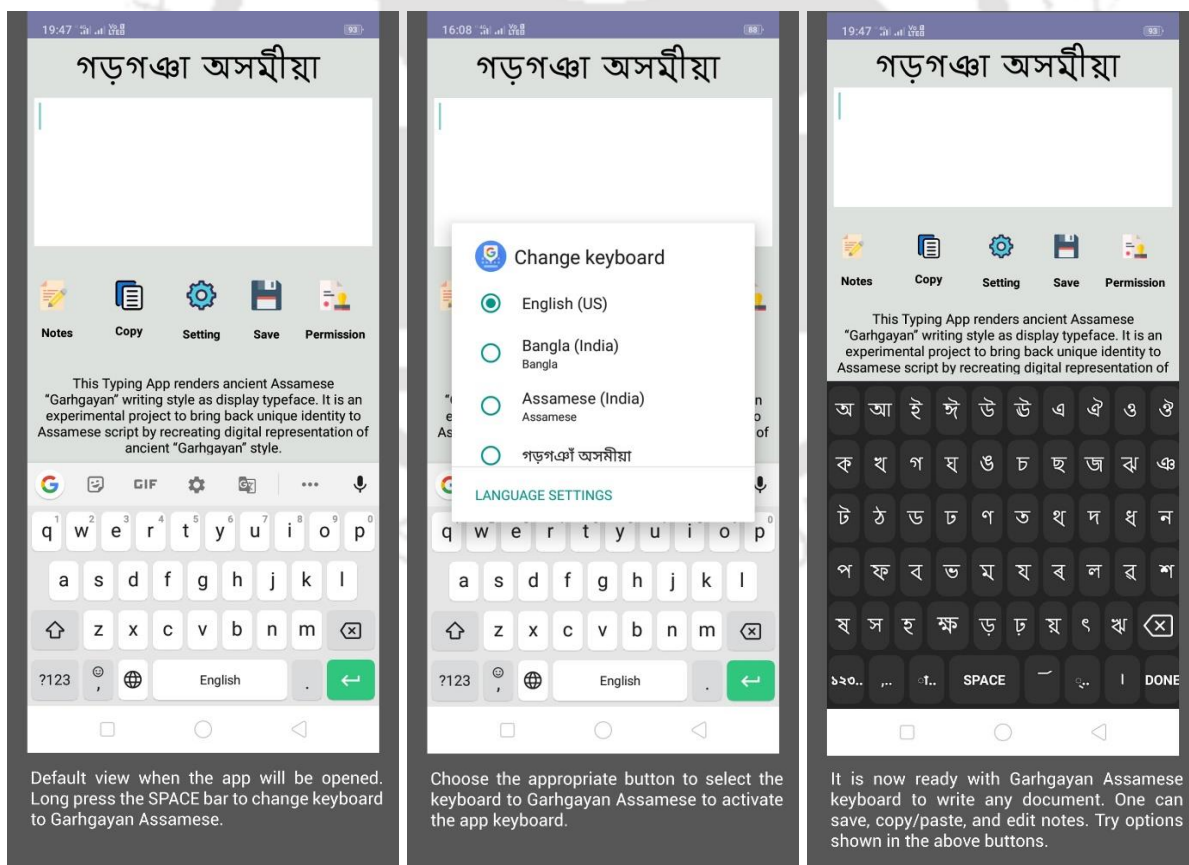
Step 3: Description of the typing app.

This Typing App renders ancient Assamese “Garhgayan” writing style as a display typeface. It is an experimental project to bring back a unique identity to Assamese script by recreating digital representation of the ancient “Garhgayan” style. The in-script keyboard also displays the custom-designed font to relate with the typing document. One can create, copy-paste, save and edit notes within the app. The keyboard can also be easily converted into a device keyboard or to a Garhgayan keyboard with shortcut keys shown on the screens. Special characters such as "start matra" and "end matra" has been introduced with dedicated keys in this custom-designed typeface to showcase ancient sentence writing style. Conjunct letters can be easily

written either by long-pressing any keys to select the desired conjunct form or following the standard Unicode format for writing a conjunct letter as shown on the screen. Long press the bottom keys to look for more options inside that key. Vowel signs are also clubbed inside the “Aa” kar key at the bottom line. This custom font will work only within this app and cannot be exported to any other app like WhatsApp or Facebook as this project is still in the experimental phase.

Step 4: Features and uses guideline – This typing app has been specifically designed and developed for typing Garhayan Assamese font. The app screen will display only the custom-designed Garhayan Assamese font as a display font. The keyboard of the app has been designed with dedicated unique keys for typing special characters included with the font. The keys of the virtual keyboard also display the custom font style to make the app look connected to the display font.

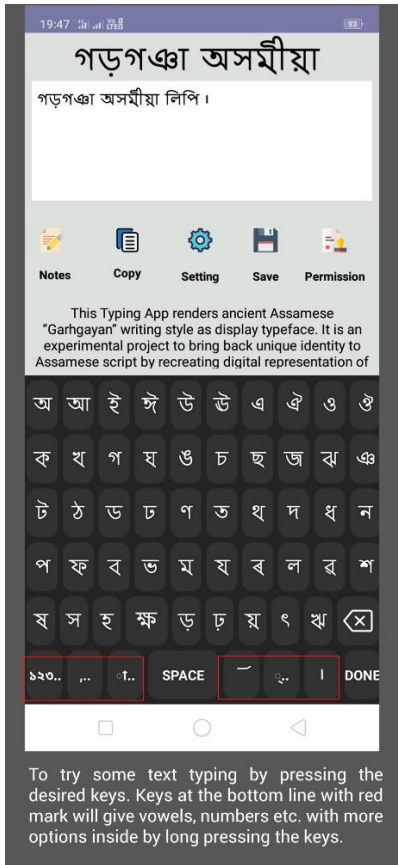
The following screenshots will describe features and how to use the app in a step by step process.



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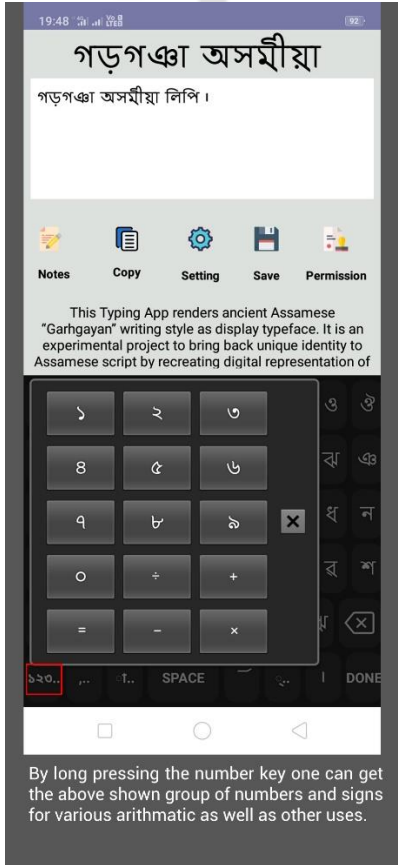
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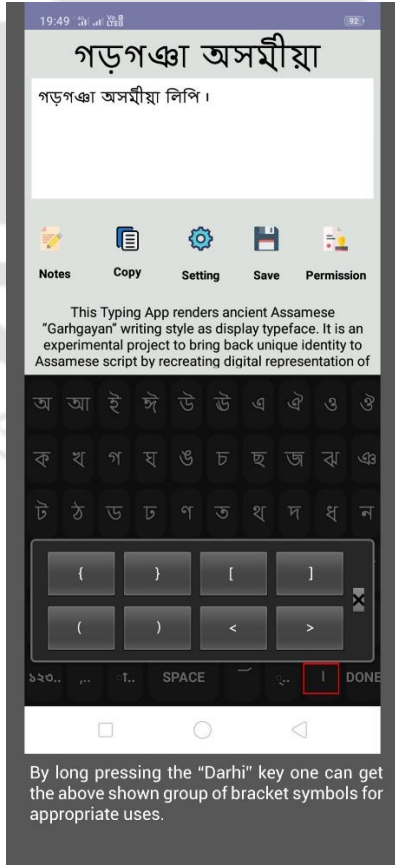
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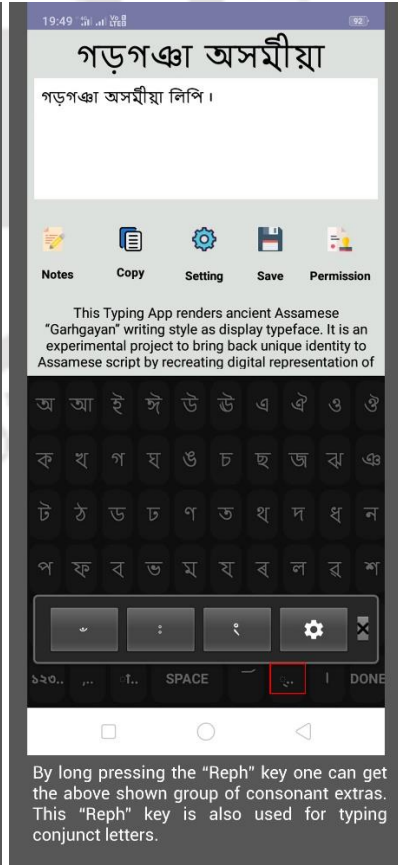
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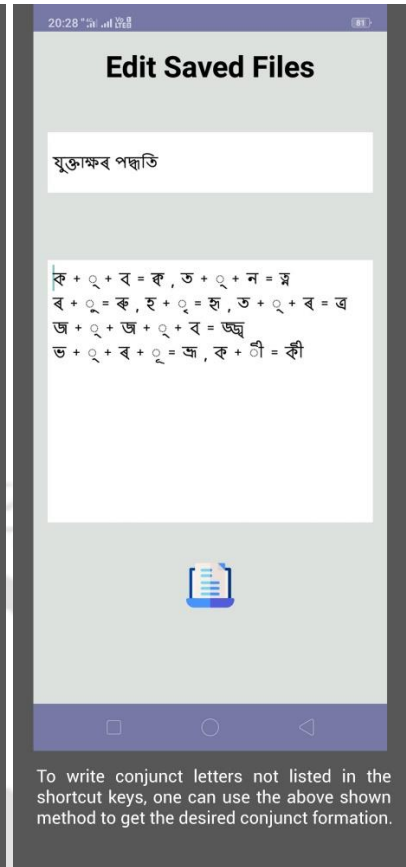
To write conjunct letters, use shortcut keys by long pressing any key to select the desired one.

10



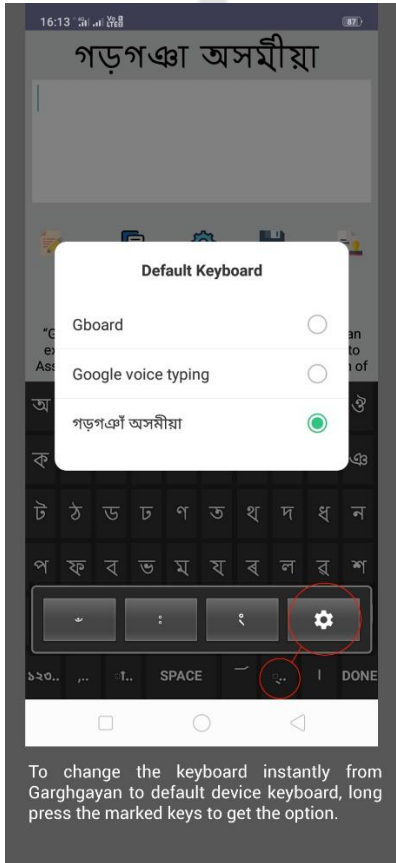
Special matra characters (Start & End matra) are introduced to write sentence similar to ancient Garhgayan style.

11



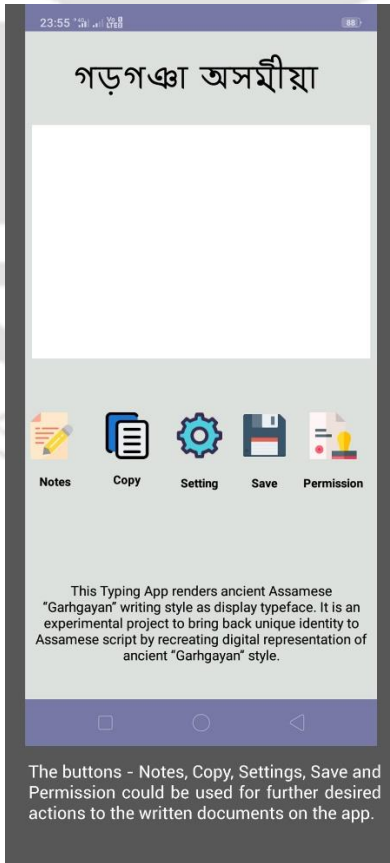
To write conjunct letters not listed in the shortcut keys, one can use the above shown method to get the desired conjunct formation.

12



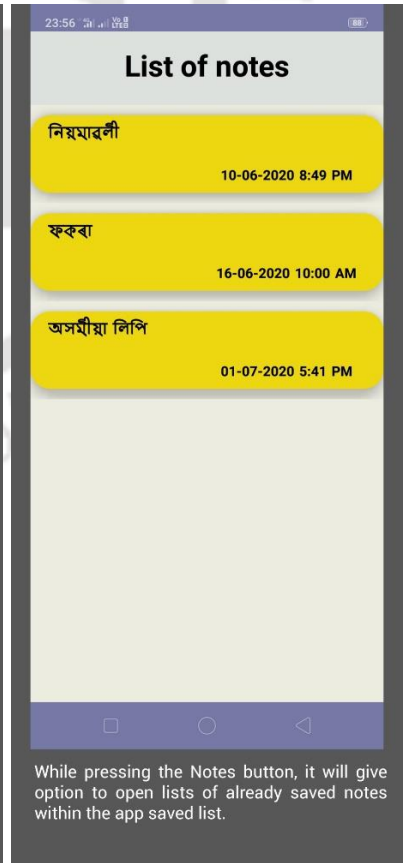
To change the keyboard instantly from Garghayan to default device keyboard, long press the marked keys to get the option.

13



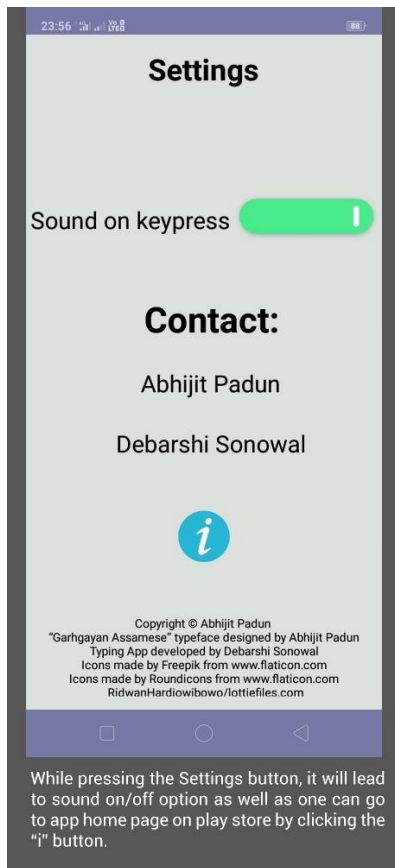
The buttons - Notes, Copy, Settings, Save and Permission could be used for further desired actions to the written documents on the app.

14

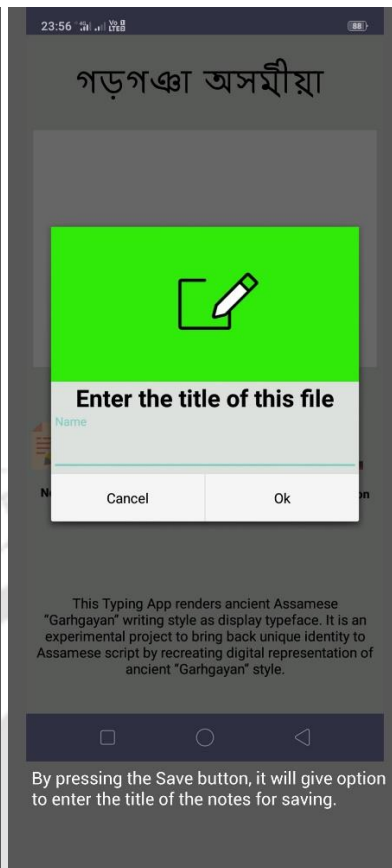


While pressing the Notes button, it will give option to open lists of already saved notes within the app saved list.

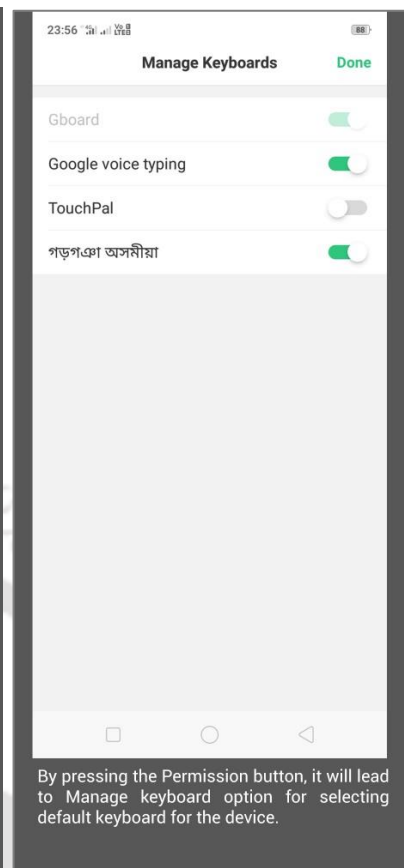
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Any updates of the app can be reached at its home page on Google Play Store.

Thank you.



APPENDIX – 4: DESCRIPTION OF SOFTWARE USED

A. Adobe Illustrator and Photoshop

Adobe Illustrator: Adobe Illustrator is a vector graphics editor and design program developed and marketed by Adobe Inc. Originally designed for the Apple Macintosh, development of Adobe Illustrator began in 1985. Along with Creative Cloud, Illustrator CC was released.

Developed by: Adobe Inc.

License: Proprietary

Latest release: CC 2020

Initial release date: January 1987

Uses in the research work:

- Tracing and vector output development of typeface at the concept level.
- Creating schematic diagrams of research planning.
- Anatomical structure drawing of the typeface.
- Various other schematic illustrations

Adobe Photoshop: Adobe Photoshop is a raster graphics editor developed and published by Adobe Inc. for Windows and macOS. It was created in 1988 by Thomas and John Knoll. Since then, the software has become the industry standard not only in raster graphics editing but in digital art as a whole.

Developed by: Adobe Inc.

License: Trialware, SaaS

Latest release: CC 2020

Initial release date: 19 February 1990

Original authors: Thomas Knoll, John Knoll

Uses in the research work:

- Image touch-up and color correction of field data.
- Digital tracing of historical writing styles.
- Conceptual hand-drawn digital typeface testing.
- Image creation, correction, and design for final presentation.

B. Font Lab Studio

Background: FontLab is both the name of a company, Fontlab Ltd, Inc., and the name of their flagship font editor product (although version 5 was called **FontLab Studio**). Since the early 2000s, FontLab has been the dominant software tool for commercial/retail digital font development. This is partly because the once-dominant Fontographer by Altsys ceased development after its acquisition by Macromedia. During Macromedia's merger/acquisition by Adobe Systems in 2005, Macromedia sold Fontographer's rights and code to FontLab Ltd, so FontLab now owns and maintains both of the most popular font editing/development tools.

Uses in research work:

- Creating detailed font design of new Assamese typeface “Garhayan Assamese Regular”.
- Assigning a Unicode number to font characters
- Leading, kerning, spacing adjustment of characters
- True Type hinting of characters
- Exporting production font in true type format (.ttf) for further process

C. Microsoft Volt

The Microsoft Visual OpenType Layout Tool (VOLT) provides an easy-to-use graphical user interface to add OpenType layout tables to fonts with TrueType outlines. It is licensed free. VOLT supports a wide range of substitution and positioning types.

Uses in research work:

- Reconfiguration of output True Type font for character adjustment on the upper and lower zone.
- Adjustment of upper modifiers and lower modifiers.
- Adjustment of “Chandrabindu” with other characters.
- Final production output for device ready True Type font.

D. Microsoft keyboard layout creator

Developed by Microsoft, the keyboard layout creator provide users to create, modify, upgrade the standard keyboard layout of the computer system. It can also help in creating layering for Indian scripts which is the most useful part of the software.

Uses in research work:

- Creating layering for Assamese script characters for Garhgayan Assamese.
- Modifying the keys placements for the new typeface for innovative use.
- Exporting application file for keyboard installation on different operating systems.



