

Handling Declensions of Sanskrit in Machine Translation

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Abstract – Declensions are known as the inflections of nouns and pronouns. Inflections of verbs are known as conjugations, and that are not the part of the paper. Since declensions in Sanskrit are gender specific, their formation varies from gender to gender. Unlike any other language, gender does not depend on the gender of the object/ person/ entity/ living-being for which the word is meant for. In general it depends on how the word is ended. Words end with either vowels or consonants in Sanskrit.

Briefly, nouns or pronouns can be derived into declensions of seven types that are known as cases. Each word will have three forms according to number, i.e., singular, dual, and plural in Sanskrit. Hence a total of twenty-one forms of declension can be obtained for a word. Declensions of only nouns that end with vowels are considered for handling in this paper.

Keywords: Noun inflections, declensions, machine translation, morphological analysis.

I. INTRODUCTION

Ancient Sanskrit grammarians of India categorized the vocabulary of Sanskrit briefly into three types; *subantas*, *tijantas* and *avyayas* as in Table 1 [3] [15].

Table 1: Classification of the terminology of Sanskrit

Category	Description	Example
<i>subanta</i>	Non-verbs	<i>krishNaH, sItA, vRksham</i> , etc
<i>tijanta</i>	Verbs	<i>kri, dhav, bhid</i> , etc
<i>avyayas</i>	Indeclinable words	<i>yadA, tadA, adya</i> etc

Inflections on non-verbs, i.e. nouns, pronouns, adjectives are known as declensions [16]. Inflections on verbs are known as conjugations and are not considered in this paper. Declensions in Sanskrit are formally categorized into eight categories and are known as cases (known as *kArakAs* in Sanskrit), viz. nominative (*karta kAraka*), vocative (*sambodhana-karta*), accusative (*karma kAraka*), instrumental (*karaNa kAraka*), dative (*sampradAna kAraka*), ablative (*apAdAna kAraka*), genitive (*sambandha kAraka*), and locative (*adhikarana kAraka*). These *kArakAs* are known as *vibhaktis* [4]. Though there are eight cases in declensions, the vocative case is not considered as very important case since it does not contain any internal declension, except prefixing an addressing term like ‘hey, bhO’, etc [5].

The basic noun/ pronoun (stem) is known as ‘*Sabda*’ in Sanskrit [7] [13]. Each *Sabda* can be derived into twenty one declensions, since each *Sabda* can have three forms for number, i.e. singular, dual and plural and seven cases [8]. *Sabda* is derived into a declension by appending a predefined case-specific inflection grammatically as in the Table 2.

Table 2: Affixes for cases in Sanskrit

Case	Vibhakti	Singular	Dual	Plural
Nominative (कर्ता <i>karta</i>)	<i>Prathama</i>	-स् -s (-म् -m)	-औ -au (-ई -I)	-अस्/ -as (-इ -i)
Accusative (कर्म <i>karma</i>)	<i>dvitiya</i>	-अम् -am (-म् -m)	-औ -au (-ई -I)	-अस् -as (-इ -i)
Instrumental (करण <i>karana</i>)	<i>tritiya</i>	-आ -ā	-भ्याम् -bhyAm	-भिसु -bhis
Dative (सम्प्रदान <i>sampradAna</i>)	<i>chaturthi</i>	-ए -e	-भ्याम् -bhyAm	-भ्यसु -bhyas
Ablative (अपादान <i>apAdana</i>)	<i>Panchami</i>	-अस् -as	-भ्याम् -bhyAm	-भ्यसु -bhyas
Genitive (सम्बन्ध <i>sambandha</i>)	<i>shashti</i>	-अस् -as	-ओस् -os	-आम् -Am
Locative (अधिकरण <i>adhikarana</i>)	<i>saptami</i>	-इ -i	-ओस् -os	-सु -su

Unlike any other language, Sanskrit considers the number of entities in three ways; singular, dual, and plural [6]. If the entity is single in number, then it is considered as singular, e.g. if only one Rama is there, the word ‘*rAmAH*’ is employed. If there are

particularly two entities, then they are considered as dual, which is a peculiar characteristic of Sanskrit [12] [17], e.g. to represent two lions, the word '*siMhau*' is employed. Plurality is considered from three entities onwards, e.g. to represent three or more snakes, '*sarpaaH*' is employed.

Sanskrit grammar predetermined the rules of *sandhi* which gives the declension as per the gender and the ending character i.e. vowel/ consonant of the stem [9] [14]. The case-terminations for the neuter gender are given in the parenthesis, the remaining are for masculine and feminine genders. The same phenomenon is also followed in Telugu by adapting the grammar from Sanskrit and by changing it suitably to derive nouns and pronouns for obtaining their declensions [1]. All the seven cases are adapted as they are, except the concept of dual number representation and declensions answer various questions about the agent or subject of the sentence as shown in Table 3 [2]. Cases are known as *vibhaktis* in Telugu.

Table 3: Cases of declensions and case-wise answers to questions in Sanskrit

Case	Vibhakti	Inflections	Answers to the question
Nominative	<i>prathama</i>	<i>Du, mu, vu, lu</i>	Who? What?
Accusative	<i>dvitiya</i>	<i>ni, nu, la, kUrci, gurinci</i>	Whom? What?
Instrumental	<i>tritiya</i>	<i>cEta, cE, tODa, tO</i>	By whom/ what?
Dative	<i>caturthi</i>	<i>koraku, kai</i>	To/ for whom/ what?
Ablative	<i>panchami</i>	<i>valana, kanTe, paTTi</i>	From whom/ what?
Genitive	<i>shashti</i>	<i>ki, ku, yokka, lO, lOpala</i>	Of whom? Whose?
Locative	<i>saptami</i>	<i>andu, na</i>	When? Where?

2. ANALYSIS ON DECLENSIONS

In the process of MT from Sanskrit to Telugu, the given input string is tokenized and the head words (i.e. the words which are available in dictionary/ database) are translated in first phase. The tokens which are not translated are considered in second phase and subjected to various types of checking. Checking for inflections is one of them. Tokens are identified as declensions if any. Inflection part of the identified declension is examined, to recognize to which case it is belonged to. Inflections vary from case to case based on the gender, ending character, and number of the *Sabda*.

Though there are few special cases, in general, gender of the *Sabda* is decided based on its ending character or suffix in Sanskrit [10][11]. General rules for determining the gender of a word in Sanskrit as follows:

- Masculine: all stems formed with the suffix *a, i, or u*, the short suffixes.
- Feminine: all stems formed with the suffixes *A, I, U, tA, trA, ti*.
- Neuter: all stems formed with the suffixes *tva, ru, is, us*, and (unless the name of a living being) *as*, and (unless meaning an agent) *ana*.
- Masculine are (in so far as they are not used adjectivally) all stems formed with the suffixes *ta, va, yu, Ayana, i* (patronymic), *ka, bha, la*.
- Masculine or feminine, are stems formed with the suffixes *ni, nu, mi, tR*; also stems formed with the bare root (neuter also if adjectives).
- Masculine or neuter are stems formed with the suffixes *a, tha, na, una, ma, ya, ra, tya, tra, tu, an, man, van*; also the adjectives formed with, *in, Ina, Iya, tana, tama, tara, maya, mat, vat*.
- Masculine feminine or neuter are stems formed with *i or u*

As per the analysis done on declensions (Table A1 through A8 of Appendix A), the maximum length of the inflection is 6 and minimum is 1.

3. MORPHOLOGY IN MACHINE TRANSLATION

The tokens which are not translated in first phase are identified and subjected to verification to find whether the inflection is present at the end of the word. Initially, last six letters of the token are verified for presence of the one of suffixes of *AbhyAM, ibhyAM, EbbhyAM*, etc. in first iteration, since they are the longest among all the inflections. If the six-letter-length suffix is not identified in the token, then the iteration will be continued for verifying the presence of five-letter-length-suffix (e.g. *ibhiH, ubhiH, ObhiH*, etc.), four-letter-length-suffix, and so on. Else, that means, if the six letter suffix is present in the token, then it is considered as declension and the suffix is separated from the token. Hence, the token become two parts, viz. stem and suffix. The case and number of the declension is identified using the suffix.

The database is searched for the equivalent meaning of the stem. If the stem is available in the database, then corresponding meaning is fetched. Otherwise the stem should be considered corrupted and it should be morphed so that its head word is obtained. Morphing is the phenomena of changing a corrupted word to obtain desired form as per the grammar rules in Machine Translation.

For instance, the token *sarpANAm* (means snakes') is considered for Machine Translation. Last four letters are identified as the inflection part of the token; hence the token is recognized as a declension. *ANAm* is the suffix appears at the end of the declensions of plural form of Genitive case, generally when the word ends with the vowel 'a' for all, masculine, feminine, and neuter genders. The declension is segmented into *sarp + ANAm*. Since *ANAm* is the suffix appears in the plural form of genitive case of the words which ends with the vowel 'a', letter 'a' is appended to the stem, i.e. *sarp* to make *sarpa*, a head-word (the words that are available in database or dictionary are known as head-words) with masculine gender.

The database is searched for the word *sarpa*. If the word is available in database, then its corresponding Telugu meaning is fetched and it is modified to genitive case according to the grammar rules of Telugu. If the word *sarpa* is not available in database, then the last letter 'a' is replaced with 'A' and then searched, since, there are chances that the declensions might be of feminine gender. For instance, the declension *ushANAm* also have the suffix *ANAm* in it and is identified as genitive case. It is segmented as *ush + ANAm*. If the stem is morphed as *usha* and searched in database, it will not be available because the declension is the genitive case of feminine gender. Hence the stem has to be made the head word of feminine gender by appending 'A'. The stem becomes '*ushA*' by appending 'A' to it and *ushA* available in database.

Tables from B1 through B7 of Appendix A describe the morphological process to morph a corrupted stem into a head-word by appending various characters according to the gender. The inflection that is mentioned in parenthesis has to be replaced with the character mentioned after the symbol '+' in the tables.

4. CONCLUSION

Though majority of declensions of nouns are formed as per the grammar rules of Sanskrit with the affixes that are mentioned in Table 2, few are not formed because of various reasons. Moreover there is ambiguity in understanding the declensions, for instance, dual form of nominative and accusative cases uses the same affix '*aW*', plural form of nominative and accusative cases uses the same affix '*as*', dual form of instrumental, dative and ablative cases uses the same affix '*bhyAM*', plural form of dative and ablative cases uses the same affix '*bhyas*', singular form of ablative and genitive use the same affix '*as*', dual form of genitive and locative cases use the same affix '*Os*'.

To avoid the structural ambiguity, only one case is considered and the remaining cases are ignored in Machine Translation. A more powerful system that preserves the context may translate the sentence with more accuracy.

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Annexure A

Table A1: Masculine declensions of words that end with the vowel 'a'(e.g. rAma) and 'i' (e.g. hari)

Case	Singular			Dual			Plural			Singular			Dual			Plural		
	Stem	Inflection	len	Stem	Inflection	len	Stem	Inflection	len	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len
Nom.	rAm	aH	2	rAm	W	1	rAm	AH	2	har	iH	2	har	I	1	har	ayah	4
Acc.	rAm	am	2	rAm	W	1	rAm	An	2	har	im	2	har	I	1	har	In	2
Ins.	rAm	ENa	3	rAm	AbhyAM	6	rAm	YH	2	har	iNA	3	har	ibhyAM	6	har	ibhiH	5
Dat.	rAm	Aya	3	rAm	AbhyAM	6	rAm	EbhyaH	6	har	ayE	3	har	ibhyAM	6	har	ibhyaH	6
Abl.	rAm	At	2	rAm	AbhyAM	6	rAm	EbhyaH	6	har	EH	2	har	ibhyAM	6	har	ibhyaH	6
Gen.	rAm	Asya	4	rAm	ayOH	4	rAm	ANAm	4	har	EH	2	har	yOH	3	har	INAm	4
Loc.	rAm	E	1	rAm	ayOH	4	rAm	Eshu	5	har	W	1	har	yOH	3	har	Ishu	5

Table A2: Masculine declensions of words that end with the vowel 'u'(e.g. guru) and 'R' (e.g. dAtR)

Case	Singular			Dual			Plural			Singular			Dual			Plural		
	Stem	Inflection	len	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len
Nom	gur	uH	2	gur	U	1	Gur	avaH	4	dAt	A	1	dAt	ArW	3	dAt	AraH	4
Acc.	gur	um	2	gur	U	1	Gur	Un	2	dAt	AraM	4	dAt	ArW	3	dAt	Run	3
Ins.	gur	uNA	3	gur	ubhyAM	6	Gur	ubhiH	5	dAt	rA	2	dAt	RbhyAM	6	dAt	RbhiH	5
Dat.	gur	avE	3	gur	ubhyAM	6	Gur	ubhyaH	6	dAt	rE	2	dAt	RbhyAM	6	dAt	RbhyaH	6
Abl.	gur	OH	2	gur	ubhyAM	6	gur	ubhyaH	6	dAt	uH	2	dAt	RbhyAM	6	dAt	RbhyaH	6
Gen.	gur	OH	2	gur	vOH	3	gur	UNAm	4	dAt	uH	2	dAt	rOH	3	dAt	RuNAm	5
Loc.	gur	W	1	gur	vOH	3	gur	Ushu	5	dAt	Ari	3	dAt	rOH	3	dAt	Rshu	3

Table A3: Masculine declensions of words that end with the vowel 'Y', e.g. rY

Case	Singular			Dual			Plural			Singular			Dual			Plural		
	Stem	Inflection	len	Stem	Inflection	len	Stem	Inflection	Len	Stem	Inflection	len	Stem	Inflection	len	Stem	Inflection	Len
Nom.	R	AH	2	rAy	W	1	rAy	aH	2	G	WH	2	G	AvW	3	g	AvaH	4
Acc.	rAy	Am	2	rAy	W	1	rAy	aH	2	G	Am	2	G	AvW	3	g	AH	2
Ins.	rAy	A	1	rAy	AbhyAM	6	r	AbhiH	5	G	avA	3	G	ObhyAM	6	g	ObhiH	5
Dat.	rAy	E	1	rAy	AbhyAM	6	r	AbhyaH	6	G	avE	3	G	ObhyAM	6	g	ObhyaH	6
Abl.	rAy	aH	2	rAy	AbhyAM	6	r	AbhyaH	6	G	OH	2	G	ObhyAM	6	g	ObhyaH	6
Gen.	rAy	aH	2	rAy	OH	2	r	AyAm	4	G	OH	2	G	avOH	4	g	avAm	4
Loc.	rAy	I	1	rAy	OH	2	r	Asu	3	G	Avi	3	G	avOH	4	g	Oshu	5

Table A4: Masculine declensions of words that end with the vowel 'W', e.g. glW

Case	Singular			Dual			Plural		
	Stem	Inflection	len	Stem	Inflection	len	Stem	Inflection	Len
Nom.	gl	WH	2	Gl	AvW	3	gl	AvaH	4
Acc.	gl	Avam	4	Gl	AvW	3	gl	AvaH	4
Ins.	gl	AvA	3	Gl	WbhyAM	6	gl	WbhiH	5

Case	Singular			Dual			Plural		
	Stem	Inflection	len	Stem	Inflection	len	Stem	Inflection	Len
Dat.	<i>gl</i>	<i>AvE</i>	3	<i>Gl</i>	<i>WbhyAM</i>	6	<i>gl</i>	<i>WbhyaH</i>	6
Abl.	<i>gl</i>	<i>AvaH</i>	4	<i>Gl</i>	<i>WbhyAM</i>	6	<i>gl</i>	<i>WbhyaH</i>	6
Gen.	<i>gl</i>	<i>AvaH</i>	4	<i>Gl</i>	<i>AvOH</i>	4	<i>gl</i>	<i>AvAm</i>	4
Loc.	<i>gl</i>	<i>Avi</i>	3	<i>Gl</i>	<i>AvOH</i>	4	<i>gl</i>	<i>Wshu</i>	3

Table A5: Feminine declensions of words that end with the vowel 'A' (e.g. *ramA*) and 'I' (e.g. *nadI*)

Case	Singular			Dual			Plural			Singular			Dual			Plural		
	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len
Nom.	<i>ram</i>	<i>A</i>	1	<i>ram</i>	<i>E</i>	1	<i>Ram</i>	<i>AH</i>	2	<i>nad</i>	<i>I</i>	1	<i>nad</i>	<i>yW</i>	2	<i>Nad</i>	<i>yaH</i>	3
Acc.	<i>ram</i>	<i>Am</i>	2	<i>ram</i>	<i>E</i>	1	<i>Ram</i>	<i>AH</i>	2	<i>nad</i>	<i>Im</i>	2	<i>nad</i>	<i>yW</i>	2	<i>Nad</i>	<i>IH</i>	2
Ins.	<i>ram</i>	<i>ayA</i>	3	<i>ram</i>	<i>AbhyAM</i>	6	<i>Ram</i>	<i>AbhiH</i>	5	<i>nad</i>	<i>yA</i>	2	<i>nad</i>	<i>IbhyAM</i>	6	<i>Nad</i>	<i>IbhiH</i>	5
Dat.	<i>ram</i>	<i>AyY</i>	3	<i>ram</i>	<i>AbhyAM</i>	6	<i>Ram</i>	<i>AbhyaH</i>	6	<i>nad</i>	<i>yY</i>	2	<i>nad</i>	<i>IbhyAM</i>	6	<i>Nad</i>	<i>IbhyaH</i>	6
Abl.	<i>ram</i>	<i>AyAH</i>	4	<i>ram</i>	<i>AbhyAM</i>	6	<i>Ram</i>	<i>AbhyaH</i>	6	<i>nad</i>	<i>yAH</i>	3	<i>nad</i>	<i>IbhyAM</i>	6	<i>Nad</i>	<i>IbhyaH</i>	6
Gen.	<i>ram</i>	<i>AyAH</i>	4	<i>ram</i>	<i>ayOH</i>	4	<i>Ram</i>	<i>ANAm</i>	4	<i>nad</i>	<i>yAH</i>	3	<i>nad</i>	<i>yOH</i>	3	<i>Nad</i>	<i>InAm</i>	4
Loc.	<i>ram</i>	<i>AyAm</i>	4	<i>ram</i>	<i>ayOH</i>	4	<i>Ram</i>	<i>Asu</i>	3	<i>nad</i>	<i>yAm</i>	3	<i>nad</i>	<i>yOH</i>	3	<i>Nad</i>	<i>Ishu</i>	3

Table A6: Feminine declensions of words that end with the vowel 'U', e.g. *vadhU*

Case	Singular			Dual			Plural			Singular			Dual			Plural		
	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len	Stem	Inflection	Len
Nom.	<i>vadh</i>	<i>UH</i>	2	<i>vadh</i>	<i>vW</i>	2	<i>vadh</i>	<i>vaH</i>	3	<i>mAt</i>	<i>A</i>	1	<i>mAt</i>	<i>arW</i>	3	<i>mAt</i>	<i>araH</i>	4
Acc.	<i>vadh</i>	<i>Um</i>	2	<i>vadh</i>	<i>vW</i>	2	<i>vadh</i>	<i>UH</i>	2	<i>mAt</i>	<i>aram</i>	4	<i>mAt</i>	<i>arW</i>	3	<i>mAt</i>	<i>RuH</i>	3
Ins.	<i>vadh</i>	<i>vA</i>	2	<i>vadh</i>	<i>UbhyAM</i>	6	<i>vadh</i>	<i>UbhiH</i>	5	<i>mAt</i>	<i>rA</i>	2	<i>mAt</i>	<i>RbhyAM</i>	6	<i>mAt</i>	<i>RbhiH</i>	5
Dat.	<i>vadh</i>	<i>vY</i>	2	<i>vadh</i>	<i>UbhyAM</i>	6	<i>vadh</i>	<i>UbhyaH</i>	6	<i>mAt</i>	<i>rE</i>	2	<i>mAt</i>	<i>RbhyAM</i>	6	<i>mAt</i>	<i>RbhyaH</i>	6
Abl.	<i>vadh</i>	<i>vAH</i>	3	<i>vadh</i>	<i>UbhyAM</i>	6	<i>vadh</i>	<i>UbhyaH</i>	6	<i>mAt</i>	<i>uH</i>	2	<i>mAt</i>	<i>RbhyAM</i>	6	<i>mAt</i>	<i>RbhyaH</i>	6
Gen.	<i>vadh</i>	<i>vAH</i>	3	<i>vadh</i>	<i>vOH</i>	3	<i>vadh</i>	<i>UnAm</i>	4	<i>mAt</i>	<i>uH</i>	2	<i>mAt</i>	<i>rOH</i>	3	<i>mAt</i>	<i>RuNAm</i>	5
Loc.	<i>vadh</i>	<i>vAm</i>	3	<i>vadh</i>	<i>vOH</i>	3	<i>vadh</i>	<i>Ushu</i>	3	<i>mAt</i>	<i>ari</i>	3	<i>mAt</i>	<i>rOH</i>	3	<i>mAt</i>	<i>Rshu</i>	3

Table A7: Neuter declensions of words that end with the vowel 'a', e.g. *phala*

Case	Singular			Dual			Plural			Singular			Dual			Plural		
	Stem	Inflection	len	Stem	Inflection	len	Stem	Inflection	Len	Stem	Inflection	len	Stem	Inflection	len	Stem	Inflection	Len
Nom.	<i>phal</i>	<i>am</i>	2	<i>Phal</i>	<i>E</i>	1	<i>phal</i>	<i>Ani</i>	3	<i>vAr</i>	<i>I</i>	1	<i>vAr</i>	<i>iNI</i>	3	<i>vAr</i>	<i>iNi</i>	3
Acc.	<i>phal</i>	<i>am</i>	2	<i>Phal</i>	<i>E</i>	1	<i>phal</i>	<i>Ani</i>	3	<i>vAr</i>	<i>I</i>	1	<i>vAr</i>	<i>iNI</i>	3	<i>vAr</i>	<i>iNi</i>	3
Ins.	<i>phal</i>	<i>ENa</i>	3	<i>Phal</i>	<i>AbhyAM</i>	6	<i>phal</i>	<i>YH</i>	2	<i>vAr</i>	<i>iNA</i>	3	<i>vAr</i>	<i>ibhyAM</i>	6	<i>vAr</i>	<i>ibhiH</i>	5
Dat.	<i>phal</i>	<i>Aya</i>	3	<i>Phal</i>	<i>AbhyAM</i>	6	<i>phal</i>	<i>EbhyaH</i>	6	<i>vAr</i>	<i>iNE</i>	3	<i>vAr</i>	<i>ibhyAM</i>	6	<i>vAr</i>	<i>ibhyaH</i>	6
Abl.	<i>phal</i>	<i>At</i>	2	<i>Phal</i>	<i>AbhyAM</i>	6	<i>phal</i>	<i>EbhyaH</i>	6	<i>vAr</i>	<i>iNaH</i>	4	<i>vAr</i>	<i>ibhyAM</i>	6	<i>vAr</i>	<i>ibhyaH</i>	6
Gen.	<i>phal</i>	<i>asya</i>	4	<i>Phal</i>	<i>ayOH</i>	4	<i>phal</i>	<i>ANAm</i>	4	<i>vAr</i>	<i>iNaH</i>	4	<i>vAr</i>	<i>iNOH</i>	4	<i>vAr</i>	<i>INAm</i>	4
Loc.	<i>phal</i>	<i>E</i>	1	<i>Phal</i>	<i>ayOH</i>	4	<i>phal</i>	<i>Eshu</i>	3	<i>vAr</i>	<i>iNi</i>	3	<i>vAr</i>	<i>iNOH</i>	4	<i>vAr</i>	<i>Ishu</i>	3

Table A8: Neuter declensions of words that end with the vowel 'u', e.g. madhu

Case	Singular			Dual			Plural		
	Stem	Inflection	len	Stem	Inflection	len	Stem	Inflection	Len
Nom.	madh	U	1	madh	unI	3	madh	Uni	3
Acc.	madh	U	1	madh	unI	3	madh	Uni	3
Ins.	madh	unA	3	madh	ubhyAM	6	madh	ubhiH	5
Dat.	madh	unE	3	madh	ubhyAM	6	madh	ubhyaH	6
Abl.	madh	unaH	4	madh	ubhyAM	6	madh	ubhyaH	6
Gen.	madh	unaH	4	madh	unOH	4	madh	UnAm	4
Loc.	madh	Uni	3	madh	unOH	4	madh	Ushu	3

Table B1: Suffices and possible appending characters of stem for Nominative case

S.No	Suffix	Affix	Singular (S)	Dual (D)	Plural (P)	Head word
			E.g.	E.g.	E.g.	
1.	aH/ W/ AH	a/ Y*	rAm(aH)+a r(AH) + Y*	rAm(W)+a rAy(W)+Y*	rAm(AH)+a rAy(aH)+Y* ram(AH) + A	rAma rY ramA
2.	iH/ I/ arayaH	i	har(iH)+i	har(I)+i	har(ayah)+i	hari
3.	uH/ U/ avaH	u	gur(uH)+u	gur(U)+u madh(U)+u	gur(avaH)+u	guru madhu
4.	A/ ArW/ AraH	R/ A	dAt(A)+R ram(A) + A mAt(A)+R	dAt(ArW)+R	dAt(AraH)+R - -	dAtR ramA mAtR
5.	WH/ AvW/ AvaH	O/W	g(WH) + O gl(WH)+W	g(AvW)+O gl(AvW)+W	g(AyaH)+O gl(AvaH)+W	gO glW
6.	A/E/AH	A/a	See S.No.4 (S)	ram(E) + A phal(E)+a	See S.No.1(P)	ramA phal
7.	I/ yW/ yaH	I/i	nad(I) + I vAr(I)+i	nad(yW)+I	nad(yaH)+I	nadI vAri
8.	UH/ vW/ vaH	U	vadh(UH)+U	vadh(vW)+U	vadh(vaH)+I	vadhU
9.	A/ arW/ araH	R	See S.No.4 (S)	mAt(arW)+R	mAt(araH)+R	matR
10.	am/ E/ Ani	a	phal(am)+a	See S.No.6 (D)	phal(Ani)+a	phala
11.	I/ iNI/ iNi	i	See S.No.7 (S)	vAr(iNI)+i	vAr(iNi)+i	vAri
12.	U/ unI/ Uni	u	See S.No.3 (D)	madh(unI)+u	madh(Uni)+u	madhu

*Y is affixed to stem if the length of stem is one or Y is replaced with 'Ay' when last two letters of stem = 'Ay'

Table B2: Suffices and possible appending characters of stem for Accusative case

S.No	Suffix	Affix	Singular (S)	Dual (D)	Plural (P)	Head word
			E.g.	E.g.	E.g.	
1.	am/ W/ An	a/ Y*	rAm(am)+a rAy(am)+Y*	rAm(W)+a	rAm(An)+a	rAma rY

S.No	Suffix	Affix	Singular (S)	Dual (D)	Plural (P)	Head word
			E.g.	E.g.	E.g.	
2.	<i>im/ I/ In</i>	<i>i</i>	<i>har(im)+i</i>	<i>har(I)+i</i>	<i>har(In)+i</i>	<i>hari</i>
3.	<i>um/ U/ Un</i>	<i>u</i>	<i>gur(um)+u</i>	<i>gur(U)+u</i>	<i>gur(Un)+u</i>	<i>guru</i>
4.	<i>Aram/ ArW/ Run</i>	<i>R</i>	<i>dAt(Aram)+R</i>	<i>dAt(ArW)+R</i>	<i>dAt(Run)+R</i>	<i>dAtR</i>
5.	<i>am/ W/ aH</i>	<i>Y*</i>	See SNo. 1(S)	<i>rAy(W)+Y*</i>	<i>rAy(aH)+Y*</i>	<i>rY</i>
6.	<i>Am/ AvW/ AH</i>	<i>O</i>	<i>g(Am)+O</i>	<i>g(AvW)+O</i>	<i>g(AH)+O</i>	<i>gO</i>
7.	<i>Avam/ AvW/ AvaH</i>	<i>W</i>	<i>gl(Avam)+W</i>	<i>gl(AvW)+W</i>	<i>gl(AvaH)+W</i>	<i>glW</i>
8.	<i>Am/ E/ AH</i>	<i>A</i>	<i>ram(Am)+A</i>	<i>ram(E)+A</i>	<i>ram(AH)+A</i>	<i>ramA</i>
9.	<i>Im/ yW/ IH</i>	<i>I</i>	<i>nad(Im)+I</i>	<i>nad(yW)+I</i>	<i>nad(IH)+I</i>	<i>nadI</i>
10.	<i>Um/ vW/ UH</i>	<i>U</i>	<i>vadh(Um)+U</i>	<i>vadh(vW)+U</i>	<i>vadh(UH)+U</i>	<i>vadhU</i>
11.	<i>aram/arW/RuH</i>	<i>R</i>	<i>mat(aram)+R</i>	<i>mat(arW)+R</i>	<i>mat(RuH)+R</i>	<i>matR</i>
12.	<i>am/ E/ Ani</i>	<i>a</i>	<i>phal(am)+a</i>	<i>phal(E)+a</i>	<i>phal(Ani)+a</i>	<i>phala</i>
13.	<i>U/ uni/ Uni</i>	<i>u</i>	<i>madh(U)+u</i>	<i>madh(uni)+u</i>	<i>madh(Uni)+u</i>	<i>madhu</i>

Table B3: Suffices and possible appending characters of stem for Instrumental case

S.No	Suffix	Afx	Singular (S)	Dual (D)	Plural (P)	Head word
			E.g.	E.g.	E.g.	
1.	<i>ENa/ AbhyAM/ YH</i>	<i>a/ A/ Y*</i>	<i>rAm(ENa)+a</i>	<i>rAm(AbhyAM)+a</i> <i>r(AbhyAM)+Y*</i>	<i>rAm(YH)+a</i> -	<i>rAma</i> <i>rY</i>
2.	<i>iNA/ inA/ ibhyAM/ibhiH</i>	<i>i</i>	<i>hari(iNA)+i</i>	<i>hari(ibhyAM)+i</i>	<i>hari(ibhiH)+i</i>	<i>hari</i>
3.	<i>uNA/unA/ ubhyAM/ubhiH</i>	<i>u</i>	<i>gur(uNA)+u</i>	<i>gur(bhyAM)+u</i>	<i>gur(ubhiH)+u</i>	<i>guru</i>
4.	<i>rA/RbhyAM/ RbhiH</i>	<i>R</i>	<i>dat(rA)+R</i>	<i>dat(RbhyAM)+R</i>	<i>dat(RbhiH)+R</i>	<i>dAtR</i>
5.	<i>A/ AbhyAM/ AbhiH</i>	<i>Y*</i>	<i>r(A)+Y*</i>	See S.No.1 (D)	<i>r(AbhiH)+Y*</i>	<i>rY</i>
6.	<i>avA/ ObhyAM/ ObhiH</i>	<i>O</i>	<i>g(avA)+O</i>	<i>g(ObhyAM)+O</i>	<i>g(ObhiH)+O</i>	<i>gO</i>
7.	<i>AvA/ WbhyAM/ WbhiH</i>	<i>W</i>	<i>gl(AvA)+W</i>	<i>gl(WbhyAM)+W</i>	<i>gl(WbhiH)+W</i>	<i>glW</i>
8.	<i>ayA/ AbhyAM/ AbhiH</i>	<i>A</i>	<i>ram(ayA)+A</i>	<i>ram(AbhyAM)+A</i>	<i>ram(AbhiH)+A</i>	<i>ramA</i>
9.	<i>yA/ IbhyAM/ IbhhiH</i>	<i>I</i>	<i>nad(yA)+I</i>	<i>nad(IbhyAM)+I</i>	<i>nad(IbhiH)+I</i>	<i>nadI</i>
10.	<i>vA/ UbhyAM/ UbhiH</i>	<i>U</i>	<i>vadh(vA)+U</i>	<i>vadh(UbhyAM)+U</i>	<i>vadh(UbhiH)+U</i>	<i>vadhU</i>

Table B4: Suffices and possible appending characters of stem for Dative case

S.No	Suffix	Affix	Singular (S)	Dual (D)	Plural (P)	Head word
			E.g.	E.g.	E.g.	
1.	<i>Aya/AbhyAM/ EbhyaH</i>	<i>a</i>	<i>rAm(Aya)+a</i>	<i>rAm(AbhyAM)+a</i>	<i>rAm(EbhyaH)+a</i>	<i>rAma</i>
2.	<i>ayE/ibhyAM/ ibhyaH</i>	<i>i</i>	<i>har(ayE)+i</i>	<i>har(ibhyAM)+i</i>	<i>har(ibhyaH)+i</i>	<i>hari</i>
3.	<i>avE/ubhyAM/ ubhyaH</i>	<i>u</i>	<i>gur(avE)+u</i>	<i>gur(ubhyAM)+u</i>	<i>gur(ubhyaH)+u</i>	<i>guru</i>
4.	<i>rE/ RbhyAM/ RbhyaH</i>	<i>R</i>	<i>dat(rE)+R</i>	<i>dat(RbhyAM)+R</i>	<i>dat(RbhyaH)+R</i>	<i>dAtR</i>
5.	<i>E/ AbhyAM/ AbhyaH</i>	<i>Y*</i>	<i>ray(E)+Y*</i>	<i>ray(AbhyAM)+Y*</i>	<i>ray(AbhyaH)+Y*</i>	<i>rY</i>
6.	<i>avE/ ObhyAM/ ObhyaH</i>	<i>O</i>	<i>g(avE)+O</i>	<i>g(ObhyAM)+O</i>	<i>g(ObhyaH)+O</i>	<i>gO</i>
7.	<i>AvE/ WbhyAM/ WbhyaH</i>	<i>W</i>	<i>gl(AvE)+W</i>	<i>gl(WbhyAM)+W</i>	<i>gl(WbhyaH)+W</i>	<i>glW</i>

S.No	Suffix	Affix	Singular (S)	Dual (D)	Plural (P)	Head word
			E.g.	E.g.	E.g.	
8.	<i>AyY/ AbhyAM/ AbhyaH</i>	<i>A</i>	<i>ram(AyY)+A</i>	<i>ram(AbhyAM)+A</i>	<i>ram(AbhyaH)+A</i>	<i>ramA</i>
9.	<i>yY/ IbhyAM/ IbhyaH</i>	<i>I</i>	<i>nad(yY)+I</i>	<i>nad(IbhyAM)+I</i>	<i>nad(IbhyaH)+I</i>	<i>nadI</i>
10.	<i>vY/UbhyAM/ UbhyaH</i>	<i>U</i>	<i>vadh(vY)+U</i>	<i>vadh(UbhyAM)+U</i>	<i>vadh(UbhyaH)+U</i>	<i>vadhU</i>
11.	<i>inE/ iNE/ ibhyAM/ibhyaH</i>	<i>i</i>	<i>vAr(iNE)+i</i>	<i>vAr(ibhyAM)+i</i>	<i>vAr(ibhyaH)+i</i>	<i>vAri</i>
12.	<i>unE/ ubhyAM/ ubhyaH</i>	<i>u</i>	<i>madh(unE)+u</i>	<i>madh(ubhyAM)+u</i>	<i>madh(ubhyaH)+u</i>	<i>madhu</i>

Table B5: Suffices and possible appending characters of stem for Ablative case

S.No	Suffix	Affix	Singular (S)	Dual (D)	Plural (P)	Head word
			E.g.	E.g.	E.g.	
1.	<i>At/ AbhyAM/ EbhyaH</i>	<i>a</i>	<i>ram(At)+a</i>	<i>ram(AbhyAM)+a</i>	<i>ram(EbhyaH)+a</i>	<i>rAma</i>
2.	<i>EH/ibhyAM/ ibhyaH</i>	<i>i</i>	<i>har(EH)+i</i>	<i>har(ibhyAM)+i</i>	<i>har(ibhyaH)+i</i>	<i>hari</i>
3.	<i>OH/ubhyAM/ ubhyaH</i>	<i>u</i>	<i>gur(OH)+u</i>	<i>gur(ubhyAM)+u</i>	<i>gur(ubhyaH)+u</i>	<i>guru</i>
4.	<i>uH/RbhyAM/ RbhyaH</i>	<i>R</i>	<i>dAt(uH)+R</i>	<i>dAt(RbhyAM)+R</i>	<i>dAt(RbhyaH)+R</i>	<i>dAtR</i>
5.	<i>aH/ AbhyAM/ abhyaH</i>	<i>Y*</i>	<i>ray(aH)+Y*</i>	<i>ray(AbhyAM)+Y*</i>	<i>ray(abhyaH)+Y*</i>	<i>rY</i>
6.	<i>OH/ObhyAM/ ObhyaH</i>	<i>O</i>	<i>g(OH)+O</i>	<i>g(ObhyAM)+O</i>	<i>g(ObhyaH)+O</i>	<i>gO</i>
7.	<i>AvaH/WbhyAM/ WbhyaH</i>	<i>W</i>	<i>gl(AvaH)+W</i>	<i>gl(WbhyAM)+W</i>	<i>gl(WbhyaH)+W</i>	<i>glW</i>
8.	<i>AyAH/AbhyAM/ AbhyaH</i>	<i>A</i>	<i>ram(AyAH)+A</i>	<i>ram(AbhyAM)+A</i>	<i>ram(AbhyaH)+A</i>	<i>ramA</i>
9.	<i>yAH/IbhyAM/ IbhyaH</i>	<i>I</i>	<i>nad(yAH)+I</i>	<i>nad(IbhyAM)+I</i>	<i>nad(IbhyaH)+I</i>	<i>nadI</i>
10.	<i>vAH/UbhyAM/ UbhyaH</i>	<i>U</i>	<i>vadh(vAH)+U</i>	<i>vadh(UbhyAM)+U</i>	<i>vadh(UbhyaH)+U</i>	<i>vadhU</i>
11.	<i>iNaH/ibhyAM/ ibhyaH</i>	<i>i</i>	<i>vAr(iNaH)+i</i>	<i>vAr(ibhyAM)+i</i>	<i>vAr(ibhyaH)+i</i>	<i>vAri</i>
12.	<i>unaH/ubhyAM/ ubhyaH</i>	<i>u</i>	<i>madh(unaH)+u</i>	<i>madh(ubhyAM)+u</i>	<i>madh(ubhyaH)+u</i>	<i>madhu</i>

Table B6: Suffices and possible appending characters of stem for Genitive case

S.No	Suffix	Afx	Singular (S)	Dual (D)	Plural (P)	Head word
			E.g.	E.g.	E.g.	
1.	<i>asya/ayOH, ANAm/ AnAm</i>	<i>a</i>	<i>rAm(asya)+a</i>	<i>rAm(ayOH)+a</i>	<i>rAm(ANAm)+a</i>	<i>rAma</i>
2.	<i>EH/yOH/INAm/InAm</i>	<i>i</i>	<i>har(EH)+i</i>	<i>har(yOH)+i</i>	<i>har(INAm)+i</i>	<i>hari</i>
3.	<i>OH/vOH/UNAm/ UnAm</i>	<i>U</i>	<i>gur(OH)+u</i>	<i>gur(vOH)+u</i>	<i>gur(UNAm)+u</i>	<i>guru</i>
4.	<i>uH/rOH/ RuNAm</i>	<i>R</i>	<i>dAt(uH)+R</i>	<i>dAt(rOH)+R</i>	<i>dAt(RuNAm)+R</i>	<i>dAtR</i>
5.	<i>aH/OH/AyAm</i>	<i>Y*</i>	<i>rAy(aH)+Y*</i>	<i>rAy(OH)+Y*</i>	<i>rAy(AyAm)+Y*</i>	<i>rY</i>
6.	<i>OH/ avOH/avAm</i>	<i>O</i>	<i>g(OH)+O</i>	<i>g(avOH)+O</i>	<i>g(avAm)+O</i>	<i>gO</i>
7.	<i>AvaH/AvOH/AvAm</i>	<i>W</i>	<i>gl(AvaH)+W</i>	<i>gl(AvOH)+W</i>	<i>gl(AvAm)+W</i>	<i>glW</i>
8.	<i>AyAH/ ayOH/ ANAm, AnAm</i>	<i>A</i>	<i>ram(AyAH)+A</i>	<i>ram(ayOH)+A</i>	<i>ram(ANAm)+A</i>	<i>ramA</i>
9.	<i>yAH/yOH/InAm, INAm</i>	<i>I</i>	<i>nad(yAH)+I</i>	<i>nad(yOH)+I</i>	<i>nad(InAm)+I</i>	<i>nadI</i>
10.	<i>vAH/vOH/UnAm, UNAm</i>	<i>U</i>	<i>vadh(vaH)+U</i>	<i>vadh(vOH)+U</i>	<i>vadh(UnAm)+U</i>	<i>vadhU</i>
11.	<i>inaH, iNaH/iNOH/INAm</i>	<i>i</i>	<i>vAr(iNaH)+i</i>	<i>vAr(iNOH)+i</i>	<i>vAr(INAm)+i</i>	<i>vAri</i>
12.	<i>unaH, uNaH /uNOH, unOH/ UNAm</i>	<i>u</i>	<i>madh(unaH)+u</i>	<i>madh(unOH)+u</i>	<i>madh(UNAm)+u</i>	<i>madhu</i>

Table B7: Suffices and possible appending characters of stem for Locative case

S.No	Suffix	Afx	Singular (S)	Dual (D)	Plural (P)	Head word
			E.g.	E.g.	E.g.	
1.	<i>E/ayOH/Eshu</i>	<i>a</i>	<i>rAm(E)+a</i>	<i>rAm(ayOH)+a</i>	<i>rAm(Eshu)+a</i>	<i>rAma</i>
2.	<i>W/yOH/Ishu</i>	<i>i</i>	<i>har(W)+i</i>	<i>har(yOH)+i</i>	<i>har(Eshu)+i</i>	<i>hari</i>
3.	<i>W/vOH/Ushu</i>	<i>u</i>	<i>gur(W)+u</i>	<i>gur(vOH)+u</i>	<i>gur(Ushu)+u</i>	<i>guru</i>
4.	<i>ari/rOH/Rshu</i>	<i>R</i>	<i>dAt(ari)+R</i>	<i>dAt(rOH)+R</i>	<i>dAt(Rshu)+R</i>	<i>dAtR</i>
5.	<i>i/OH/Asu</i>	<i>Y*</i>	<i>rAy(i)+Y*</i>	<i>rAy(OH)+Y*</i>	<i>rAy(Asu)+Y*</i>	<i>rY</i>
6.	<i>Avi/avOH/Oshu</i>	<i>O</i>	<i>g(Avi)+O</i>	<i>g(avOH)+O</i>	<i>g(Oshu)+O</i>	<i>gO</i>
7.	<i>Avi/AvOH/Wshu</i>	<i>W</i>	<i>gl(Avi)+W</i>	<i>gl(AvOH)+W</i>	<i>gl(Wshu)+W</i>	<i>glW</i>
8.	<i>AyAm/ayOH/Asu</i>	<i>A</i>	<i>ram(AyAm)+A</i>	<i>ram(ayOH)+A</i>	<i>ram(Asu)+A</i>	<i>ramA</i>
9.	<i>yAm/yOH/Ishu</i>	<i>I</i>	<i>nad(yAm)+I</i>	<i>nad(yOH)+I</i>	<i>nad(Ishu)+I</i>	<i>nadI</i>
10.	<i>vAm/vOH/Ushu</i>	<i>U</i>	<i>vadh(vAm)+U</i>	<i>vadh(vOH)+U</i>	<i>vadh(Ushu)+U</i>	<i>vadhU</i>
11.	<i>iNi/iNOH/Ishu</i>	<i>i</i>	<i>vAr(iNi)+i</i>	<i>vAr(iNOH)+i</i>	<i>vAr(Ishu)+i</i>	<i>vAri</i>
12.	<i>Uni/unOH/Ushu</i>	<i>u</i>	<i>madh(Uni)+u</i>	<i>madh(unOH)+u</i>	<i>madh(Ushu)+u</i>	<i>madhu</i>