Assignment 1
HUL479
Algorithms in Ancient India:Answers

February 8, 2017

1 Write the krama pāṭha and Ganapāṭha for the following string of Gayatri mantra. (10)
dhiyaḥ yaḥ na pracodayāt.

1A
- Krama pāṭha: Here consecutive words are paired and recited.
dhiyaḥ yaḥ; yaḥ na; na pracodayāt; pracodayāt iti pracodayāt
- Ghana pāṭha: Here the order is:
1 2 2 1 1 2 3 3 2 1 1 2 3; 2 3 3 2 2 3 4 4 3 2 2 3 4;...
dhiyaḥ yaḥ yaḥ dhiyaḥ dhiyaḥ yaḥ na na yaḥ dhiyaḥ dhiyaḥ yaḥ na; yaḥ na na yaḥ yaḥ na pracodayāt pracodayāt na yaḥ yaḥ na pracodayāt; na pracodayāt pracodayāt na na pracodayāt iti pracodayāt

2 Give all possible De Bruijn sequences of length 4 of binary alphabet. (20)

2A
- 0000100110101111
- 0000100111101011
- 0000101001101111
- 0000101001111011
- 0000101100111101
- 0000101101001111
- 0000101111001101
- 0000101111010011
- 0000110010111101
- 0000110100101111
- 0000110101111001
- 0000110111100101
- 0000111100101101

- 0000111101001011
- 0000111101011001
- 0000111101100101

3 Classify each akṣara in the following śloka into laghu and guru.
pratyādiṣṭam samaraśirasaḥ kāndīśībhūyanaṣṭtaṁ (5)

3A

pra	tyā	di	ṣṭam	sa	ma
G	G	G	G	L	L
ra	śi	ra	saḥ	kā	ndī
L	L	L	G	G	G
śī	bhū	ya	na	ṣṭaṁ	
G	G	L	G	G	

4 Explain Kedar Bhatt's procedure for prastāra for generating all combinations of 4 aksharas, explaining at each step how it is arrived at from the previous one. (10)

Table 1: Kedar Bhaṭṭa's algorithm

4A

G	G	G	G	start with all Gs
L	G	G	G	place L below 1st G of above line, copy remaining right bits viz. G G G as in the above line
G	**L**	G	G	place L below 1st G of above line, copy remaining right bit viz. G as in the above line, and G in the remaining place to the left of L
L	L	G	G	
G	G	**L**	G	
L	G	L	G	
G	**L**	L	G	
L	L	L	G	
G	G	G	L	
L	G	G	L	
G	**L**	G	L	
L	L	G	L	
G	G	**L**	G	
L	G	L	L	
G	**L**	L	L	
L	L	L	L	place L below 1st G of above line, copy remaining remaining right bits viz. L L as in the above line and stop the process since all are Ls.

5 Explain why Kedar Bhatt did not need any algorithm for Naṣṭa. (5)

5A Because, the erased row can be constructed from the previous row, following his algorithm.

6 List the positions of chandas with 1 laghu, 2 laghus, etc. in a prastāra of 5 syllables (10)

6A

1	2	4	8	16	32
	3	6	12	24	
	5	10	20	28	
	9	18	14	30	
	17	7	22	31	
		11	26		
		19	15		
		13	23		
		21	27		
		25	29		

7 Explain the following shloka by Bhaskaracharya describing a formula to find the sum of all permutations of n digit number. (10)
sthānāntamekādicayāṅkaghātaḥ saṃkhyāvibhedā nitaiḥ syuraṅkaiḥ .
bhakto'ṅkamityāṅkasamāsanighnaḥ sthāneṣu yukto mitisaṃyutiḥ syāt .. 261 ..

ghāḥ The product	ekādi of 1, 2, 3, ...	cayāṅka sthānāntam upto last digit of given number N
syuḥ shall be	saṃkhyāvibhedāḥ number of permutations P	niyataiḥ aṅkaiḥ of given n digits.
saḥ ghāḥ The product	nighnaḥ multiplied by	aṅkasamāsa sum of digits s
bhakta aṅkamitya divided by number of digits n,	yuktāḥ (and) result S' being filled	
sthāneṣu in places of digits	syāt shall be	mitisaṃyutiḥ sum S of all permutations.

7A See if the explanation is according to the gist of each term provided above.

8 Explain the formula given by Baudhāyana for drawing a circle of area equal to a given square. Calculate the error in the area of a circle thus drawn. (10)

8A The procedure is described in Applied+Geometry+in+SulbaSutras.pdf

9 Following the procedure of squaring a rectangle, give a series for approximate value of square root of 3 upto 4 terms. (15)

9A I would like to evaluate this question myself.

10 Find the sum of all permutations of 3 digit numbers formed with 7, 8 and 9 using Bhaskarachary's formula and verify it with actual sum. (5)

10A (7+8+9)*2*111 = 5328