Sample questions
Algorithms in Ancient India

1. Explain the following Piṅgaḷa's sūtras for calculating 2^n, for n=9. (8)
   dviḥarddhe (8.28)
   (If the number is divisible by 2, divide by 2 and write 2.)
   rūpe śūnyam (8.29)
   (If not, subtract 1, and write 0.)
   dviḥśūnye (8.30)
   (If the answer were 0, multiply by 2,)
   tāvadardhe tadguṇitam (8.31)
   (and if the answer were 2, multiply by itself)

2. Give a procedure to construct a square equal to the sum of two unequal squares. (5)

3. Find the solutions of $17x + 5 = 15y$ by Kuṭṭaka method. (7)

4. Show that $x = \frac{2a}{N-a^2}$ is a possible solution for the equation $Nx^2 + 1 = y^2$. (5)

5. Solve the equation $32x^2 + 1 = y^2$ by Cakravāla method. (10)

6. There are 8 books (A,B,C,D,E,F,G,H) that are interdisciplinary in nature. Various disciplines to which these books belong to are as shown below.

   - Discipline 1: D,E
   - Discipline 2: B,C,D,F,G,H,I
   - Discipline 3: A,B
   - Discipline 4: F,I
   - Discipline 5: C,D,E,F,G,H,I
   - Discipline 6: G,H

   (a) Is it possible to arrange these books in such a way that all the books belonging to a certain discipline are together?

   (b) If yes, in which order should they be arranged?
   If there are multiple ways of arranging them, indicate all of them.

7. Explain what is collective blocking and justify that अकः सवर्णे दीर्घः collectively blocks इको यणचि and आद् गुणः (5)
The meanings of each sūtra are given below.
a) अकः सवर्णे दीर्घः :
(When a single vowel is followed by a homogenous vowel, both are replaced by the corresponding long vowel)
b) इको यणचि, : (The semi-vowels य् व् र् ल् are the substitutes of the corresponding vowels इ उ ऋ and ऌ (long and short), when followed by a vowel) and
c) आद् गुणः :
(The final अ or आ of a preceding word and the initial vowel of the succeeding word are replaced by one of अ ए ओ)

8. Below are given a set of sūtras from Pāṇini's Aṣṭādhyāyī, in their expanded form (by borrowing the words from the previous sūtras in order to make each sūtra self sufficient in itself). The borrowed words are shown in parenthesis. Show that if we follow the factorisation as in Mathematics, we arrive at the sūtras with words excluding those in parenthesis. (10)

   - 6-1-87 ād guṇaḥ (saṃhitāyām aci ekaḥ pūrvaparayoḥ)
   - 6-1-88 vṛddhiḥ eci (saṃhitāyām ekaḥ pūrvaparayoḥ ād)
   - 6-1-89 etyedhatyūṭhsu (saṃhitāyām ekaḥ pūrvaparayoḥ ād vṛddhiḥ eci)
   - 6-1-90 āṭaḥ ca (saṃhitāyām aci ekaḥ pūrvaparayoḥ vṛddhiḥ)
   - 6-1-91 upasargāt ṛti dhātau (saṃhitāyām ekaḥ pūrvaparayoḥ ād vṛddhiḥ)
   - 6-1-92 vā supi āpiśaleḥ (saṃhitāyām ekaḥ pūrvaparayoḥ ād vṛddhiḥ upasargāt ṛti dhātau)
   - 6-1-93 ā ot amśasoḥ (saṃhitāyām aci ekaḥ pūrvaparayoḥ)
   - 6-1-94 eṅi pararūpam (saṃhitāyām ekaḥ pūrvaparayoḥ ād upasargāt dhātau)

   Explain in what way anuvṛtti is different from the factorisation in Mathematics.

9. What is a pratyāhāra? How many pratyāhāras are possible with the following śivasūtras? (7)

a i u (Ṇ)
ṛ ḷ(K)
e o (Ṇ)

ai au (C)
ha ya va ra (Ṭ)
l (Ṇ)

Is there any ambiguity in the pratyāhāras? If yes, which pratyāhāras are ambiguous?