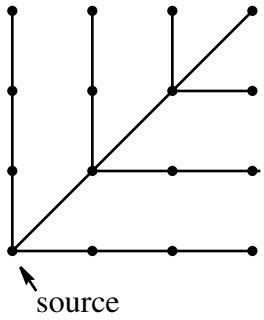
Please show your work on all questions

1. The diagram on the right shows a branching structure which distributes nutrients from the source at the lower corner to points on a square grid. Find the total length of the branches and the average distance of each point from the source. Show your working.



Let each horizontal or vertical edge be one unit. Then each diagonal section will be $\sqrt{2}$ units. Therefore, the total length will be

$$3+3+2+2+1+1+3\sqrt{2} = 12+3\sqrt{2} \approx 16.24 \text{ units},$$

where in calculating this sum we add the branches first and then the stem. For the average distance we must sum up the distance of each point from the source and divide by the number of points. There are 15 points not counting the source. The sum of the distances is

$$2(1+2+3)+2(1+\sqrt{2}+2+\sqrt{2})+2(1+2\sqrt{2})+\sqrt{2}+2\sqrt{2}+3\sqrt{2} = 20+14\sqrt{2} \text{ units},$$

where in calculating this sum we make use of the symmetric distribution of the branches and added the distances for the points on the branches first and then the points on the stem. The average is $(20+14\sqrt{2})/15 \approx 2.65$ units.

2. Suppose the primordia of a flower emerge and grow out radially with a constant divergence of angle of 70^o.

   (a) Write the angle 70^o as a fraction of a complete revolution in simplest terms.
   $\frac{70}{360} = \frac{7}{36}$, so 70^o is $\frac{7}{36}$ of a revolution.

   (b) How many straight line parastichies would emerge in this growth pattern?
   There will be 36 straight parastichies.

   (c) Express the fraction in part (a) as a continued fraction.
   $\frac{7}{36} = \frac{1}{\frac{36}{7}} = \frac{1}{5+\frac{1}{7}}$

   (d) Find an approximation to the continued fraction and hence write down how many curved parastichies you would expect to see.
   $\frac{1}{5+\frac{1}{7}} \approx \frac{1}{5}$ so there will be five curved parastichies.