Problem 4

We need to have a space-division switch with 1000 inputs and outputs.
What is the total number of crosspoints in each of the following cases?
a. Using one single crossbar.
b. Using a multi-stage switch based on the Clos criteria

Ans:-

a. Total crosspoints $= N^2 = 1000^2 =$ ***1,000,000***

b. Total crosspoints $= 4N[\sqrt{2N} - 1] \geq$ ***174,886. With less than 200,000 crosspoints we can design a three-stage switch.***

We can use $n = \left(\sqrt{\frac{N}{2}}\right) = 23$ ***and choose*** $k = (2n - 1) = 45$

The total number of crosspoints is 178,200

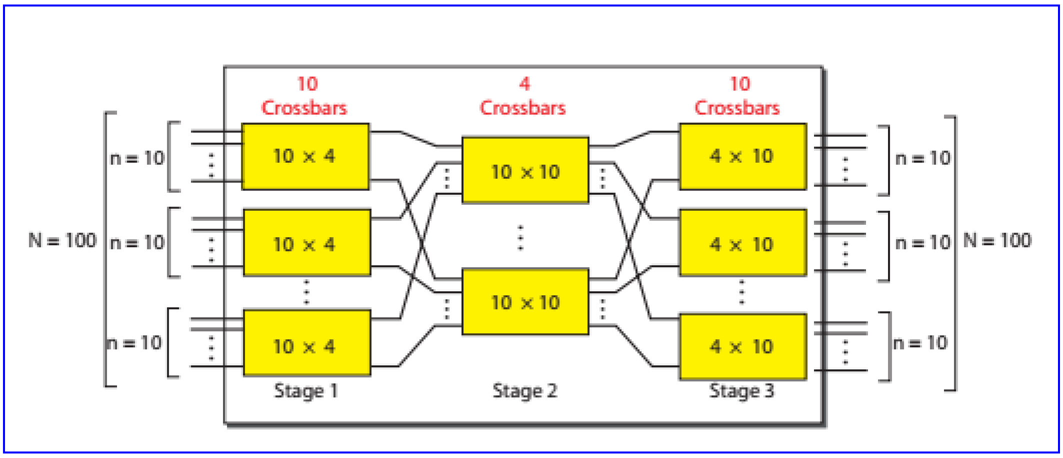
Problem 5)

We need a three-stage space-division switch with N =100.
We use 10 crossbars at the first and third stages and 4 crossbars at the middle stage.
a. Draw the configuration diagram.
b. Calculate the total number of crosspoints.
c. Find the possible number of simultaneous connections.
d. Find the possible number of simultaneous connections if we use one single crossbar (100 x 100).
e. Find the blocking factor, the ratio of the number of connections in c and in d.

Ans:-

a. See Figure 8.1.

Figure 8.1 *Solution to* **Problem 5**



b. The total number of crosspoints are

Number of crosspoints = 10 (10 × 4) + 4 (10 × 10) + 10 (4 × 10) = 1200

c. Only four simultaneous connections are possible for each crossbar at the first stage.

This means that the total number of simultaneous connections is 40.

d. If we use one crossbar (100 × 100), all input lines can have a connection at the same time,

which means 100 simultaneous connections.

e. The blocking factor is 40/100 or 40 percent.

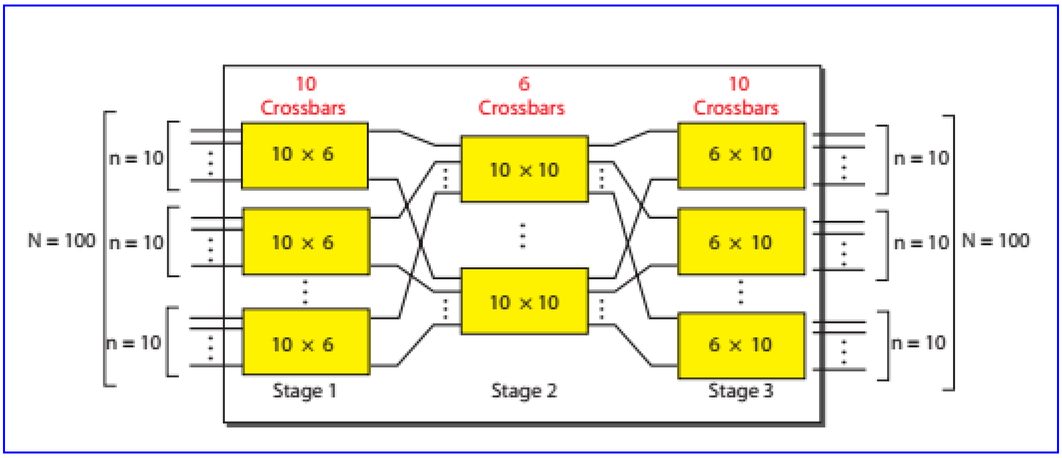
Problem 6))

Repeat problem 5 if we use 6 crossbars at the middle stage.

Ans:-

a. See Figure 8.2.

Figure 8.2 *Solution to* **Problem 6**



b. The total number of crosspoints are

Number of crosspoints = 10 (10 × 6) + 6 (10 × 10) + 10 (6 × 10) = **1800**

c. Only six simultaneous connections are possible for each crossbar at the first stage. This means that the total number of simultaneous connections is **60**.

d. If we use one crossbar (100 × 100), all input lines can have a connection at the same time, which means **100** simultaneous connections.

e. The blocking factor is 60/100 or ***60 percent.***

Problem 7)

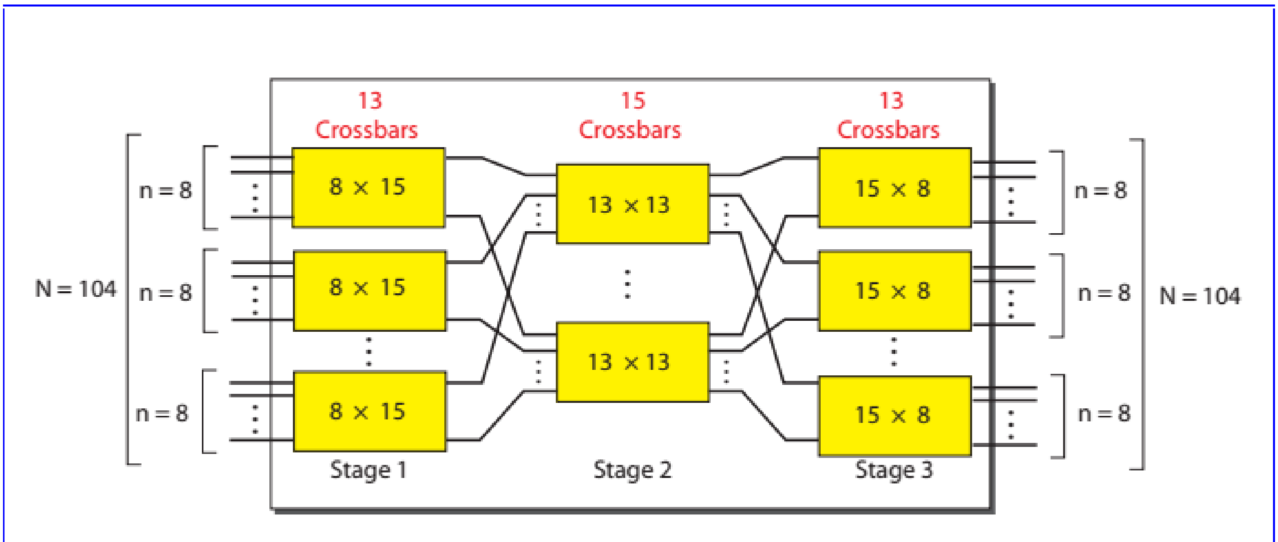
Redesign the configuration of **problem 5** using the Clos criteria.

Ans:-

According to Clos, $\boldsymbol{n} = \left(\sqrt{\frac{N}{2}}\right) = \mathbf{7.07}$, We can choose n = 8.

The number of crossbars in the first stage can be 13 (to have similar crossbars). Some of the input lines can be left unused. We then have $k = 2n - 1 = 15$. Figure 8.3 shows the configuration.

Figure 8.3 *Solution to* **Problem 7**



We can calculate the total number of crosspoints as 13 (8 × 15) + 15 (13 × 13) + 13 (15 × 8) = ***5655***

The number of crosspoints is still much less than the case with one crossbar (10,000).

We can see that there is no blocking involved because each 8 input line has 15 intermediate crossbars.

The total number of crosspoints here is a little greater than the minimum number of crosspoints according to Clos using the formula, $4N[\sqrt{2N}-1]$, which is 5257.

Problem 8)
We need a three-stage time-space-time switch with N = 100.
We use 10 TSIs at the first and third stages and 4 crossbars at the middle stage.
a. Draw the configuration diagram.
b. Calculate the total number of crosspoints.
c. Calculate the total number of memory locations we need for the TSIs
Ans:-
We give two solutions.
Solution a.
We first solve the problem using only crossbars and then we replace the crossbars at the first and the last stage with TSIs. Figure 8.1 shows the solution using only crossbars.
We can replace the crossbar at the first and third stages with TSIs as shown in Figure 8.2.
The total number of crosspoints is ***400*** and the total number of memory locations is ***200***.
Each TSI at the first stage needs one TDM multiplexer and one TDM demultiplexer.
The multiplexer is 10 × 1, but the demultiplexer is 1 × 4. In other words, the input frame has 10 slots and the output frame has only 4 slots.
The data in the first slot of all input TSIs are directed to the first switch, the output in the second slot are directed to the second switch, and so on.

Figure 8.1

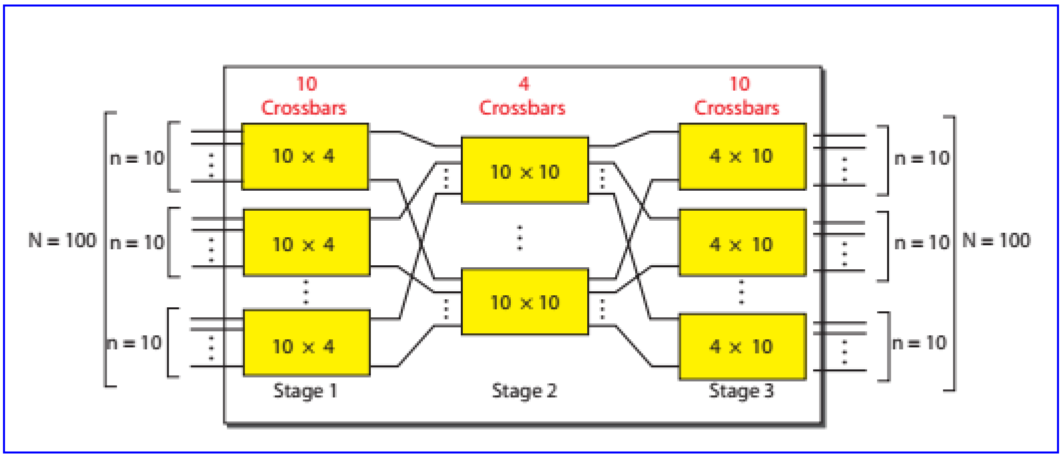
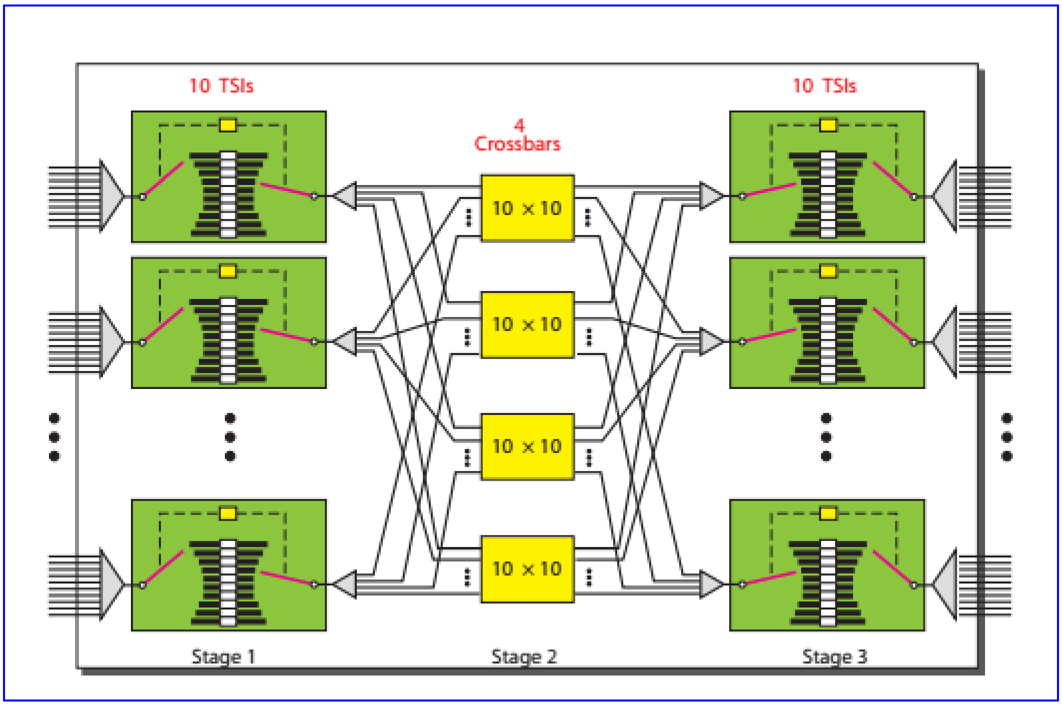


Figure 8.2 *First solution to* **Problem 8**



Solution b.

We can see the inefficiency in the first solution. Since the slots are separated in time, only one of the switches at the middle stage is active at each moment.
This means that, instead of 4 crossbars, we could have used only one with the same result.
Figure 8.3 shows the new design. In this case we still need ***200*** memory locations but only ***100*** crosspoints.

Figure 8.3 *Second solution to* **problem 8**