Matrix Multiplication

- **Sequential algorithm**
- **t(n)= O(n^3)**

procedure MATRIX MULTIPLICATION (A, B, C)

for $i = 1$ **to** m **do**
  for $j = 1$ **to** k **do**
    (1) $c_{ij} \leftarrow 0$
    (2) **for** $s = 1$ **to** n **do**
        $c_{ij} \leftarrow c_{ij} + (a_{is} \times b_{sj})$
      end for
  end for
end for. □

Parallel Matrix Multiplication

On mesh connected computer

```
procedure MESH MATRIX MULTIPLICATION (A, B, C)

  for i = 1 to m do in parallel
    for j = 1 to k do in parallel
      (1) c_ij ← 0
      (2) while P(i, j) receives two inputs a and b do
             (i) c_ij ← c_ij + (a × b)
            (ii) if i < m then send b to P(i + 1, j)
                 end if
           (iii) if j < k then send a to P(i, j + 1)
                 end if
          end while
    end for
  end for. □
```

Ex-

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \quad \text{and} \quad B = \begin{bmatrix} -5 & -6 \\ -7 & -8 \end{bmatrix}.$$

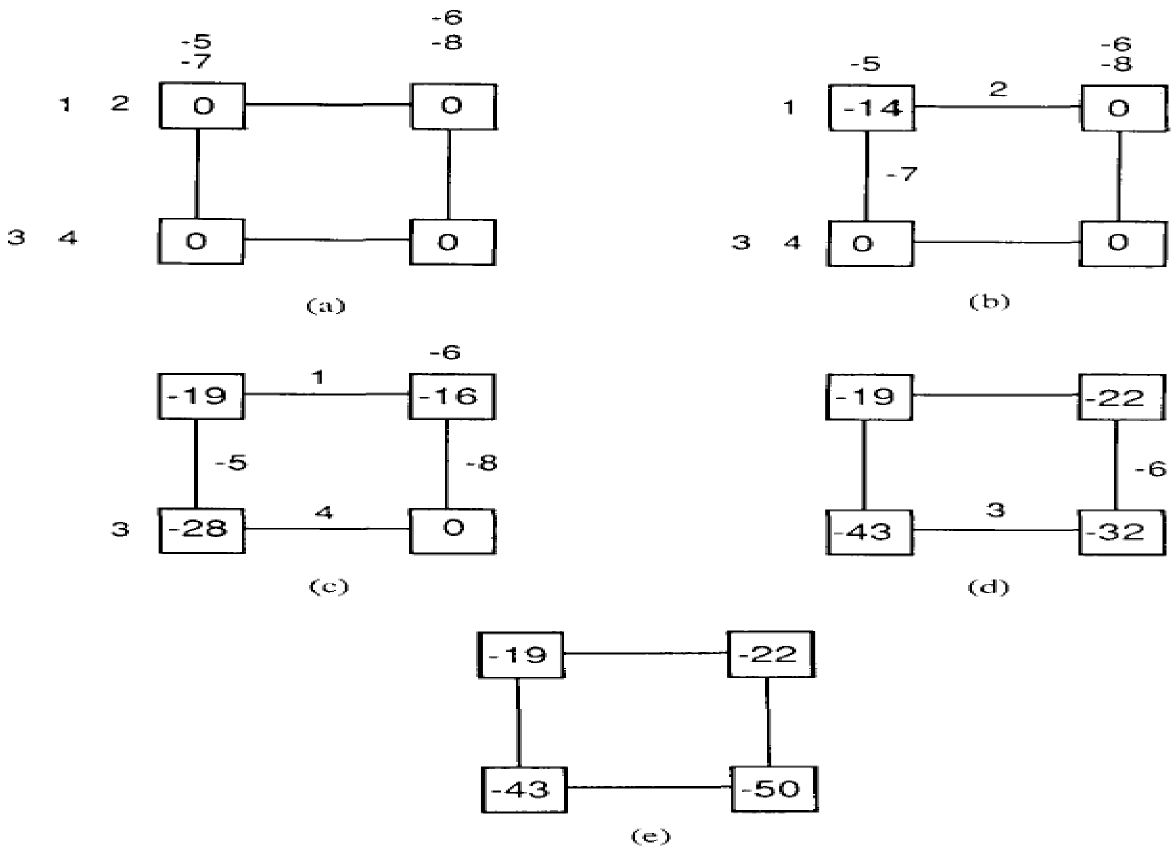

Figure 7.8 Multiplying two matrices using procedure MESH MATRIX

<u>Analysis-</u>

- **<u>Elements of first row of A and first column of B takes (m+k+n-2) steps to reach the last processor, i.e., P(m,k)</u>**
- **<u>t(n)= O(n), as m<=n and k<=n (assumed)</u>**

- **c(n)= p(n) * t(n)**

$= n^2 * n = O(n^3)$, i.e., cost-optimal

Another cost-optimal algorithm is CRCW MATRIX MULTIPLICATION