Problem(1) --> Data file name : DA_01_MosierTaube(1985a)_10x10.cfp

< Machines visited by parts: Process route numbers(PRN) >

```
Part[   1] = {   1,   4,   6 }
Part[   2] = {   9,  10 }
Part[   3] = {   2,   7,   9,  10 }
Part[   4] = {   2,   9,  10 }
Part[   5] = {   3 }
Part[   6] = {   3,   8 }
Part[   7] = {   5,   6 }
Part[   8] = {   2,   7,   9 }
Part[   9] = {   8 }
Part[  10] = {   1,   5,   6 }
```

< Block Diagonal Solution Matrix >

```
             < Locations >
               0 0 0 0 0 0 0 0 0 0
               0 0 0 0 0 0 0 0 0 1
               1 2 3 4 5 6 7 8 9 0
             < Machines >
               0 0 0 0 0 0 0 0 0 0
               0 0 0 0 0 0 0 1 0 0
< Parts >      1 4 5 6 2 7 9 0 3 8
=========== * * * * * * * * * * * *
(   1)   1  * 1 1   1              *
(   2)   7  *     1 1              *
(   3)  10  * 1   1 1              *
=========== * = = = = = = = = = = *
(   4)   2  *               1 1    *
(   5)   3  *         1 1 1 1      *
(   6)   4  *         1   1 1      *
(   7)   8  *         1 1 1        *
=========== * = = = = = = = = = = *
(   8)   5  *                 1    *
(   9)   6  *                 1 1  *
(  10)   9  *                   1  *
=========== * * * * * * * * * * * *
```

< Machine cells and Part families >

```
Machine Cell[ 1] = { 1, 4, 5, 6 }
Machine Cell[ 2] = { 2, 7, 9, 10 }
Machine Cell[ 3] = { 3, 8 }
```

```
Part  Family[ 1] = { 1, 7, 10 }
Part  Family[ 2] = { 2, 3, 4, 8 }
Part  Family[ 3] = { 5, 6, 9 }
```

< Summary of the performance measures >

```
No. of machines                              = 10
No. of part types                            = 10
No. of cells                                 = 3
Machine cell size                            = 4
Total no. of 1's in the original MPIM : |A| = 24
Matrix density                               = 0.24
Total no. of within-block 1's                = 24
No. of exceptional elements (EEs)            = 0
No. of voids                                 = 10
Sum of EEs and voids                         = 10
Group Cability Index (GCI)                   = 100.00%
grouping efficiency (GE)                     = 85.29 %
Grouping efficacy (GF)                       = 70.59 %
Machine utilization (MU)                     = 70.59 %
No. of redundant machines (RMs)              = 0
```

Problem(2) --> Data file name : DA_02_ChanMilner(1982)_10x15.cfp

< Machines visited by parts: Process route numbers(PRN) >

```
Part[   1] = {   3,   4,   6 }
Part[   2] = {   1,   7,  10 }
Part[   3] = {   2,   5,   8 }
Part[   4] = {   4,   6,   9 }
Part[   5] = {   2,   5,   8 }
Part[   6] = {   3,   6,   9 }
Part[   7] = {   7,  10 }
Part[   8] = {   2,   5,   8 }
Part[   9] = {   3,   4,   6,   9 }
Part[  10] = {   1,   7,  10 }
Part[  11] = {   1,   7,  10 }
Part[  12] = {   1,   7,  10 }
Part[  13] = {   2,   5,   8 }
Part[  14] = {   3,   4,   6,   9 }
Part[  15] = {   2,   5,   8 }
```

< Block Diagonal Solution Matrix >

```
            < Locations >
              0 0 0 0 0 0 0 0 0 0
              0 0 0 0 0 0 0 0 0 1
              1 2 3 4 5 6 7 8 9 0
            < Machines >
              0 0 0 0 0 0 0 0 0 0
              0 0 0 0 0 0 0 0 0 1
< Parts >     2 5 8 3 4 6 9 1 7 0
=========== * * * * * * * * * * *
(   1)   3  * 1 1 1               *
(   2)   5  * 1 1 1               *
(   3)   8  * 1 1 1               *
(   4)  13  * 1 1 1               *
(   5)  15  * 1 1 1               *
=========== * = = = = = = = = = *
(   6)   1  *       1 1 1         *
(   7)   4  *         1 1 1       *
(   8)   6  *       1   1 1       *
(   9)   9  *       1 1 1 1       *
(  10)  14  *       1 1 1 1       *
=========== * = = = = = = = = = *
(  11)   2  *               1 1 1 *
(  12)   7  *                 1 1 *
(  13)  10  *               1 1 1 *
(  14)  11  *               1 1 1 *
(  15)  12  *               1 1 1 *
=========== * * * * * * * * * * *
```

< Machine cells and Part families >

```
Machine Cell[ 1] = { 2, 5, 8 }
Machine Cell[ 2] = { 3, 4, 6, 9 }
Machine Cell[ 3] = { 1, 7, 10 }
```

```
Part  Family[ 1] = { 3, 5, 8, 13, 15 }
Part  Family[ 2] = { 1, 4, 6, 9, 14 }
Part  Family[ 3] = { 2, 7, 10, 11, 12 }
```

< Summary of the performance measures >

```
No. of machines                          = 10
No. of part types                        = 15
No. of cells                             = 3
Machine cell size                        = 4
Total no. of 1's in the original MPIM : |A| = 46
Matrix density                           = 0.307
Total no. of within-block 1's            = 46
No. of exceptional elements (EEs)        = 0
```

```
No. of voids                                    = 4
Sum of EEs and voids                            = 4
Group Cability Index (GCI)                      = 100.00%
grouping efficiency (GE)                        = 96.00 %
Grouping efficacy (GF)                          = 92.00 %
Machine utilization (MU)                        = 92.00 %
No. of redundant machines (RMs)                 = 0
============================================================
```

Problem(3) --> Data file name : DA_03_ChandraRaja_1(1989)_24x40.cfp

< Machines visited by parts: Process route numbers(PRN) >

```
Part[   1] = {   1,  13,  21,  22 }
Part[   2] = {   3,  20 }
Part[   3] = {   7,  14,  23,  24 }
Part[   4] = {   6,   8,  12,  15,  18 }
Part[   5] = {   6,   8,  12,  15,  18 }
Part[   6] = {   9,  10,  17 }
Part[   7] = {   9,  10,  17 }
Part[   8] = {   4,  16 }
Part[   9] = {   1,  13,  21,  22 }
Part[  10] = {   2,   5,  11,  19 }
Part[  11] = {   3,  20 }
Part[  12] = {   3,  20 }
Part[  13] = {   2,   5,  11,  19 }
Part[  14] = {   2,   5,  11,  19 }
Part[  15] = {   3,  20 }
Part[  16] = {   1,  13,  21,  22 }
Part[  17] = {   1,  13,  21,  22 }
Part[  18] = {   6,   8,  12,  15,  18 }
Part[  19] = {   4,  16 }
Part[  20] = {   9,  10,  17 }
Part[  21] = {   4,  16 }
Part[  22] = {   2,   5,  11,  19 }
Part[  23] = {   3,  20 }
Part[  24] = {   3,  20 }
Part[  25] = {   7,  14,  23,  24 }
Part[  26] = {   6,   8,  12,  15,  18 }
Part[  27] = {   6,   8,  12,  15,  18 }
Part[  28] = {   4,  16 }
Part[  29] = {   9,  10,  17 }
Part[  30] = {   6,   8,  12,  15,  18 }
Part[  31] = {   3,  20 }
Part[  32] = {   7,  14,  23,  24 }
Part[  33] = {   1,  13,  21,  22 }
Part[  34] = {   3,  20 }
Part[  35] = {   2,   5,  11,  19 }
Part[  36] = {   2,   5,  11,  19 }
Part[  37] = {   4,  16 }
Part[  38] = {   4,  16 }
Part[  39] = {   4,  16 }
Part[  40] = {   9,  10,  17 }
```

< Block Diagonal Solution Matrix >

```
            < Locations >
              0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
              0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2
              1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8
            < Machines >
              0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
              0 2 0 1 0 0 1 1 0 1 2 2 0 1 2 2 0 0 1 1 1 0 1 1 1 1 1 1
< Parts >     3 0 4 6 2 5 1 9 7 4 3 4 1 3 1 2 6 8 2 5 8 9 0 7 3 4 5 6
========== * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
(   1)   2  * 1 1                                                     *
(   2)  11  * 1 1                                                     *
(   3)  12  * 1 1                                                     *
(   4)  15  * 1 1                                                     *
(   5)  23  * 1 1                                                     *
(   6)  24  * 1 1                                                     *
(   7)  31  * 1 1                                                     *
(   8)  34  * 1 1                                                     *
========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(   9)   8  *     1 1                                                 *
(  10)  19  *     1 1                                                 *
(  11)  21  *     1 1                                                 *
(  12)  28  *     1 1                                                 *
(  13)  37  *     1 1                                                 *
(  14)  38  *     1 1                                                 *
```

```
(  15)  39  *     1 1                                                  *
=========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(  16)  10  *         1 1 1 1                                          *
(  17)  13  *         1 1 1 1                                          *
(  18)  14  *         1 1 1 1                                          *
(  19)  22  *         1 1 1 1                                          *
(  20)  35  *         1 1 1 1                                          *
(  21)  36  *         1 1 1 1                                          *
=========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(  22)   3  *                 1 1 1 1                                  *
(  23)  25  *                 1 1 1 1                                  *
(  24)  32  *                 1 1 1 1                                  *
=========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(  25)   1  *                         1 1 1 1                          *
(  26)   9  *                         1 1 1 1                          *
(  27)  16  *                         1 1 1 1                          *
(  28)  17  *                         1 1 1 1                          *
(  29)  33  *                         1 1 1 1                          *
=========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(  30)   4  *                                 1 1 1 1 1                *
(  31)   5  *                                 1 1 1 1 1                *
(  32)  18  *                                 1 1 1 1 1                *
(  33)  26  *                                 1 1 1 1 1                *
(  34)  27  *                                 1 1 1 1 1                *
(  35)  30  *                                 1 1 1 1 1                *
=========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(  36)   6  *                                           1 1 1          *
(  37)   7  *                                           1 1 1          *
(  38)  20  *                                           1 1 1          *
(  39)  29  *                                           1 1 1          *
(  40)  40  *                                           1 1 1          *
=========== * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

< Machine cells and Part families  >
============================================================
Machine Cell[ 1] = { 3, 20 }
Machine Cell[ 2] = { 4, 16 }
Machine Cell[ 3] = { 2, 5, 11, 19 }
Machine Cell[ 4] = { 7, 14, 23, 24 }
Machine Cell[ 5] = { 1, 13, 21, 22 }
Machine Cell[ 6] = { 6, 8, 12, 15, 18 }
Machine Cell[ 7] = { 9, 10, 17 }
============================================================
Part  Family[ 1] = { 2, 11, 12, 15, 23, 24, 31, 34 }
Part  Family[ 2] = { 8, 19, 21, 28, 37, 38, 39 }
Part  Family[ 3] = { 10, 13, 14, 22, 35, 36 }
Part  Family[ 4] = { 3, 25, 32 }
Part  Family[ 5] = { 1, 9, 16, 17, 33 }
Part  Family[ 6] = { 4, 5, 18, 26, 27, 30 }
Part  Family[ 7] = { 6, 7, 20, 29, 40 }
============================================================

< Summary of the performance measures >
============================================================
No. of machines                          = 24
No. of part types                        = 40
No. of cells                             = 7
Machine cell size                        = 5
Total no. of 1's in the original MPIM : |A| = 131
Matrix density                           = 0.136
Total no. of within-block 1's            = 131
No. of exceptional elements (EEs)        = 0
No. of voids                             = 0
Sum of EEs and voids                     = 0
Group Cability Index (GCI)               = 100.00%
grouping efficiency (GE)                 = 100.00%
Grouping efficacy (GF)                   = 100.00%
Machine utilization (MU)                 = 100.00%
No. of redundant machines (RMs)          = 0
============================================================
```

Problem(4) --> Data file name : DA_04_ChanMilner(1982)_Figure_1a_7x5.cfp

< Machines visited by parts: Process route numbers(PRN) >
```
Part[   1] = {   3,   5,   7 }
Part[   2] = {   1,   2,   4,   6 }
Part[   3] = {   2,   4,   6 }
Part[   4] = {   3,   5,   7 }
Part[   5] = {   1,   4,   6 }
```

< Block Diagonal Solution Matrix >

		< Locations >						
		0	0	0	0	0	0	0
		0	0	0	0	0	0	0
		1	2	3	4	5	6	7
	< Machines >							
		0	0	0	0	0	0	0
		0	0	0	0	0	0	0
< Parts >		3	5	7	1	2	4	6
(1)	1	1	1	1				
(2)	4	1	1	1				
(3)	2				1	1	1	1
(4)	3				1	1	1	
(5)	5			1		1	1	

< Machine cells and Part families >
```
Machine Cell[ 1] = { 3, 5, 7 }
Machine Cell[ 2] = { 1, 2, 4, 6 }
```
```
Part  Family[ 1] = { 1, 4 }
Part  Family[ 2] = { 2, 3, 5 }
```

< Summary of the performance measures >
```
No. of machines                              = 7
No. of part types                            = 5
No. of cells                                 = 2
Machine cell size                            = 4
Total no. of 1's in the original MPIM : |A| = 16
Matrix density                               = 0.457
Total no. of within-block 1's                = 16
No. of exceptional elements (EEs)            = 0
No. of voids                                 = 2
Sum of EEs and voids                         = 2
Group Cability Index (GCI)                   = 100.00%
grouping efficiency (GE)                     = 94.44 %
Grouping efficacy (GF)                       = 88.89 %
Machine utilization (MU)                     = 88.89 %
No. of redundant machines (RMs)              = 0
```

Problem(5) --> Data file name : DA_05_Kumar(1986)_9x15.cfp

< Machines visited by parts: Process route numbers(PRN) >

```
Part[   1] = {   3,   9 }
Part[   2] = {   5 }
Part[   3] = {   1,   2 }
Part[   4] = {   1,   5 }
Part[   5] = {   4,   7,   8 }
Part[   6] = {   4,   6 }
Part[   7] = {   3,   9 }
Part[   8] = {   1,   2,   5 }
Part[   9] = {   1,   2,   5 }
Part[  10] = {   1,   5 }
Part[  11] = {   4,   7,   8 }
Part[  12] = {   2 }
Part[  13] = {   1,   2,   5 }
Part[  14] = {   6 }
Part[  15] = {   1,   5 }
```

< Block Diagonal Solution Matrix >

```
            < Locations >
              0 0 0 0 0 0 0 0 0
              0 0 0 0 0 0 0 0 0
              1 2 3 4 5 6 7 8 9
            < Machines >
              0 0 0 0 0 0 0 0 0
              0 0 0 0 0 0 0 0 0
< Parts >     1 2 5 4 6 7 8 3 9
=========== * * * * * * * * * *
(   1)   2  *     1             *
(   2)   3  * 1 1               *
(   3)   4  * 1   1             *
(   4)   8  * 1 1 1             *
(   5)   9  * 1 1 1             *
(   6)  10  * 1   1             *
(   7)  12  *   1               *
(   8)  13  * 1 1 1             *
(   9)  15  * 1   1             *
=========== * = = = = = = = = = *
(  10)   5  *       1   1 1     *
(  11)   6  *       1 1         *
(  12)  11  *       1   1 1     *
(  13)  14  *         1         *
=========== * = = = = = = = = = *
(  14)   1  *               1 1 *
(  15)   7  *               1 1 *
=========== * * * * * * * * * * *
```

< Machine cells and Part families >

```
Machine Cell[ 1] = { 1, 2, 5 }
Machine Cell[ 2] = { 4, 6, 7, 8 }
Machine Cell[ 3] = { 3, 9 }
```

```
Part  Family[ 1] = { 2, 3, 4, 8, 9, 10, 12, 13, 15 }
Part  Family[ 2] = { 5, 6, 11, 14 }
Part  Family[ 3] = { 1, 7 }
```

< Summary of the performance measures >

```
No. of machines                          = 9
No. of part types                        = 15
No. of cells                             = 3
Machine cell size                        = 4
Total no. of 1's in the original MPIM : |A| = 32
Matrix density                           = 0.237
Total no. of within-block 1's            = 32
No. of exceptional elements (EEs)        = 0
```

```
No. of voids                                  = 15
Sum of EEs and voids                          = 15
Group Cability Index (GCI)                    = 100.00%
grouping efficiency (GE)                      = 84.04 %
Grouping efficacy (GF)                        = 68.09 %
Machine utilization (MU)                      = 68.09 %
No. of redundant machines (RMs)               = 0
============================================================
```

Problem(6) --> Data file name : DA_06_KusiakChow(1987a)_Example_2_7x8.cfp

< Machines visited by parts: Process route numbers(PRN) >
```
Part[   1] = {   2 }
Part[   2] = {   1 }
Part[   3] = {   1,   7 }
Part[   4] = {   3,   6 }
Part[   5] = {   1,   7 }
Part[   6] = {   2,   4 }
Part[   7] = {   3 }
Part[   8] = {   5,   7 }
```

< Block Diagonal Solution Matrix >
```
            < Locations >
              0 0 0 0 0 0 0
              0 0 0 0 0 0 0
              1 2 3 4 5 6 7
            < Machines >
              0 0 0 0 0 0 0
              0 0 0 0 0 0 0
< Parts >     1 5 7 2 4 3 6
=========== * * * * * * * * *
(   1)   2  * 1             *
(   2)   3  * 1   1         *
(   3)   5  * 1   1         *
(   4)   8  *   1 1         *
=========== * = = = = = = = *
(   5)   1  *       1       *
(   6)   6  *       1 1     *
=========== * = = = = = = = *
(   7)   4  *           1 1 *
(   8)   7  *           1   *
=========== * * * * * * * * *
```

< Machine cells and Part families >
```
Machine Cell[ 1] = { 1, 5, 7 }
Machine Cell[ 2] = { 2, 4 }
Machine Cell[ 3] = { 3, 6 }
Part  Family[ 1] = { 2, 3, 5, 8 }
Part  Family[ 2] = { 1, 6 }
Part  Family[ 3] = { 4, 7 }
```

< Summary of the performance measures >
```
No. of machines                                = 7
No. of part types                              = 8
No. of cells                                   = 3
Machine cell size                              = 3
Total no. of 1's in the original MPIM : |A|    = 13
Matrix density                                 = 0.232
Total no. of within-block 1's                  = 13
No. of exceptional elements (EEs)              = 0
No. of voids                                   = 7
Sum of EEs and voids                           = 7
Group Cability Index (GCI)                     = 100.00%
grouping efficiency (GE)                       = 82.50 %
Grouping efficacy (GF)                         = 65.00 %
Machine utilization (MU)                       = 65.00 %
No. of redundant machines (RMs)                = 0
```

Problem(7) --> Data file name : DA_07_MorrisTersine(1990)_30x40.cfp

< Machines visited by parts: Process route numbers(PRN) >

```
Part[   1] = {  30,   5 }
Part[   2] = {  11,   1,  30 }
Part[   3] = {  11,   1 }
Part[   4] = {  11,  30,   5 }
Part[   5] = {  30,   5 }
Part[   6] = {  11,   1,   5 }
Part[   7] = {  11,   1,  30,   5 }
Part[   8] = {   1,  30,   5 }
Part[   9] = {  29,  19,  27 }
Part[  10] = {   6,  19,  27 }
Part[  11] = {   6,  19 }
Part[  12] = {  14,  27 }
Part[  13] = {  29,  19,  27 }
Part[  14] = {   6,  19 }
Part[  15] = {  29,   6,  19,  27 }
Part[  16] = {  14,  27 }
Part[  17] = {  29,  14,   6,  19 }
Part[  18] = {  14,  27 }
Part[  19] = {  26,   7,  20,  12 }
Part[  20] = {  26,   2,  15,   7,  17,   4 }
Part[  21] = {   2,  17,   4,  20,  12 }
Part[  22] = {   2,  15,   7,  17,   4 }
Part[  23] = {  26,  20,  12 }
Part[  24] = {  26,   2,  15,   7,  17,   4 }
Part[  25] = {  17,   4,  20,  12 }
Part[  26] = {   2,  15,   7,  17,   4 }
Part[  27] = {  22,  28,  24,   9 }
Part[  28] = {   8,  28,  24,   9,  21 }
Part[  29] = {   8,   9,  21 }
Part[  30] = {  22,   8,  28,  24,   9 }
Part[  31] = {  22,  28,  24 }
Part[  32] = {  22,   8,  28,  24,   9 }
Part[  33] = {  25,   3,  10 }
Part[  34] = {  18,  25,  13,   3,  23,  10 }
Part[  35] = {  13,  10,  16 }
Part[  36] = {  13,   3,  23,  10,  16 }
Part[  37] = {  13,  23,  10,  16 }
Part[  38] = {  18,  25,   3,  23 }
Part[  39] = {  25,  13,  23,  10 }
Part[  40] = {  18,  25,   3,  23,  16 }
```

< Block Diagonal Solution Matrix >

```
            < Locations >
              0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
              0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3
              1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0
            < Machines >
              0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
              0 0 0 1 1 1 2 2 0 1 1 2 2 0 0 1 3 0 0 2 2 2 2 0 1 1 1 1 2 2
< Parts >     2 4 7 2 5 7 0 6 6 4 9 7 9 1 5 1 0 8 9 1 2 4 8 3 0 3 6 8 3 5
=========== * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
(   1)  19  *     1 1     1 1                                                   *
(   2)  20  * 1 1 1   1 1   1                                                   *
(   3)  21  * 1 1   1   1 1                                                     *
(   4)  22  * 1 1 1   1 1                                                       *
(   5)  23  *       1     1 1                                                   *
(   6)  24  * 1 1 1   1 1   1                                                   *
(   7)  25  *   1   1   1 1                                                     *
(   8)  26  * 1 1 1   1 1                                                       *
=========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(   9)   9  *                   1 1 1                                         *
(  10)  10  *                 1   1 1                                         *
(  11)  11  *                 1   1                                           *
(  12)  12  *                   1   1                                         *
(  13)  13  *                     1 1 1                                       *
(  14)  14  *                 1   1                                           *
```

```
(  15)  15  *                 1   1 1 1                                 *
(  16)  16  *                   1   1                                   *
(  17)  17  *                 1 1 1   1                                 *
(  18)  18  *                   1   1                                   *
=========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(  19)   1  *                             1   1                         *
(  20)   2  *                           1   1 1                         *
(  21)   3  *                           1   1                           *
(  22)   4  *                             1 1 1                         *
(  23)   5  *                             1   1                         *
(  24)   6  *                           1 1 1                           *
(  25)   7  *                           1 1 1 1                         *
(  26)   8  *                           1 1   1                         *
=========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(  27)  27  *                                     1   1 1 1             *
(  28)  28  *                                   1 1 1   1 1             *
(  29)  29  *                                   1 1 1                   *
(  30)  30  *                                   1 1   1 1 1             *
(  31)  31  *                                       1 1 1               *
(  32)  32  *                                   1 1   1 1 1             *
=========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(  33)  33  *                                           1 1         1 *
(  34)  34  *                                           1 1 1   1 1 1 *
(  35)  35  *                                             1 1 1       *
(  36)  36  *                                           1 1 1 1   1   *
(  37)  37  *                                             1 1 1   1   *
(  38)  38  *                                           1       1 1 1 *
(  39)  39  *                                             1 1     1 1 *
(  40)  40  *                                           1     1 1 1 1 *
=========== * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

```
< Machine cells and Part families  >
============================================================
Machine Cell[ 1] = { 2, 4, 7, 12, 15, 17, 20, 26 }
Machine Cell[ 2] = { 6, 14, 19, 27, 29 }
Machine Cell[ 3] = { 1, 5, 11, 30 }
Machine Cell[ 4] = { 8, 9, 21, 22, 24, 28 }
Machine Cell[ 5] = { 3, 10, 13, 16, 18, 23, 25 }
============================================================
Part  Family[ 1] = { 19, 20, 21, 22, 23, 24, 25, 26 }
Part  Family[ 2] = { 9, 10, 11, 12, 13, 14, 15, 16, 17, 18 }
Part  Family[ 3] = { 1, 2, 3, 4, 5, 6, 7, 8 }
Part  Family[ 4] = { 27, 28, 29, 30, 31, 32 }
Part  Family[ 5] = { 33, 34, 35, 36, 37, 38, 39, 40 }
============================================================

< Summary of the performance measures >
============================================================
No. of machines                          = 30
No. of part types                        = 40
No. of cells                             = 5
Machine cell size                        = 8
Total no. of 1's in the original MPIM : |A| = 146
Matrix density                           = 0.122
Total no. of within-block 1's            = 146
No. of exceptional elements (EEs)        = 0
No. of voids                             = 92
Sum of EEs and voids                     = 92
Group Cability Index (GCI)               = 100.00%
grouping efficiency (GE)                 = 80.67 %
Grouping efficacy (GF)                   = 61.34 %
Machine utilization (MU)                 = 61.34 %
No. of redundant machines (RMs)          = 0
============================================================
```

Problem(8) --> Data file name : DA_08_TabounSharma(1991)_9x7.cfp

< Machines visited by parts: Process route numbers(PRN) >
```
Part[   1] = {   1,   6,   7 }
Part[   2] = {   2,   3,   8 }
Part[   3] = {   1,   6,   9 }
Part[   4] = {   3,   5,   8 }
Part[   5] = {   2,   3,   5 }
Part[   6] = {   1,   4,   6,   9 }
Part[   7] = {   1,   4,   6,   7 }
```

< Block Diagonal Solution Matrix >

		< Locations >								
		0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0
		1	2	3	4	5	6	7	8	9
	< Machines >									
		0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0
< Parts >		1	4	6	7	9	2	3	5	8
	*	*	*	*	*	*	*	*	*	*
(1)	1	*	1			1	1			*
(2)	3	*	1			1		1		*
(3)	6	*	1	1	1		1			*
(4)	7	*	1	1	1	1				*
	*	=	=	=	=	=	=	=	=	*
(5)	2	*					1	1	1	*
(6)	4	*						1	1	*
(7)	5	*					1	1	1	*
	*	*	*	*	*	*	*	*	*	*

< Machine cells and Part families >
```
Machine Cell[ 1] = { 1, 4, 6, 7, 9 }
Machine Cell[ 2] = { 2, 3, 5, 8 }
```
```
Part  Family[ 1] = { 1, 3, 6, 7 }
Part  Family[ 2] = { 2, 4, 5 }
```

< Summary of the performance measures >
```
No. of machines                                = 9
No. of part types                              = 7
No. of cells                                   = 2
Machine cell size                              = 5
Total no. of 1's in the original MPIM : |A|    = 23
Matrix density                                 = 0.365
Total no. of within-block 1's                  = 23
No. of exceptional elements (EEs)              = 0
No. of voids                                   = 9
Sum of EEs and voids                           = 9
Group Cability Index (GCI)                     = 100.00%
grouping efficiency (GE)                       = 85.94 %
Grouping efficacy (GF)                         = 71.88 %
Machine utilization (MU)                       = 71.88 %
No. of redundant machines (RMs)                = 0
```

Problem(9) --> Data file name : DA_09_Moossa(1996)_6x20.cfp

< Machines visited by parts: Process route numbers(PRN) >

```
==============================================================
Part[   1] = {   1,   2 }
Part[   2] = {   6 }
Part[   3] = {   1,   2 }
Part[   4] = {   1,   2 }
Part[   5] = {   3,   4 }
Part[   6] = {   3,   4 }
Part[   7] = {   5,   6 }
Part[   8] = {   4 }
Part[   9] = {   3 }
Part[  10] = {   3 }
Part[  11] = {   3,   4 }
Part[  12] = {   1,   2 }
Part[  13] = {   3 }
Part[  14] = {   6 }
Part[  15] = {   5,   6 }
Part[  16] = {   1 }
Part[  17] = {   6 }
Part[  18] = {   6 }
Part[  19] = {   5 }
Part[  20] = {   6 }
==============================================================
```

< Block Diagonal Solution Matrix >

```
            < Locations >
              0 0 0 0 0 0
              0 0 0 0 0 0
              1 2 3 4 5 6
            < Machines >
              0 0 0 0 0 0
              0 0 0 0 0 0
< Parts >     3 4 5 6 1 2
=========== * * * * * * * *
(   1)   5  * 1 1         *
(   2)   6  * 1 1         *
(   3)   8  *   1         *
(   4)   9  * 1           *
(   5)  10  * 1           *
(   6)  11  * 1 1         *
(   7)  13  * 1           *
=========== * = = = = = = *
(   8)   2  *       1     *
(   9)   7  *     1 1     *
(  10)  14  *       1     *
(  11)  15  *     1 1     *
(  12)  17  *       1     *
(  13)  18  *       1     *
(  14)  19  *     1       *
(  15)  20  *       1     *
=========== * = = = = = = *
(  16)   1  *         1 1 *
(  17)   3  *         1 1 *
(  18)   4  *         1 1 *
(  19)  12  *         1 1 *
(  20)  16  *         1   *
=========== * * * * * * * *
```

< Machine cells and Part families >

```
==============================================================
Machine Cell[ 1] = { 3, 4 }
Machine Cell[ 2] = { 5, 6 }
Machine Cell[ 3] = { 1, 2 }
==============================================================
Part  Family[ 1] = { 5, 6, 8, 9, 10, 11, 13 }
Part  Family[ 2] = { 2, 7, 14, 15, 17, 18, 19, 20 }
Part  Family[ 3] = { 1, 3, 4, 12, 16 }
==============================================================
```

< Summary of the performance measures >

No. of machines	= 6
No. of part types	= 20
No. of cells	= 3
Machine cell size	= 2
Total no. of 1's in the original MPIM : |A|	= 29
Matrix density	= 0.242
Total no. of within-block 1's	= 29
No. of exceptional elements (EEs)	= 0
No. of voids	= 11
Sum of EEs and voids	= 11
Group Cability Index (GCI)	= 100.00%
grouping efficiency (GE)	= 86.25 %
Grouping efficacy (GF)	= 72.50 %
Machine utilization (MU)	= 72.50 %
No. of redundant machines (RMs)	= 0

Problem(10) --> Data file name :
DA_10_SeifoddiniDjassemi(1996a)_Version_1_7x11.cfp

< Machines visited by parts: Process route numbers(PRN) >
```
==============================================================
Part[   1] = {   2,   3 }
Part[   2] = {   2,   3 }
Part[   3] = {   1,   5,   6 }
Part[   4] = {   4,   7 }
Part[   5] = {   4,   7 }
Part[   6] = {   2,   3 }
Part[   7] = {   1,   5,   6 }
Part[   8] = {   4,   7 }
Part[   9] = {   2,   3 }
Part[  10] = {   4,   7 }
Part[  11] = {   1,   5,   6 }
==============================================================
```

< Block Diagonal Solution Matrix >

		< Locations >						
		0	0	0	0	0	0	0
		0	0	0	0	0	0	0
		1	2	3	4	5	6	7
	< Machines >							
		0	0	0	0	0	0	0
		0	0	0	0	0	0	0
< Parts >		2	3	4	7	1	5	6
==========	*	*	*	*	*	*	*	*
(1)	1	*	1	1				*
(2)	2	*	1	1				*
(3)	6	*	1	1				*
(4)	9	*	1	1				*
==========	*	=	=	=	=	=	=	*
(5)	4	*			1	1		*
(6)	5	*			1	1		*
(7)	8	*			1	1		*
(8)	10	*			1	1		*
==========	*	=	=	=	=	=	=	*
(9)	3	*				1	1	1 *
(10)	7	*				1	1	1 *
(11)	11	*				1	1	1 *
==========	*	*	*	*	*	*	*	*

< Machine cells and Part families >
```
==============================================================
Machine Cell[ 1] = { 2, 3 }
Machine Cell[ 2] = { 4, 7 }
Machine Cell[ 3] = { 1, 5, 6 }
==============================================================
Part  Family[ 1] = { 1, 2, 6, 9 }
Part  Family[ 2] = { 4, 5, 8, 10 }
Part  Family[ 3] = { 3, 7, 11 }
==============================================================
```

< Summary of the performance measures >
```
==============================================================
No. of machines                              = 7
No. of part types                            = 11
No. of cells                                 = 3
Machine cell size                            = 3
Total no. of 1's in the original MPIM : |A|  = 25
Matrix density                               = 0.325
Total no. of within-block 1's                = 25
No. of exceptional elements (EEs)            = 0
No. of voids                                 = 0
Sum of EEs and voids                         = 0
Group Cability Index (GCI)                   = 100.00%
grouping efficiency (GE)                     = 100.00%
Grouping efficacy (GF)                       = 100.00%
Machine utilization (MU)                     = 100.00%
No. of redundant machines (RMs)              = 0
```

==========

Problem(11) --> Data file name :
DA_11_SeifoddiniDjassemi(1996b)_Figure_7_41x51.cfp

< Machines visited by parts: Process route numbers(PRN) >
==========
Part[1] = { 1, 4, 6, 8 }
Part[2] = { 1, 4, 6 }
Part[3] = { 4 }
Part[4] = { 1, 4, 7, 8 }
Part[5] = { 1, 3 }
Part[6] = { 1, 3 }
Part[7] = { 1, 3 }
Part[8] = { 1, 3 }
Part[9] = { 1, 3 }
Part[10] = { 1, 3 }
Part[11] = { 1, 3 }
Part[12] = { 1, 3 }
Part[13] = { 1, 3 }
Part[14] = { 2, 4, 5, 9 }
Part[15] = { 2, 4, 5, 9 }
Part[16] = { 4, 6, 8 }
Part[17] = { 10, 12, 13 }
Part[18] = { 10, 12, 13 }
Part[19] = { 10, 12, 13 }
Part[20] = { 10, 12, 13 }
Part[21] = { 10, 12, 13 }
Part[22] = { 10, 12, 13 }
Part[23] = { 10, 11, 12, 14 }
Part[24] = { 10, 11, 12, 13, 14 }
Part[25] = { 12, 13 }
Part[26] = { 15, 16, 17, 18, 19, 20, 22 }
Part[27] = { 19, 20, 21 }
Part[28] = { 15, 16, 18, 22 }
Part[29] = { 15, 16, 17, 18, 22 }
Part[30] = { 15, 16, 18, 20, 21 }
Part[31] = { 15, 17, 18, 20, 23, 24, 25 }
Part[32] = { 15, 17, 18, 20, 23, 24, 25 }
Part[33] = { 26, 30, 31, 32 }
Part[34] = { 26, 30 }
Part[35] = { 26, 30 }
Part[36] = { 29, 32 }
Part[37] = { 27, 31 }
Part[38] = { 26 }
Part[39] = { 33 }
Part[40] = { 26, 32, 33 }
Part[41] = { 33 }
Part[42] = { 28, 33 }
Part[43] = { 28, 29 }
Part[44] = { 34, 35, 40 }
Part[45] = { 36, 37, 39, 40 }
Part[46] = { 34 }
Part[47] = { 35, 37 }
Part[48] = { 36, 37 }
Part[49] = { 36, 37, 38, 41 }
Part[50] = { 36, 37, 38, 41 }
Part[51] = { 35, 39, 41 }
==========

< Block Diagonal Solution Matrix >
```
            < Locations >
             00000000000000000000000000000000000000000
             00000000011111111112222222222333333333344
             12345678901234567890123456789012345678901
            < Machines >
             00000000000000000000000000000000000000000
             00000000011111111112222223333334422223333
< Parts >    12345678901234567890123454567890167890123
=========== *********************************************
(   1)   1  *1  1 1 1                                   *
(   2)   2  *1  1 1                                     *
(   3)   3  *   1                                       *
```

```
(   4)   4  *1  1  11                                  *
(   5)   5  *1 1                                       *
(   6)   6  *1 1                                       *
(   7)   7  *1 1                                       *
(   8)   8  *1 1                                       *
(   9)   9  *1 1                                       *
(  10)  10  *1 1                                       *
(  11)  11  *1 1                                       *
(  12)  12  *1 1                                       *
(  13)  13  *1 1                                       *
(  14)  14  * 1 11   1                                 *
(  15)  15  * 1 11   1                                 *
(  16)  16  *   1 1 1                                  *
========== *========================================== *
(  17)  17  *         1 11                             *
(  18)  18  *         1 11                             *
(  19)  19  *         1 11                             *
(  20)  20  *         1 11                             *
(  21)  21  *         1 11                             *
(  22)  22  *         1 11                             *
(  23)  23  *         111 1                            *
(  24)  24  *         11111                            *
(  25)  25  *           11                             *
========== *========================================== *
(  26)  26  *              111111 1                    *
(  27)  27  *                  111                     *
(  28)  28  *              11 1   1                    *
(  29)  29  *              1111   1                    *
(  30)  30  *              11 1 11                     *
(  31)  31  *              1 11 1  111                 *
(  32)  32  *              1 11 1  111                 *
========== *========================================== *
(  33)  44  *                        11    1           *
(  34)  45  *                          11 11           *
(  35)  46  *                        1                 *
(  36)  47  *                         1 1              *
(  37)  48  *                          11              *
(  38)  49  *                          111  1          *
(  39)  50  *                          111  1          *
(  40)  51  *                         1   1 1          *
========== *========================================== *
(  41)  33  *                                  1   111 *
(  42)  34  *                                  1   1   *
(  43)  35  *                                  1   1   *
(  44)  36  *                                     1  1 *
(  45)  37  *                                   1   1  *
(  46)  38  *                                  1       *
(  47)  39  *                                          1*
(  48)  40  *                                  1     11*
(  49)  41  *                                          1*
(  50)  42  *                                    1     1*
(  51)  43  *                                    11    *
========== ****************************************

< Machine cells and Part families  >
============================================================
Machine Cell[ 1] = { 1, 2, 3, 4, 5, 6, 7, 8, 9 }
Machine Cell[ 2] = { 10, 11, 12, 13, 14 }
Machine Cell[ 3] = { 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25 }
Machine Cell[ 4] = { 34, 35, 36, 37, 38, 39, 40, 41 }
Machine Cell[ 5] = { 26, 27, 28, 29, 30, 31, 32, 33 }
============================================================
Part  Family[ 1] = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 }
Part  Family[ 2] = { 17, 18, 19, 20, 21, 22, 23, 24, 25 }
Part  Family[ 3] = { 26, 27, 28, 29, 30, 31, 32 }
Part  Family[ 4] = { 44, 45, 46, 47, 48, 49, 50, 51 }
Part  Family[ 5] = { 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43 }
============================================================

< Summary of the performance measures >
============================================================
```

```
No. of machines                                 = 41
No. of part types                               = 51
No. of cells                                    = 5
Machine cell size                               = 11
Total no. of 1's in the original MPIM : |A|     = 153
Matrix density                                  = 0.0732
Total no. of within-block 1's                   = 153
No. of exceptional elements (EEs)               = 0
No. of voids                                    = 265
Sum of EEs and voids                            = 265
Group Cability Index (GCI)                      = 100.00%
grouping efficiency (GE)                        = 68.30 %
Grouping efficacy (GF)                          = 36.60 %
Machine utilization (MU)                        = 36.60 %
No. of redundant machines (RMs)                 = 0
============================================================
```

```
Problem(12) --> Data file name :    DA_12_SeifoddiniDjassemi(2001)_Figure_4_36x15.cfp

< Machines visited by parts: Process route numbers(PRN) >
==============================================================
Part[   1] = {   3,  21,  32 }
Part[   2] = {  19,  10,  14,  31,  26 }
Part[   3] = {  15,  11,  28,  36 }
Part[   4] = {   3,  21,  32 }
Part[   5] = {   1,  16,  17,  27,  13,  23,  29 }
Part[   6] = {   2,  20,  11,  18 }
Part[   7] = {  19,  22,  12,  14,  33,  31 }
Part[   8] = {   1,  17,  27,   8,  35 }
Part[   9] = {   1,  16,   6,   8,  13,  30 }
Part[  10] = {  34,  24,   5 }
Part[  11] = {   2,  20,  15,  28 }
Part[  12] = {  25,  10,  22,  33,  31 }
Part[  13] = {   9,  34,   4,  24 }
Part[  14] = {   7,  15,  11,  18 }
Part[  15] = {   1,  16,   6,  17,  27,   8,  13,  23,  35,  29 }
==============================================================

< Block Diagonal Solution Matrix >
           < Locations >
             0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
             0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3 3 3 3 3 3
             1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6
           < Machines >
             0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
             0 0 0 1 1 1 2 2 2 3 3 0 0 1 1 1 2 2 3 0 2 3 0 0 0 2 3 1 1 1 1 2 2 2 3 3
< Parts >    1 6 8 3 6 7 3 7 9 0 5 2 7 1 5 8 0 8 6 3 1 2 4 5 9 4 4 0 2 4 9 2 5 6 1 3
========== * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
(   1)   5 * 1     1 1 1 1 1 1                                                       *
(   2)   8 * 1   1     1   1     1                                                   *
(   3)   9 * 1 1 1 1 1         1                                                     *
(   4)  15 * 1 1 1 1 1 1 1 1 1   1                                                   *
========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(   5)   3 *                           1 1     1 1                                   *
(   6)   6 *                       1   1   1 1                                       *
(   7)  11 *                       1     1   1 1                                     *
(   8)  14 *                         1 1 1 1                                         *
========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(   9)   1 *                                       1 1 1                             *
(  10)   4 *                                       1 1 1                             *
========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(  11)  10 *                                               1   1 1                   *
(  12)  13 *                                             1   1 1 1                   *
========== * = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = *
(  13)   2 *                                                       1   1 1     1 1   *
(  14)   7 *                                                         1 1 1 1   1 1 *
(  15)  12 *                                                       1       1 1   1 1 *
========== * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

< Machine cells and Part families  >
============================================================
Machine Cell[ 1] = { 1, 6, 8, 13, 16, 17, 23, 27, 29, 30, 35 }
Machine Cell[ 2] = { 2, 7, 11, 15, 18, 20, 28, 36 }
Machine Cell[ 3] = { 3, 21, 32 }
Machine Cell[ 4] = { 4, 5, 9, 24, 34 }
Machine Cell[ 5] = { 10, 12, 14, 19, 22, 25, 26, 31, 33 }
============================================================
Part  Family[ 1] = { 5, 8, 9, 15 }
Part  Family[ 2] = { 3, 6, 11, 14 }
Part  Family[ 3] = { 1, 4 }
Part  Family[ 4] = { 10, 13 }
Part  Family[ 5] = { 2, 7, 12 }
============================================================

< Summary of the performance measures >
============================================================
No. of machines                             = 36
No. of part types                           = 15
No. of cells                                = 5
Machine cell size                           = 11
Total no. of 1's in the original MPIM : |A| = 73
Matrix density                              = 0.135
Total no. of within-block 1's               = 73
No. of exceptional elements (EEs)           = 0
No. of voids                                = 46
```

```
Sum of EEs and voids                          = 46
Group Cability Index (GCI)                    = 100.00%
grouping efficiency (GE)                      = 80.67 %
Grouping efficacy (GF)                        = 61.34 %
Machine utilization (MU)                      = 61.34 %
No. of redundant machines (RMs)               = 0
============================================================
```

Problem(13) --> Data file name :   DA_13_Mahdavi(2007)_6x6.cfp

< Machines visited by parts: Process route numbers(PRN) >
```
============================================================
Part[   1] = {   4,   5 }
Part[   2] = {   1,   3,   6 }
Part[   3] = {   4,   5 }
Part[   4] = {   1,   6 }
Part[   5] = {   2,   3,   6 }
Part[   6] = {   1,   2,   3 }
============================================================
```

< Block Diagonal Solution Matrix >

	< Locations >					
	0	0	0	0	0	0
	0	0	0	0	0	0
	1	2	3	4	5	6
< Machines >						
	0	0	0	0	0	0
	0	0	0	0	0	0
< Parts >	1	2	3	6	4	5
==========	*	*	*	*	*	*
(1) 2	*	1		1	1	
(2) 4	*	1			1	
(3) 5	*		1	1	1	
(4) 6	*	1	1	1		
==========	*	=	=	=	=	=
(5) 1	*				1	1
(6) 3	*				1	1
==========	*	*	*	*	*	*

< Machine cells and Part families >
```
============================================================
Machine Cell[ 1] = { 1, 2, 3, 6 }
Machine Cell[ 2] = { 4, 5 }
============================================================
Part  Family[ 1] = { 2, 4, 5, 6 }
Part  Family[ 2] = { 1, 3 }
============================================================
```

< Summary of the performance measures >
```
============================================================
No. of machines                                = 6
No. of part types                              = 6
No. of cells                                   = 2
Machine cell size                              = 4
Total no. of 1's in the original MPIM : |A|    = 15
Matrix density                                 = 0.417
Total no. of within-block 1's                  = 15
No. of exceptional elements (EEs)              = 0
No. of voids                                   = 5
Sum of EEs and voids                           = 5
Group Cability Index (GCI)                     = 100.00%
grouping efficiency (GE)                       = 87.50 %
Grouping efficacy (GF)                         = 75.00 %
Machine utilization (MU)                       = 75.00 %
No. of redundant machines (RMs)                = 0
============================================================
```

Problem(14) --> Data file name : DA_14_YangYang(2008)_Figure_6a_15x15.cfp

< Machines visited by parts: Process route numbers(PRN) >

```
Part[   1] = {   3,  13 }
Part[   2] = {   2,   4,   8,   9,  12 }
Part[   3] = {   2,   4,   8,   9,  12 }
Part[   4] = {   3,  13 }
Part[   5] = {   5,   6,   7,  11,  15 }
Part[   6] = {   5,   6,   7,  11,  15 }
Part[   7] = {   3,  13 }
Part[   8] = {   3,  13 }
Part[   9] = {   2,   4,   8,   9,  12 }
Part[  10] = {   1,  10,  14 }
Part[  11] = {   3,  13 }
Part[  12] = {   1,  10,  14 }
Part[  13] = {   2,   4,   8,   9,  12 }
Part[  14] = {   5,   6,   7,  11,  15 }
Part[  15] = {   1,  10,  14 }
```

< Block Diagonal Solution Matrix >

```
            < Locations >
              0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
              0 0 0 0 0 0 0 0 0 1 1 1 1 1 1
              1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
            < Machines >
              0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
              0 0 0 0 1 0 1 0 0 0 1 1 0 1 1
< Parts >     2 4 8 9 2 3 3 5 6 7 1 5 1 0 4
=========== * * * * * * * * * * * * * * * *
(   1)   2  * 1 1 1 1 1                     *
(   2)   3  * 1 1 1 1 1                     *
(   3)   9  * 1 1 1 1 1                     *
(   4)  13  * 1 1 1 1 1                     *
=========== * = = = = = = = = = = = = = = = *
(   5)   1  *           1 1                 *
(   6)   4  *           1 1                 *
(   7)   7  *           1 1                 *
(   8)   8  *           1 1                 *
(   9)  11  *           1 1                 *
=========== * = = = = = = = = = = = = = = = *
(  10)   5  *               1 1 1 1 1       *
(  11)   6  *               1 1 1 1 1       *
(  12)  14  *               1 1 1 1 1       *
=========== * = = = = = = = = = = = = = = = *
(  13)  10  *                       1 1 1 * 
(  14)  12  *                       1 1 1 * 
(  15)  15  *                       1 1 1 * 
=========== * * * * * * * * * * * * * * * *
```

< Machine cells and Part families >

```
Machine Cell[ 1] = { 2, 4, 8, 9, 12 }
Machine Cell[ 2] = { 3, 13 }
Machine Cell[ 3] = { 5, 6, 7, 11, 15 }
Machine Cell[ 4] = { 1, 10, 14 }
```

```
Part  Family[ 1] = { 2, 3, 9, 13 }
Part  Family[ 2] = { 1, 4, 7, 8, 11 }
Part  Family[ 3] = { 5, 6, 14 }
Part  Family[ 4] = { 10, 12, 15 }
```

< Summary of the performance measures >

```
No. of machines                          = 15
No. of part types                        = 15
No. of cells                             = 4
Machine cell size                        = 5
Total no. of 1's in the original MPIM : |A| = 54
```

Matrix density	= 0.24
Total no. of within-block 1's	= 54
No. of exceptional elements (EEs)	= 0
No. of voids	= 0
Sum of EEs and voids	= 0
Group Cability Index (GCI)	= 100.00%
grouping efficiency (GE)	= 100.00%
Grouping efficacy (GF)	= 100.00%
Machine utilization (MU)	= 100.00%
No. of redundant machines (RMs)	= 0

==========

Problem(15) --> Data file name : DA_15_YangYang(2008)_Figure_6c_15x15.cfp

< Machines visited by parts: Process route numbers(PRN) >
```
Part[   1] = {   3,  13 }
Part[   2] = {   2,   4,   8,   9 }
Part[   3] = {   2,   4,   8,   9,  12 }
Part[   4] = {  13 }
Part[   5] = {   5,   7,  11,  15 }
Part[   6] = {   5,   6,   7,  15 }
Part[   7] = {   3,  13 }
Part[   8] = {   3,  13 }
Part[   9] = {   2,   4,   9,  12 }
Part[  10] = {   1,  10,  14 }
Part[  11] = {   3 }
Part[  12] = {   1,  10,  14 }
Part[  13] = {   4,   8,   9,  12 }
Part[  14] = {   6,   7,  11,  15 }
Part[  15] = {   1,  14 }
```

< Block Diagonal Solution Matrix >

```
            < Locations >
              0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
              0 0 0 0 0 0 0 0 0 1 1 1 1 1
              1 2 3 4 5 6 7 8 9 0 1 2 3 4
            < Machines >
              0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
              0 1 0 0 0 1 0 0 0 1 1 0 1 1
< Parts >     3 3 2 8 9 2 5 6 7 1 5 1 0 4
=========== * * * * * * * * * * * * * * * *
(   1)   1  * 1 1                         *
(   2)   4  *   1                         *
(   3)   7  * 1 1                         *
(   4)   8  * 1 1                         *
(   5)  11  * 1                           *
=========== * = = = = = = = = = = = = = = *
(   6)   2  *     1 1 1                   *
(   7)   3  *     1 1 1 1                 *
(   8)   9  *     1   1 1                 *
(   9)  13  *       1 1 1                 *
=========== * = = = = = = = = = = = = = = *
(  10)   5  *             1   1 1 1       *
(  11)   6  *             1 1 1   1       *
(  12)  14  *               1 1 1 1       *
=========== * = = = = = = = = = = = = = = *
(  13)  10  *                       1 1 1 *
(  14)  12  *                       1 1 1 *
(  15)  15  *                       1   1 *
=========== * * * * * * * * * * * * * * * *
```

< Machine cells and Part families >
```
Machine Cell[ 1] = { 3, 13 }
Machine Cell[ 2] = { 2, 8, 9, 12 }
Machine Cell[ 3] = { 5, 6, 7, 11, 15 }
Machine Cell[ 4] = { 1, 10, 14 }
```
```
Part  Family[ 1] = { 1, 4, 7, 8, 11 }
Part  Family[ 2] = { 2, 3, 9, 13 }
Part  Family[ 3] = { 5, 6, 14 }
Part  Family[ 4] = { 10, 12, 15 }
```

< Summary of the performance measures >
```
No. of machines                          = 14
No. of part types                        = 15
No. of cells                             = 4
Machine cell size                        = 5
Total no. of 1's in the original MPIM : |A| = 41
```

Matrix density	= 0.195
Total no. of within-block 1's	= 41
No. of exceptional elements (EEs)	= 0
No. of voids	= 9
Sum of EEs and voids	= 9
Group Cability Index (GCI)	= 100.00%
grouping efficiency (GE)	= 91.00 %
Grouping efficacy (GF)	= 82.00 %
Machine utilization (MU)	= 82.00 %
No. of redundant machines (RMs)	= 0

==========

Problem(16) --> Data file name : DA_16_FengPheng(2011)_Matrix_1_10x10.cfp

< Machines visited by parts: Process route numbers(PRN) >
```
Part[   1] = {   1,   2,   3 }
Part[   2] = {   1,   2,   3 }
Part[   3] = {   1,   2,   3 }
Part[   4] = {   4,   5,   6 }
Part[   5] = {   4,   5,   6 }
Part[   6] = {   4,   5,   6 }
Part[   7] = {   7,   8,   9,  10 }
Part[   8] = {   7,   8,   9,  10 }
Part[   9] = {   7,   8,   9,  10 }
Part[  10] = {   7,   8,   9,  10 }
```

< Block Diagonal Solution Matrix >

		< Locations >									
		0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	1
		1	2	3	4	5	6	7	8	9	0
	< Machines >										
		0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	1	0	0	0
< Parts >		1	2	3	7	8	9	0	4	5	6
==========	*	*	*	*	*	*	*	*	*	*	*
(1)	1	*	1	1	1						*
(2)	2	*	1	1	1						*
(3)	3	*	1	1	1						*
==========	*	=	=	=	=	=	=	=	=	=	*
(4)	7	*			1	1	1	1			*
(5)	8	*			1	1	1	1			*
(6)	9	*			1	1	1	1			*
(7)	10	*			1	1	1	1			*
==========	*	=	=	=	=	=	=	=	=	=	*
(8)	4	*							1	1	1 *
(9)	5	*							1	1	1 *
(10)	6	*							1	1	1 *
==========	*	*	*	*	*	*	*	*	*	*	*

< Machine cells and Part families >
```
Machine Cell[ 1] = { 1, 2, 3 }
Machine Cell[ 2] = { 7, 8, 9, 10 }
Machine Cell[ 3] = { 4, 5, 6 }
```
```
Part  Family[ 1] = { 1, 2, 3 }
Part  Family[ 2] = { 7, 8, 9, 10 }
Part  Family[ 3] = { 4, 5, 6 }
```

< Summary of the performance measures >
```
No. of machines                              = 10
No. of part types                            = 10
No. of cells                                 = 3
Machine cell size                            = 4
Total no. of 1's in the original MPIM : |A| = 34
Matrix density                               = 0.34
Total no. of within-block 1's                = 34
No. of exceptional elements (EEs)            = 0
No. of voids                                 = 0
Sum of EEs and voids                         = 0
Group Cability Index (GCI)                   = 100.00%
grouping efficiency (GE)                     = 100.00%
Grouping efficacy (GF)                       = 100.00%
Machine utilization (MU)                     = 100.00%
No. of redundant machines (RMs)              = 0
```

Problem(17) --> Data file name : DA_17_FengPheng(2011)_Matrix_2_12x12.cfp

< Machines visited by parts: Process route numbers(PRN) >
```
============================================================
Part[   1] = {   1,   2 }
Part[   2] = {   1,   2 }
Part[   3] = {   3,   4 }
Part[   4] = {   3,   4 }
Part[   5] = {   5,   6 }
Part[   6] = {   5,   6 }
Part[   7] = {   7,   8 }
Part[   8] = {   7,   8 }
Part[   9] = {   9,  10 }
Part[  10] = {   9,  10 }
Part[  11] = {  11,  12 }
Part[  12] = {  11,  12 }
============================================================
```

< Block Diagonal Solution Matrix >

	< Locations >											
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	1	1	1
	1	2	3	4	5	6	7	8	9	0	1	2
< Machines >												
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	1	1	1
< Parts >	1	2	3	4	5	6	7	8	9	0	1	2
==========	*	*	*	*	*	*	*	*	*	*	*	*
(1) 1	*	1	1									*
(2) 2	*	1	1									*
==========	*	=	=	=	=	=	=	=	=	=	=	*
(3) 3	*			1	1							*
(4) 4	*			1	1							*
==========	*	=	=	=	=	=	=	=	=	=	=	*
(5) 5	*					1	1					*
(6) 6	*					1	1					*
==========	*	=	=	=	=	=	=	=	=	=	=	*
(7) 7	*							1	1			*
(8) 8	*							1	1			*
==========	*	=	=	=	=	=	=	=	=	=	=	*
(9) 9	*									1	1	*
(10) 10	*									1	1	*
==========	*	=	=	=	=	=	=	=	=	=	=	*
(11) 11	*										1	1 *
(12) 12	*										1	1 *
==========	*	*	*	*	*	*	*	*	*	*	*	*

< Machine cells and Part families >
```
============================================================
Machine Cell[ 1] = { 1, 2 }
Machine Cell[ 2] = { 3, 4 }
Machine Cell[ 3] = { 5, 6 }
Machine Cell[ 4] = { 7, 8 }
Machine Cell[ 5] = { 9, 10 }
Machine Cell[ 6] = { 11, 12 }
============================================================
Part  Family[ 1] = { 1, 2 }
Part  Family[ 2] = { 3, 4 }
Part  Family[ 3] = { 5, 6 }
Part  Family[ 4] = { 7, 8 }
Part  Family[ 5] = { 9, 10 }
Part  Family[ 6] = { 11, 12 }
============================================================
```

< Summary of the performance measures >
```
============================================================
No. of machines                              = 12
No. of part types                            = 12
No. of cells                                 = 6
Machine cell size                            = 2
Total no. of 1's in the original MPIM : |A| = 24
```

Matrix density	= 0.167
Total no. of within-block 1's	= 24
No. of exceptional elements (EEs)	= 0
No. of voids	= 0
Sum of EEs and voids	= 0
Group Cability Index (GCI)	= 100.00%
grouping efficiency (GE)	= 100.00%
Grouping efficacy (GF)	= 100.00%
Machine utilization (MU)	= 100.00%
No. of redundant machines (RMs)	= 0

==========

Problem(18) --> Data file name : DA_18_ShaferRogers(1993)_Figure_2_20x20.cfp

< Machines visited by parts: Process route numbers(PRN) >

```
Part[   1] = {   1,   2,   5 }
Part[   2] = {   1,   4 }
Part[   3] = {   1,   2,   3,   4 }
Part[   4] = {   1,   3,   4 }
Part[   5] = {   1,   2 }
Part[   6] = {   6,   7 }
Part[   7] = {   6,   7 }
Part[   8] = {   6,   8,   9,  10 }
Part[   9] = {   6,   7,   9,  10 }
Part[  10] = {   6,   7,   9,  10 }
Part[  11] = {  11,  12,  14,  15 }
Part[  12] = {  15 }
Part[  13] = {  11,  13,  15 }
Part[  14] = {  12,  13,  14,  15 }
Part[  15] = {  15 }
Part[  16] = {  17,  18,  20 }
Part[  17] = {  16,  19,  20 }
Part[  18] = {  16,  18,  19,  20 }
Part[  19] = {  16,  17,  19 }
Part[  20] = {  17,  18,  19 }
```

< Block Diagonal Solution Matrix >

	< Locations >																			
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	2
		1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
	< Machines >																			
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	2
< Parts >		1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
==========	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
(1) 1	*	1	1			1															*
(2) 2	*	1			1																*
(3) 3	*	1	1	1	1																*
(4) 4	*	1		1	1																*
(5) 5	*	1	1																		*
==========	*	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	*
(6) 6	*					1	1														*
(7) 7	*					1	1														*
(8) 8	*					1		1	1	1											*
(9) 9	*					1	1		1	1											*
(10) 10	*					1	1		1	1											*
==========	*	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	*
(11) 11	*										1	1		1	1						*
(12) 12	*														1						*
(13) 13	*										1		1		1						*
(14) 14	*											1	1	1	1						*
(15) 15	*														1						*
==========	*	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	*
(16) 16	*															1	1		1		*
(17) 17	*														1			1	1		*
(18) 18	*														1		1	1	1		*
(19) 19	*														1	1		1			*
(20) 20	*															1	1	1			*
==========	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

< Machine cells and Part families >

```
Machine Cell[ 1] = { 1, 2, 3, 4, 5 }
Machine Cell[ 2] = { 6, 7, 8, 9, 10 }
Machine Cell[ 3] = { 11, 12, 13, 14, 15 }
Machine Cell[ 4] = { 16, 17, 18, 19, 20 }
```

```
Part  Family[ 1] = { 1, 2, 3, 4, 5 }
Part  Family[ 2] = { 6, 7, 8, 9, 10 }
Part  Family[ 3] = { 11, 12, 13, 14, 15 }
```

Part Family[4] = { 16, 17, 18, 19, 20 }
==

< Summary of the performance measures >
==
No. of machines   = 20
No. of part types   = 20
No. of cells   = 4
Machine cell size   = 5
Total no. of 1's in the original MPIM : |A| = 59
Matrix density   = 0.147
Total no. of within-block 1's   = 59
No. of exceptional elements (EEs)   = 0
No. of voids   = 41
Sum of EEs and voids   = 41
Group Cability Index (GCI)   = 100.00%
grouping efficiency (GE)   = 79.50 %
Grouping efficacy (GF)   = 59.00 %
Machine utilization (MU)   = 59.00 %
No. of redundant machines (RMs)   = 0
==