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ภาคผนวก

ภาคผนวก ก
การกำหนดค่าพารามิเตอร์

สำหรับค่าพารามิเตอร์ที่ใช้สำหรับสร้างข้อมูลนำเข้าเพื่อจัดตารางการทำงานของพยาบาล ผู้วิจัยได้ทำการกำหนดขึ้นให้เป็นดังตารางที่ ก.1

ตารางที่ ก.1 ค่าพารามิเตอร์สำหรับสร้างข้อมูลนำเข้า

พารามิเตอร์	ค่าของพารามิเตอร์
1.) ความต้องการกำลังคนในแต่ละกะงาน	ยูนิฟอร์ม(1,n/3)
2.) การลาหยุดของพยาบาล วันที่พยาบาลลา	ยูนิฟอร์ม(0,8) ยูนิฟอร์ม(1,28)
3.) วันสุดท้ายของสถานการณ์ปกติ	ยูนิฟอร์ม(1,28)

ภาคผนวก ข

แบบจำลองทางคณิตศาสตร์บน AMPL

ภาคผนวก ข.1 แบบจำลองทางคณิตศาสตร์ สำหรับเหตุการณ์ปกติ

```
#nurse scheduling #

#set#
set N;
set S;
set DAY;

set C1;

#parameter#
param D {S,DAY};
param A {N,DAY};

#variable#
var X {N,S,DAY} binary;
var MAX {S} integer, >=0;
var MIN {S} integer, >=0;
var MAXDUTY integer, >=0;
var MINDUTY integer, >=0;

#model#
minimize RANK:
      sum {j in S}(MAX[j]-MIN[j])+(MAXDUTY-MINDUTY);

subject to
con2 {i in N,j in S}:
      MAX [j] >= sum {k in DAY}X[i,j,k];

con3{i in N,j in S}:
      MIN [j] <= sum {k in DAY}X[i,j,k];

con4 {i in N}:
      MAXDUTY >= sum {j in S,k in DAY}X[i,j,k];

con5 {i in N}:
      MINDUTY <= sum {j in S,k in DAY}X[i,j,k];

con6 {j in S,k in DAY}:
      sum {i in N}X[i,j,k] >= D[j,k];

con7 {i in N,k in 1..23}:
      sum {k1 in k..k+5,j in S}X[i,j,k1] <= 5;

con8 {i in N,j in S,k in 1..27}:
      X[i,3,k]+X[i,1,k+1]+X[i,2,k+1] <= 1;

con9 {i in N,j in S,k in 1..25}:
      sum {k2 in k..k+3}X[i,j,k2] <= 3;

con10 {i in N,k in 1..25}:
      sum {k2 in k..k+3,j in S}X[i,j,k2] >= 1;

con11 {i in N,k in DAY}:
```

```
      sum {j in S}X[i,j,k] <= A[i,k];

con12a {i in N,k in C1}:
      sum {k4 in k..k+6,j in S}X[i,j,k4] >=2;
con12b {i in N,k in C1}:
      sum {k4 in k..k+6,j in S}X[i,j,k4] <=5;
```

ภาคผนวก ข.2 แบบจำลองทางคณิตศาสตร์ สำหรับสถานการณ์ฉุกเฉิน

```
#nurse scheduling #

#set#
set N;
set S;
set DAY;
set ED;

set C1;
set C2;


#parameter#
param D {S,ED};
param A {N,ED};
param X {N,S,DAY};
param p;


#variable#
var Z {N,S,ED} binary, >=0;
var Y {N,S,ED} binary, >=0;
var MAXA {S} integer, >=0;
var MINA {S} integer, >=0;
var MAXB {S} integer, >=0;
var MINB {S} integer, >=0;
var MAXDUTYA integer, >=0;
var MINDUTYA integer, >=0;
var MAXDUTYB integer, >=0;
var MINDUTYB integer, >=0;

#model#
minimize RANK:
       sum {j in S}(MAXA[j]-MINA[j])+sum {j in S}(MAXB[j]-MINB[j])
       +(MAXDUTYA-MINDUTYA)+(MAXDUTYB-MINDUTYB);

subject to

con1a {i in N,j in S,l in 1..28-p}:
       Z[i,j,l] = Y[i,j,l]+X[i,j,l+p];

con2a {i in N,j in S}:
       MAXA [j] >= (sum {l in 1..28-p}Y[i,j,l])+(sum {k in DAY}X[i,j,k]);

con2b {i in N,j in S}:
       MAXB [j] >= (sum {l in ED}Y[i,j,l])+(sum {k in p+1..28}X[i,j,k]);

con3a {i in N,j in S}:
       MINA [j] <= (sum {l in 1..28-p}Y[i,j,l])+(sum {k in DAY}X[i,j,k]);

con3b {i in N,j in S}:
       MINB [j] <= (sum {l in ED}Y[i,j,l])+(sum {k in p+1..28}X[i,j,k]);

con4a {i in N}:
       MAXDUTYA >= (sum {l in 1..28-p,j in S}Y[i,j,l])+(sum {k in DAY,j in
       S}X[i,j,k]);

con4b {i in N}:
       MAXDUTYB >= (sum {l in ED,j in S}Y[i,j,l])+(sum {k in p+1..28,j in
       S}X[i,j,k]);
```

```
con5a {i in N}:
       MINDUTYA <= (sum {l in 1..28-p,j in S}Y[i,j,l])+(sum {k in DAY,j in
       S}X[i,j,k]);

con5b {i in N}:
       MINDUTYB <= (sum {l in ED,j in S}Y[i,j,l])+(sum {k in p+1..28,j in
       S}X[i,j,k]);

con6a {j in S,l in 1..28-p}:
       sum {i in N}Z[i,j,l] >= D[j,l];

con6b {j in S,l in 29-p..28}:
       sum {i in N}Y[i,j,l] >= D[j,l];

con7a {i in N,m in 1..6}:
       sum {l in 29-p..35-p-m,j in S}Y[i,j,l]+ sum {l in 29-p-m..28-p,j in
       S}Z[i,j,l]<= 5;

con7b1 {i in N}:
       sum {l in 1..7,j in S}Z[i,j,l]<= 9;

con7b3 {i in N,l in 8..22-p}:
       sum {l1 in l..l+6,j in S}Z[i,j,l1]<= 5;

con7c {i in N,l in 29-p..22}:
       sum {l1 in l..l+6,j in S}Y[i,j,l1]<= 5;

con8a2 {i in N,l in 7..28-p}:
       Z[i,3,l]+Z[i,1,l+1]+Z[i,2,l+1] <= 1;

con8b {i in N}:
       Z[i,3,28-p]+Y[i,1,29-p]+Y[i,2,29-p] <= 1;

con8c {i in N,l in 29-p..27}:
       Y[i,3,l]+Y[i,1,l+1]+Y[i,2,l+1] <= 1;

con8d {i in N,l in 1..6,m in 1..2}:
       sum {j in 3-m..3}Z[i,j,l]+(sum {j in 1..3-m}Z[i,j,l+1]) <= 3;

con9a {i in N,j in S,l in 1..25-p}:
       sum {l2 in l..l+3}Z[i,j,l2]<= 3;

con9b {i in N,j in S,m in 1..3}:
       sum {l in 29-p..32-p-m}Y[i,j,l]+ sum {l in 29-p-m..28-p}Z[i,j,l]<= 3;

con9c {i in N,j in S,l in 29-p..25}:
       sum {l2 in l..l+3}Y[i,j,l2]<= 3;

con10a {i in N,l in 1..25-p}:
       sum {l2 in l..l+3,j in S}Z[i,j,l2]>= 1;

con10b {i in N,m in 1..3}:
       sum {l in 29-p..32-p-m,j in S}Y[i,j,l]+ sum {l in 29-p-m..28-p,j in
       S}Z[i,j,l]>= 1;

con10c {i in N,l in 29-p..25}:
       sum {l2 in l..l+3,j in S}Y[i,j,l2]>= 1;

con11a {i in N,l in 1..7}:
       sum {j in S}Z[i,j,l] <= (3*(A[i,l]));

con11b2 {i in N,l in 8..28-p}:
       sum {j in S}Z[i,j,l] <= A[i,l];
```

```
con11c {i in N,l in 29-p..28}:
       sum {j in S}Y[i,j,l] <= A[i,l];

con12a {i in N}:
       (sum {l in 1..28-p,j in S}Y[i,j,l])+(sum {k in DAY,j in S}X[i,j,k])<=
       30;

con12b {i in N}:
       (sum {l in ED,j in S}Y[i,j,l])+(sum {k in p+1..28,j in S}X[i,j,k])<=
       20;
```

ภาคผนวก ค

ตัวอย่างไฟล์กำหนดลำดับการทำงาน

ภาคผนวก ค.1 ไฟล์กำหนดการทำงานเพื่อทดสอบแบบจำลองในสถานการณ์ปกติ (สำหรับพยาบาล 10 คน)

```
reset;
model nurse-2.mod;
data 10-1.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-1.txt;
reset;
model nurse-2.mod;
data 10-2.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-2.txt;
reset;
model nurse-2.mod;
data 10-3.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-3.txt;
reset;
model nurse-2.mod;
data 10-4.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-4.txt;
reset;
model nurse-2.mod;
data 10-5.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-5.txt;
reset;
model nurse-2.mod;
data 10-6.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-6.txt;
reset;
model nurse-2.mod;
data 10-7.dat;
solve;
```

```
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-7.txt;
reset;
model nurse-2.mod;
data 10-8.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-8.txt;
reset;
model nurse-2.mod;
data 10-9.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-9.txt;
reset;
model nurse-2.mod;
data 10-10.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-10.txt;
reset;
model nurse-2.mod;
data 10-11.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-11.txt;
reset;
model nurse-2.mod;
data 10-12.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-12.txt;
reset;
model nurse-2.mod;
data 10-13.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-13.txt;
reset;
model nurse-2.mod;
data 10-14.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-14.txt;
reset;
model nurse-2.mod;
data 10-15.dat;
solve;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY,X>rn10-15.txt;
reset;
```

ภาคผนวก ค.2 ไฟล์กำหนดการทำงานเพื่อทดสอบแบบจำลองในสถานการณ์ฉุกเฉิน (สำหรับพยาบาล 10 คน)

```
reset;
model nurse-ed28-2a.mod;
data e10-1.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
1.txt;
reset;
model nurse-ed28-2a.mod;
data e10-2.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
2.txt;
reset;
model nurse-ed28-2a.mod;
data e10-3.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
3.txt;
reset;
model nurse-ed28-2a.mod;
data e10-4.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
4.txt;
reset;
model nurse-ed28-2a.mod;
data e10-5.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
5.txt;
reset;
model nurse-ed28-2a.mod;
data e10-6.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
6.txt;
```

```
reset;
model nurse-ed28-2a.mod;
data e10-7.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
7.txt;
reset;
model nurse-ed28-2a.mod;
data e10-8.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
8.txt;
reset;
model nurse-ed28-2a.mod;
data e10-9.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
9.txt;
reset;
model nurse-ed28-2a.mod;
data e10-10.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
10.txt;
reset;
model nurse-ed28-2a.mod;
data e10-11.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
11.txt;
reset;
model nurse-ed28-2a.mod;
data e10-12.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
12.txt;
reset;
model nurse-ed28-2a.mod;
data e10-13.dat;
```

```
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
13.txt;
reset;
model nurse-ed28-2a.mod;
data e10-14.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
14.txt;
reset;
model nurse-ed28-2a.mod;
data e10-15.dat;
solve;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB,Z,Y>e10-
15.txt;
reset;
```

ภาคผนวก ค.3 ไฟล์กำหนดการทำงานเพื่อใช้แบบจำลองร่วมกับโปรแกรม Microsoft Excel (ในสถานการณ์ปกติสำหรับพยาบาล 10 คน)

```
reset;
model nurse-2.mod;
data 10nset.dat;
table DEMAND IN "ODBC" "DEMAND10.xls": [S,DAY],D;
table AVAILABLE IN "ODBC" "AVN10.xls": [N,DAY],A;
read table DEMAND;
read table AVAILABLE;
solve;
table DUTY OUT "ODBC" "XN10.xls": [N,S,DAY],X;
write table DUTY;
display _total_solve_time,RANK,MAX,MIN,MAXDUTY,MINDUTY>result10n.txt;
reset;
```

ภาคผนวก ค.4 ไฟล์กำหนดการทำงานเพื่อใช้แบบจำลองร่วมกับโปรแกรม Microsoft Excel (ในสถานการณ์ฉุกเฉินสำหรับพยาบาล 10 คน)

```
reset;
model nurse-ed28-2a.mod;
data e10nset.dat;
data p.txt;
table DEMAND IN "ODBC" "EDEMAND10.xls": [S,ED],D;
table AVAILABLE IN "ODBC" "EAVN10.xls": [N,ED],A;
table DUTY IN "ODBC" "XN10.xls": [N,S,DAY],X;
read table DEMAND;
read table AVAILABLE;
read table DUTY;
solve;
table EDUTY OUT "ODBC" "ZN10.xls": [N,S,ED],Z;
write table EDUTY;
display _total_solve_time,RANK,MAXA,MINA,MAXB,MINB,MAXDUTYA,MINDUTYA,MAXDUTYB,MINDUTYB>result28-10n.txt;
reset;
```

ภาคผนวก ง

ผลการทดสอบแบบจำลองทางคณิตศาสตร์

ภาคผนวก ง.1 ผลการทดสอบแบบจำลองทางคณิตศาสตร์สำหรับพยาบาล 10 คน

_total_solve_time = 0.0469

RANK = 0

: MAX MIN :=

1 6 6

2 5 5

3 7 7

;

MAXDUTY = 18

MINDUTY = 18

X [*,1,*] (tr)

:	1	2	3	4	5	6	7	8	9	10	:=
1	0	0	0	1	0	0	0	0	0	0	
2	1	0	0	0	0	0	0	1	0	0	
3	1	0	0	0	0	0	0	0	0	1	
4	1	1	0	0	0	0	0	0	0	0	
5	0	0	0	0	1	0	1	0	0	0	
6	0	0	0	0	1	0	1	0	0	0	
7	0	0	0	0	0	1	0	1	0	0	
8	0	1	0	1	0	0	0	0	0	0	
9	1	0	0	0	1	1	0	0	0	0	
10	0	1	0	0	1	1	0	0	0	0	
11	0	1	0	0	0	0	1	0	0	1	
12	0	1	0	0	0	0	0	1	0	0	
13	0	0	0	0	1	0	0	0	0	1	
14	0	1	0	0	0	0	0	0	0	0	
15	0	0	0	0	0	1	0	0	0	0	
16	0	0	0	0	0	0	1	0	1	0	
17	1	0	0	1	0	0	0	0	0	1	
18	0	0	0	0	0	1	0	0	0	0	
19	0	0	0	0	0	0	0	1	0	0	
20	0	0	1	0	0	0	0	1	0	1	
21	0	0	0	0	0	0	0	1	1	1	
22	1	0	1	0	0	0	0	0	1	0	

```
23  0  0  1  1  0  0  0  0  0  0
24  0  0  0  1  0  0  1  0  1  0
25  0  0  1  0  1  0  0  0  0  0
26  0  0  1  0  0  1  1  0  0  0
27  0  0  1  1  0  0  0  0  1  0
28  0  0  0  0  0  0  0  0  1  0
```

```
[*,2,*] (tr)
:  1  2  3  4  5  6  7  8  9  10  :=
1  0  0  0  0  0  0  0  0  1  0
2  0  1  0  0  0  0  0  0  0  0
3  0  1  1  0  0  0  0  0  0  0
4  0  0  0  0  0  0  1  0  0  1
5  0  0  0  0  0  0  0  1  0  0
6  1  0  0  0  0  0  0  0  0  0
7  0  0  0  1  0  0  0  0  0  0
8  0  0  0  0  0  0  1  0  0  0
9  0  0  0  1  0  0  0  1  1  0
10 1  0  0  1  0  0  0  0  0  0
11 0  0  0  0  0  0  0  0  1  0
12 0  0  0  0  0  0  0  1  0  1  1
13 0  0  0  0  0  0  0  1  0  0  0
14 1  0  0  0  1  0  1  0  0  1
15 0  0  0  0  1  0  0  0  0  0
16 0  0  1  0  0  1  0  0  0  0
17 0  0  1  0  1  0  1  0  0  0
18 1  0  1  0  0  0  0  0  0  1
19 0  1  0  1  1  0  0  0  0  0
20 0  1  0  0  0  0  0  0  0  0
21 0  0  1  0  0  0  0  0  0  0
22 0  0  0  1  0  0  0  0  0  1
23 0  1  0  0  0  0  0  0  0  0
24 0  0  0  0  1  0  0  1  0  0
25 0  0  0  0  0  1  0  1  0  0
26 0  0  0  0  0  0  0  0  1  1  0
27 1  0  0  0  0  0  1  0  0  0  0
28 0  0  0  0  0  0  1  0  0  0  0
```

```
[*,3,*] (tr)
:  1  2  3  4  5  6  7  8  9  10  :=
1  0  0  0  0  0  0  1  0  0  0  0
2  0  0  0  0  0  0  1  0  0  0  0
3  0  0  0  1  1  0  0  1  0  0
```

```
4  0 0 1 1 0 1 0 0 1 0
5  0 1 1 1 0 0 0 0 0 0
6  0 0 1 0 0 0 0 0 1 0
7  1 0 0 0 0 0 1 0 0 1
8  0 0 0 0 0 0 1 0 0 0
9  0 0 0 0 0 0 0 0 0 1
10 0 0 1 0 0 0 0 1 0 0
11 1 0 1 0 1 0 0 0 0 0
12 1 0 1 0 0 1 0 0 0 0
13 0 0 0 1 0 0 0 1 1 0
14 0 0 1 1 0 0 0 1 1 0
15 1 1 0 0 0 0 0 0 0 1
16 0 1 0 0 0 0 0 1 0 0
17 0 1 0 0 0 0 0 1 1 0
18 0 0 0 0 0 0 1 0 1 0
19 0 0 0 0 0 0 1 1 0 1 0
20 0 0 0 1 1 1 0 0 0 0
21 0 0 0 0 1 0 1 0 0 0
22 0 0 0 0 1 0 1 1 0 0
23 1 0 0 0 0 1 0 0 0 1
24 1 1 0 0 0 0 0 0 0 1
25 0 1 0 1 0 0 0 0 0 0
26 0 1 0 0 0 0 0 0 0 1
27 0 0 0 0 1 0 0 0 0 1
28 1 0 0 0 1 0 1 0 0 0
;
```

ภาคผนวก ง.2 ผลการทดสอบแบบจำลองทางคณิตศาสตร์สำหรับพยาบาล 15 คน

_total_solve_time = 2.32812

RANK = 0

: MAX MIN :=

1 6 6

2 6 6

3 5 5

;

MAXDUTY = 17

MINDUTY = 17

X [*,1,*] (tr)

:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	:=
1	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	
2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	
3	0	0	1	0	0	0	0	0	0	0	0	1	0	1	1	
4	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	
5	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	
6	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0
7	1	0	0	0	0	1	0	1	0	0	1	0	1	0	0	
8	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	
9	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	
10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
11	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	
12	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	
13	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	
14	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	
15	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	
16	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	
17	0	0	0	0	1	0	0	1	1	0	1	0	0	1	0	
18	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	
19	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	
20	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	
21	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	
22	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	
23	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
24	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	
25	0	1	0	0	0	0	0	0	0	1	0	1	1	0	1	
26	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
27	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	

28 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1

[*,2,*] (tr)

: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 :=

1 1 0 0 0 1 0 1 0 0 0 0 1 0 1 0

2 1 0 1 0 0 0 0 0 0 1 0 0 0 0 0

3 1 0 0 0 0 0 0 0 0 0 1 0 1 0 0

4 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0

5 0 0 0 1 0 0 0 0 0 0 0 1 1 0 1

6 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0

7 0 0 0 0 0 0 0 0 0 1 0 0 0 1 0

8 0 0 0 0 0 1 1 0 0 0 1 0 0 0 0

9 0 0 1 0 0 0 0 0 0 0 0 1 1 0 0

10 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0

11 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0

12 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1

13 0 0 0 0 0 1 0 0 0 0 0 1 0 0 1

14 0 1 1 1 1 1 0 0 0 0 0 0 0 0 0

15 1 0 0 0 0 0 0 1 1 0 0 0 0 1 0

16 0 1 0 1 1 0 0 1 0 1 0 0 0 1 0

17 0 1 0 1 0 1 0 0 0 0 0 0 0 0 1

18 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0

19 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0

20 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0

21 1 0 0 0 0 0 0 0 0 0 1 0 1 1 0

22 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0

23 0 0 1 0 0 0 0 0 0 0 0 0 1 0 0

24 0 0 0 0 0 0 1 0 1 0 0 1 0 0 1

25 1 0 1 1 0 0 1 0 1 0 0 0 0 0 0

26 0 1 0 0 0 1 0 1 1 0 0 0 0 0 1

27 0 0 0 0 0 0 0 1 0 1 1 0 0 0 0

28 0 0 1 0 1 0 1 1 0 0 0 0 0 0 0

[*,3,*] (tr)

: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 :=

1 0 0 0 0 0 0 0 1 0 0 0 0 1 0 1

2 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0

3 0 0 0 0 0 0 1 1 0 1 1 0 0 0 0 0

4 0 0 1 0 1 0 1 0 0 1 1 0 0 0 0

5 1 0 0 0 1 0 1 0 0 0 0 0 0 1 0

6 0 1 1 0 0 0 0 0 0 0 0 1 0 0 1

7 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0

8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

```
9  0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0
10 0 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0
11 0 0 0 1 0 0 0 1 0 1 0 0 0 0 0 0
12 0 1 0 0 0 0 1 0 0 0 1 0 0 0 0 0
13 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0
14 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0
15 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0
16 0 0 1 0 0 0 0 0 0 0 0 1 1 0 0 0
17 1 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0
18 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0
19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
20 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1
21 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0
22 0 0 0 1 0 1 0 1 1 0 0 0 0 0 0 0
23 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0
24 0 0 0 0 1 1 0 1 0 0 1 0 0 1 0
25 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0
26 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0
27 1 1 0 0 0 0 0 0 0 0 0 0 1 1 0
28 1 0 0 0 0 1 0 0 1 1 0 0 0 0 0
;
```

ภาคผนวก ง.3 ผลการทดสอบแบบจำลองทางคณิตศาสตร์สำหรับพยาบาล 20 คน

_total_solve_time = 0.1406

RANK = 0

: MAX MIN :=

1 5 5

2 6 6

3 5 5

;

MAXDUTY = 16

MINDUTY = 16

X [*,1,*] (tr)

: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

:=

1 0 0 0 1 1 0 0 0 1 1 0 0 0 0 1 0 0 0 0

2 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0

3 0 0 0 0 0 1 0 0 1 0 1 1 0 0 0 0 0 0 0

4 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0

5 0 1 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0

6 0 1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 1 0

7 1 0 1 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0

8 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

9 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0

10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0

11 1 0 0 1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0

12 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 0

13 0 0 0 0 0 1 0 1 0 1 0 0 0 0 1 0 0 0 0

14 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0

15 0 1 1 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1

16 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1

17 0 0 1 0 1 1 0 1 0 0 0 0 0 0 0 0 0 0 1

18 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 1 1 0

19 1 0 0 0 0 0 0 0 1 0 1 0 0 0 1 0 0 0 0

20 0 0 0 0 0 0 0 1 1 0 0 0 0 0 1 0 0 1 0 1

21 0 0 0 1 0 0 1 0 0 0 1 0 1 0 0 1 0 0 0

22 0 0 0 0 0 0 0 1 0 0 0 0 1 1 0 0 1 1 0 0

23 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0

24 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1

25 0 0 1 0 1 0 0 0 0 0 0 0 1 1 0 1 0 0 1 0

26 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0

27 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0

```
28  0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0

:  20  :=
1   1
2   0
3   1
4   1
5   0
6   0
7   1
8   0
9   0
10  0
11  1
12  0
13  0
14  0
15  0
16  0
17  0
18  0
19  0
20  0
21  0
22  0
23  0
24  0
25  0
26  0
27  0
28  0

[*,2,*] (tr)
:  1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16 17 18 19
:=
1   1  0  0  0  0  0  0  0  0  0  0  0  1  1  1  0  1  0  0  0
2   0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  1  1  1
3   0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0
4   0  1  0  0  0  0  0  1  1  0  0  1  1  0  0  0  0  0  1  0  0
5   0  0  0  0  0  0  0  1  1  0  0  0  0  0  1  0  0  0  0  0  0
6   0  0  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
7   0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  1  0  0  0  0  0  0
8   0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  1  1  1  0  0  0  1
```

```
9  0 1 1 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 1 0
10 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
11 0 0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0
12 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0
13 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 1 1 1 0
14 0 1 0 1 0 1 0 0 0 1 0 1 0 1 1 1 1 1 0 0
15 0 0 0 0 0 1 0 0 1 0 1 0 0 0 1 1 0 0 0 0 0
16 1 0 1 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
17 0 1 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0
18 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
19 0 0 1 0 0 0 0 1 0 0 0 1 1 0 0 0 0 0 0 0
20 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0
21 1 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 1 1 0
22 1 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
23 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1
24 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 1 0 0 1 0
25 1 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 1
26 0 0 0 0 1 1 1 0 0 1 0 1 0 0 0 0 0 0 0 1
27 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1
28 0 0 0 1 0 0 1 0 1 0 1 0 0 0 0 0 1 0 0 0
```

```
: 20 :=
1  0
2  0
3  0
4  0
5  1
6  0
7  0
8  0
9  1
10 0
11 0
12 0
13 1
14 0
15 0
16 1
17 1
18 0
19 0
20 0
21 0
```

```
22  0
23  1
24  0
25  0
26  0
27  0
28  0

[*,3,*] (tr)
:  1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16 17 18 19
:=
1  0  0  0  0  0  1  0  1  0  0   1  0  0  0  0  0  0  0  0
2  0  1  0  0  0  0  0  0  0  0   0  0  0  0  0  0  0  0  0
3  1  0  1  0  0  0  0  0  0  0   0  0  1  0  0  0  0  1  0
4  0  0  0  0  1  1  0  0  0  0   0  0  0  0  1  1  0  1  0
5  1  0  0  0  0  0  0  0  0  0   1  0  0  0  1  0  1  0  1
6  0  0  0  0  0  0  0  0  1  1   0  1  0  0  0  1  0  0  1
7  0  0  0  1  0  1  0  0  0  0   1  1  0  0  0  1  0  0  0
8  0  0  0  0  1  0  0  0  0  0   0  0  0  0  0  0  0  0  0
9  0  0  0  0  0  0  1  0  0  0   0  0  0  0  0  0  0  0  0
10 0  0  0  0  0  0  0  0  0  1   0  0  0  0  1  0  0  0  0  0
11 0  0  0  0  0  0  0  0  0  0   0  1  1  0  0  1  0  1  0  0
12 0  0  1  1  0  0  0  0  0  1   0  0  0  0  0  0  0  0  0  1
13 0  0  0  0  0  0  0  0  0  0   0  0  0  1  0  0  0  0  0  1
14 0  0  0  0  0  0  0  0  0  0   0  0  0  0  0  0  0  0  1  0
15 0  0  0  0  0  0  0  1  0  0   0  0  0  0  0  0  0  1  1  0
16 0  0  0  0  0  0  0  1  0  0   0  1  0  0  0  1  0  1  0  0
17 1  0  0  1  0  0  1  0  0  1   0  0  0  0  0  0  1  0  0  0
18 0  0  0  0  0  0  0  0  0  0   0  0  0  0  0  0  0  0  0  0
19 0  0  0  1  0  0  0  0  0  0   0  0  0  0  0  0  0  0  0  0
20 0  0  0  0  1  0  0  0  0  0   0  1  0  0  0  0  0  0  0  0
21 0  0  0  0  0  0  0  0  0  1   1  0  0  0  0  0  0  0  0  1
22 0  0  1  1  1  0  0  0  1  1   0  0  0  1  0  0  0  1  0  0
23 0  1  1  0  0  0  0  0  0  1   0  0  1  0  0  0  0  0  0  0
24 0  1  0  0  0  1  1  1  0  0   0  0  0  1  0  1  0  0  0  0
25 0  0  0  0  0  0  0  0  0  0   0  0  0  1  0  0  0  0  0  0
26 1  1  0  0  0  0  0  0  0  0   0  1  1  0  0  0  0  0  0  0
27 1  1  0  0  0  0  0  1  0  0   0  0  1  0  0  0  1  0  0  0
28 0  0  1  0  1  1  0  1  0  1   0  0  0  1  1  0  0  0  0  0

:  20  :=
1  0
2  0
```

```
3  0
4  0
5  0
6  0
7  0
8  0
9  0
10  0
11  0
12  0
13  0
14  1
15  0
16  0
17  0
18  1
19  0
20  1
21  1
22  0
23  0
24  0
25  1
26  0
27  0
28  0
;
```

ภาคผนวก ง.4 ผลการทดสอบแบบจำลองทางคณิตศาสตร์สำหรับพยาบาล 25 คน

_total_solve_time = 3.7969

: MAX MIN :=
1 6 6
2 6 6
3 5 5
;

MAXDUTY = 17
MINDUTY = 17

X [*,1,*] (tr)

:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
:=																			
1	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
2	0	0	0	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0
3	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
4	0	0	0	0	1	1	0	1	1	0	0	0	0	1	0	0	0	0	1
5	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0
6	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0
7	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0
8	1	0	0	0	0	1	0	0	1	0	0	0	1	0	1	1	0	0	1
9	0	0	0	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1
10	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
11	1	0	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
12	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
13	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0
14	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0
15	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
16	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0
17	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1
18	1	0	0	0	0	1	0	1	0	0	1	0	0	0	1	0	0	1	0
19	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
20	0	0	1	0	0	0	1	0	0	1	0	0	1	1	0	1	1	0	0
21	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0
22	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
23	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0
24	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
25	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
26	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0

```
27  1  0  1  0  0  1  0  0  0  0  0  0  0  0  1  0  1  0  1  0
28  0  1  0  0  0  1  0  0  0  0  1  0  0  0  0  0  0  0  0  0

:  20  21  22  23  24  25  :=
1   0   0   1   1   1   0
2   0   1   1   0   0   0
3   1   0   0   0   0   0
4   0   0   0   0   1   0
5   1   0   0   0   0   0
6   1   0   0   0   0   1
7   1   0   1   0   0   0
8   0   1   0   1   0   0
9   1   1   0   0   1   0
10  0   0   0   0   0   0
11  0   0   1   0   0   1
12  0   0   0   0   0   0
13  0   0   0   0   0   0
14  0   0   0   0   1   0
15  0   0   0   0   0   0
16  1   1   0   0   0   0
17  0   0   0   0   0   1
18  0   0   1   1   1   0
19  0   0   0   0   0   0
20  0   0   0   1   0   0
21  0   0   0   0   0   0
22  0   1   0   1   0   0
23  0   0   0   0   0   0
24  0   0   0   0   0   1
25  0   0   0   0   0   1
26  0   0   0   1   1   0
27  0   1   1   0   0   1
28  0   0   0   0   0   0

[*,2,*] (tr)
:  1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17  18  19
:=
1   1  0  0  0  0  1  1  0  0  0   0   0   1   1   0   0   1   0   1
2   1  1  0  0  0  0  0  0  1  1   0   0   0   0   0   0   0   1   0
3   0  0  0  1  0  0  0  0  1  0   0   0   0   0   0   0   0   0   0
4   0  0  0  1  0  0  0  0  0  0   1   0   0   0   0   0   0   0   0
5   0  0  0  0  1  0  1  0  1  0   0   0   0   0   0   0   1   1   1
6   0  0  0  0  0  1  1  0  0  0   0   0   0   1   0   0   0   0   0
7   0  0  0  0  0  0  0  0  0  0   0   0   1   0   1   0   0   0   0
```

8	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	1	1	0	0	1	0	0	0	1	0	0	0	1	1	0	0	1	0		
10	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1		
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
12	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
13	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0			
14	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1		
15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0		
16	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	1		
17	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	1	0	0	0		
18	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
19	0	0	1	1	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0		
20	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1		
21	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0		
22	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0		
23	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0		
24	0	0	0	1	1	0	1	0	1	0	1	0	1	0	0	0	1	1	0		
25	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0		
26	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0		
27	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
28	1	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	1	0		

:	20	21	22	23	24	25	:=
1	0	0	0	0	0	0	
2	1	0	0	0	0	0	
3	0	0	0	0	0	0	
4	0	0	1	1	0	1	
5	0	0	0	0	1	1	
6	0	0	0	0	0	0	
7	0	1	0	1	0	0	
8	0	0	1	0	0	0	
9	0	0	0	1	0	0	
10	0	1	1	0	0	0	
11	0	0	0	0	0	0	
12	0	0	0	1	0	1	
13	1	1	0	0	0	0	
14	1	1	0	0	0	0	
15	1	0	0	0	1	1	
16	0	0	1	1	0	0	
17	0	0	0	0	0	0	
18	0	0	0	0	0	0	
19	0	0	1	1	0	0	
20	0	0	0	0	1	0	

```
21  0  0  1  0  1  0
22  0  0  0  0  0  0
23  0  0  0  0  0  0
24  0  1  0  0  0  0
25  0  0  0  0  1  0
26  1  0  0  0  0  1
27  0  0  0  0  0  0
28  1  1  0  0  1  1
```

```
[*,3,*] (tr)
:  1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16 17 18 19
:=
1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0
2  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  1  1  0  1
3  1  0  0  0  0  0  0  0  0  0  1  0  0  1  0  0  1  0  1  0
4  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
5  0  1  0  1  0  0  0  1  0  0  0  1  0  0  0  0  0  0  0  0
6  1  1  1  1  1  1  0  0  0  0  0  1  0  0  0  0  1  0  0  0
7  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
8  0  0  0  0  0  0  0  0  1  0  0  0  1  0  0  0  0  1  0  0
9  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
10 0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0
11 0  1  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0
12 0  0  1  0  0  0  1  0  1  1  0  0  0  0  0  1  0  1  1
13 1  0  1  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0
14 0  0  0  0  0  0  0  0  1  0  0  0  0  0  1  0  0  0  0  0
15 0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  1  0
16 0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0
17 0  0  0  0  0  0  0  0  0  1  0  0  0  0  1  0  0  0  0  0
18 0  1  0  0  1  0  0  0  0  0  0  0  0  0  1  0  0  1  0  0
19 0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  1  0
20 0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  1  0  0  0  0
21 0  0  0  1  0  0  1  0  0  0  1  0  0  0  1  0  0  0  1
22 0  0  1  0  0  0  0  0  0  0  1  0  0  0  0  0  0  1  1  0
23 1  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  1
24 1  0  0  0  0  0  1  0  1  0  0  0  0  0  1  0  0  0  0  0
25 0  0  0  1  0  1  0  0  0  1  1  0  0  0  1  0  1  0  0
26 0  0  0  0  0  0  0  0  0  1  1  1  0  0  0  1  0  0  0  1
27 0  0  0  0  0  0  0  0  0  1  0  0  1  1  0  0  0  0  0  0
28 0  0  1  0  1  0  1  0  0  0  0  1  1  0  1  0  0  0  0
```

```
:  20 21 22 23 24 25 :=
1  0  0  0  0  0  1
```

```
2  0  0  0  0  0  0
3  0  1  0  0  0  0
4  0  1  0  0  0  0
5  0  1  1  1  0  0
6  0  0  0  0  1  0
7  0  0  0  0  1  0
8  0  0  0  0  0  1
9  0  0  0  0  0  0
10 1  0  0  1  0  0
11 0  0  0  0  0  0
12 0  0  1  0  1  0
13 0  0  0  0  0  0
14 0  0  1  0  0  0
15 0  0  0  0  0  0
16 0  0  0  0  0  0
17 1  0  0  0  0  0
18 0  0  0  0  0  1
19 0  0  0  0  0  1
20 1  1  0  0  0  1
21 1  0  0  0  0  0
22 0  0  0  0  1  0
23 1  0  1  1  1  0
24 0  0  1  1  0  0
25 0  1  0  0  0  0
26 0  0  0  0  0  0
27 0  0  0  1  0  0
28 0  0  0  0  0  0
;
```

ภาคผนวก ง.5 ผลการทดสอบแบบจำลองทางคณิตศาสตร์สำหรับพยาบาล 30 คน

_total_solve_time = 9.40625

RANK = 0

: MAX MIN :=

1 5 5

2 6 6

3 5 5

;

MAXDUTY = 16

MINDUTY = 16

X [*,1,*]

: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

:=

1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0

2 0 0 0 1 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0

3 0 0 1 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0

4 1 1 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0

5 0 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 0

6 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0

7 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 0 0 0

8 1 1 0 1 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0

9 0 0 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0

10 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1

11 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1

12 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 0

13 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0

14 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 1 0 0 0

15 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0

16 0 0 1 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0

17 0 0 0 1 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0

18 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0

19 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 1 0 0

20 0 0 1 0 0 0 0 0 1 0 0 1 1 1 0 0 0 0 0

21 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0

22 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0

23 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 1 0 0 0 1

24 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 1 0 0 0

25 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0

```
26 0 0 0 1 0 0 0 1 0 0  0 0 0 0 0 1 0 1 0
27 0 0 0 0 0 0 0 0 1 0  1 0 0 0 0 0 0 0 0
28 1 0 0 0 0 0 0 1 0 0  0 0 0 0 0 0 0 0 0
29 0 0 1 1 0 0 0 1 0 0  0 0 0 0 0 0 0 0 0
30 0 0 0 1 0 0 0 0 0 0  0 0 0 1 1 1 0 0 0

:  20 21 22 23 24 25 26 27 28  :=
1  0  0  1  0  0  0  0  0  0
2  0  1  0  0  0  0  0  0  1
3  0  1  0  0  0  0  0  0  0
4  0  0  0  0  0  0  0  1  0
5  0  0  1  1  0  0  0  0  0
6  1  0  0  0  1  0  0  1  0
7  0  0  0  0  0  0  0  1  0  1
8  0  0  0  0  0  0  0  0  0  0
9  0  1  0  0  0  0  0  0  0  0
10 0  0  1  1  0  0  0  0  0  1
11 1  0  0  0  0  1  0  0  0
12 0  0  0  0  1  0  1  0  0
13 0  1  1  0  1  0  0  0  1
14 0  0  0  1  0  0  0  0  0
15 1  1  0  1  0  0  0  0  0
16 0  0  0  0  1  0  0  0  0
17 1  0  0  0  1  0  0  0  0
18 0  1  1  0  1  0  0  0  0
19 0  0  0  1  0  0  0  1  0
20 0  0  0  0  0  0  0  0  0  0
21 0  1  1  1  0  0  0  0  0
22 1  0  0  0  0  0  0  1  0
23 0  0  0  0  0  0  0  0  0  0
24 0  0  0  1  0  0  0  0  0
25 0  0  0  0  0  0  1  0  1
26 0  0  0  0  0  0  0  0  1
27 0  1  1  0  0  0  1  0  0
28 0  0  0  0  0  0  1  1  1
29 0  0  0  1  0  0  1  0  0
30 0  1  0  0  0  0  0  0  0

[*,2,*]
:  1 2 3 4 5 6 7 8 9  10 11 12 13 14 15 16 17 18 19
:=
1  0 1 0 0 0 1 0 0 1 0  0 0 0 0 0 0 0 0 1
2  1 0 0 0 0 0 0 1 0 0  0 0 1 0 0 0 0 0 0
```

3	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0								
4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1							
5	0	0	1	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	1							
6	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0							
7	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0								
8	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0								
9	1	0	0	0	0	1	0	1	0	0	1	0	0	0	0	1	0	0	0								
10	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0								
11	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0								
12	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0								
13	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0									
14	0	1	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0								
15	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0								
16	0	0	0	0	1	1	0	0	1	0	0	0	0	1	1	0	0	0	0								
17	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	1								
18	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	1								
19	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	0							
20	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0							
21	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0							
22	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1							
23	0	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0							
24	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0							
25	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1								
26	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0								
27	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1								
28	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	1								
29	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0								
30	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0							

:	20	21	22	23	24	25	26	27	28	:=
1	0	0	0	1	0	0	1	0	0	
2	1	0	0	0	0	0	1	1	0	
3	1	0	1	0	0	1	0	0	0	
4	1	1	0	0	0	0	1	0	0	
5	0	0	0	0	0	0	0	0	0	
6	0	1	0	0	0	0	0	0	1	
7	1	1	1	0	0	0	0	0	0	
8	1	1	1	0	0	0	0	0	0	
9	0	0	0	0	0	0	1	0	0	
10	1	1	0	0	0	1	0	0	0	
11	0	1	0	1	0	0	0	1	0	
12	0	0	0	0	0	1	0	1	1	
13	1	0	0	0	0	0	1	0	0	

14 0 1 0 0 0 0 0 0 0
15 0 0 1 0 0 1 0 1 1
16 0 0 0 0 0 1 0 0 0
17 0 0 0 0 0 0 0 0 0
18 1 0 0 0 0 0 0 0 0
19 0 0 0 0 0 1 1 0 0
20 1 1 0 1 0 0 0 0 0
21 1 0 0 0 0 0 0 0 1
22 0 1 1 0 0 0 1 0 0
23 0 0 0 0 0 0 0 1 1
24 0 0 1 0 0 1 0 0 0
25 0 1 0 0 0 0 0 0 0
26 0 0 0 0 1 0 1 1 0
27 0 0 0 0 0 0 0 1 1
28 0 0 0 0 0 0 0 0 0
29 0 0 0 0 0 0 0 0 1
30 0 0 1 0 0 0 1 1 1

[*,3,*]
: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
:=
1 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0
2 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 1 1 0
3 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 1 0
4 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
5 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0
6 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 1 1 0 0
7 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0
9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
10 1 0 0 0 0 1 0 1 1 0 0 0 0 1 0 0 0 0 0
11 0 0 1 0 1 0 1 0 1 0 0 0 0 1 0 0 0 0 0
12 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0
13 0 0 0 0 0 1 0 0 1 1 1 0 0 0 0 1 0 0 0
14 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
15 1 0 0 1 0 0 0 0 0 0 0 1 0 0 0 1 0 1 0
16 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0
17 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0
18 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
19 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
20 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 0 1 1 0
21 0 0 1 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
22 0 0 0 0 1 0 0 0 0 1 1 0 0 0 0 1 0 0 0

```
23  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
24  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  1  1  1
25  0  0  0  0  0  1  1  0  0  0  0  0  0  0  1  0  0  0  0  0
26  1  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  1
27  1  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  1  1  0  0
28  0  0  0  0  0  0  1  0  0  0  0  1  0  0  0  0  0  0  0  0
29  0  0  0  0  0  1  0  0  0  0  0  0  1  1  0  0  0  0  0  0
30  1  1  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  1  1

:  20  21  22  23  24  25  26  27  28  :=
1   0   0   0   0   0   0   0   1   1
2   0   0   1   0   0   0   0   0   0
3   0   0   0   0   0   0   0   1   1
4   0   0   1   1   0   0   0   0   1
5   0   0   0   0   0   0   0   1   1
6   0   0   1   0   0   0   0   0   0
7   0   0   0   1   1   0   0   0   0
8   0   0   0   1   0   1   1   1   0
9   0   0   1   0   1   0   0   1   1
10  0   0   0   0   0   0   0   0   0
11  0   0   0   0   0   0   0   0   0
12  1   1   0   0   0   0   0   0   0
13  0   0   0   0   0   0   0   0   0
14  0   0   0   0   1   1   0   1   1
15  0   0   0   0   0   0   0   0   0
16  1   1   0   0   0   0   0   1   1
17  0   1   0   0   0   1   0   1   1
18  0   0   0   0   0   0   1   1   1
19  0   1   0   0   0   0   0   0   1
20  0   0   0   0   0   0   0   1   0
21  0   0   0   0   0   1   1   0   0
22  0   0   0   0   0   0   0   0   1
23  1   1   1   0   1   1   0   0   0
24  0   0   0   0   0   0   1   0   0
25  0   0   1   0   1   0   0   0   0
26  1   1   0   0   0   0   0   0   0
27  0   0   0   0   1   0   0   0   0
28  1   1   1   0   0   0   0   0   0
29  1   1   0   0   0   0   0   0   0
30  0   0   0   0   0   0   0   0   0
;
```

ประวัติผู้เขียนวิทยานิพนธ์

นางสาวฑิตยรัตน์ มงคลรังสฤษฎ์ เกิดวันที่ 21 กันยายน พ.ศ. 2523 ที่จังหวัดกรุงเทพมหานคร สำเร็จการศึกษาในระดับปริญญาวิศวกรรมศาสตรบัณฑิต สาขาวิชาวิศวกรรมอุตสาหการ ภาควิชาวิศวกรรมอุตสาหการ คณะวิศวกรรมศาสตร์ มหาวิทยาลัยมหิดล เมื่อวันที่ 9 เมษายน พ.ศ. 2546 และเข้าศึกษาต่อในระดับปริญญาวิศวกรรมศาสตรมหาบัณฑิต สาขาวิชาวิศวกรรมอุตสาหการ ภาควิชาวิศวกรรมอุตสาหการ คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย เมื่อ พ.ศ. 2546