"MRT"

MRT:

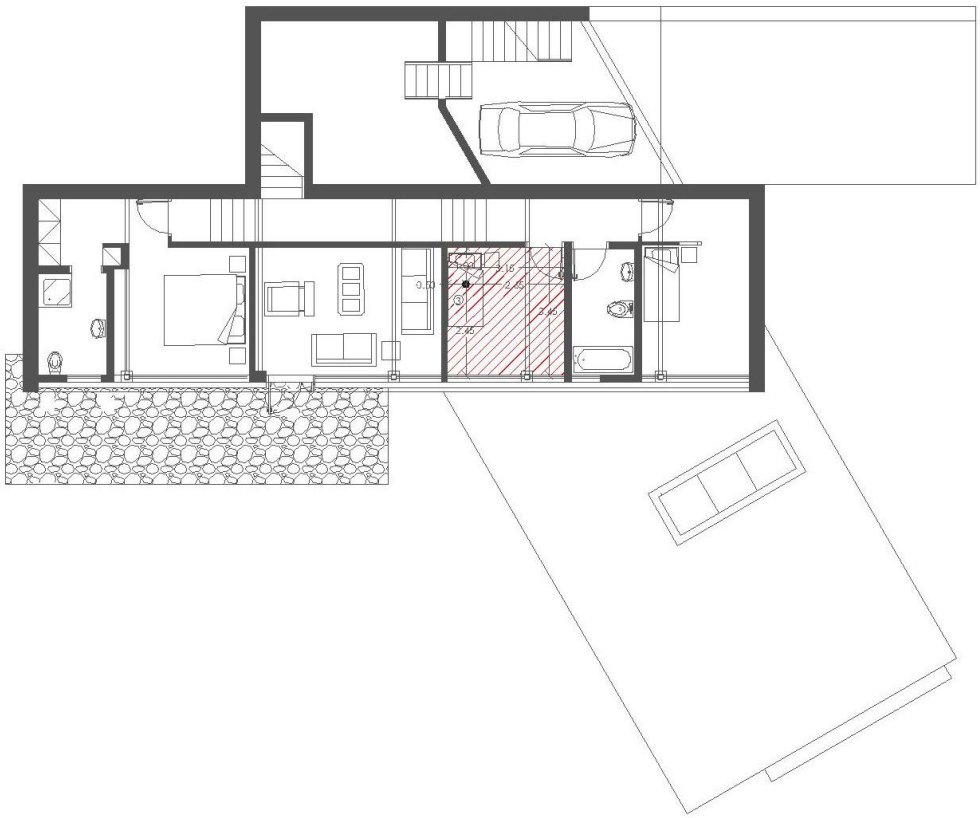
The mean radiant temperature is the total radiation located in one point of a room, it's calculated applying the following formula:

MRT = Σi (tiFv,i)

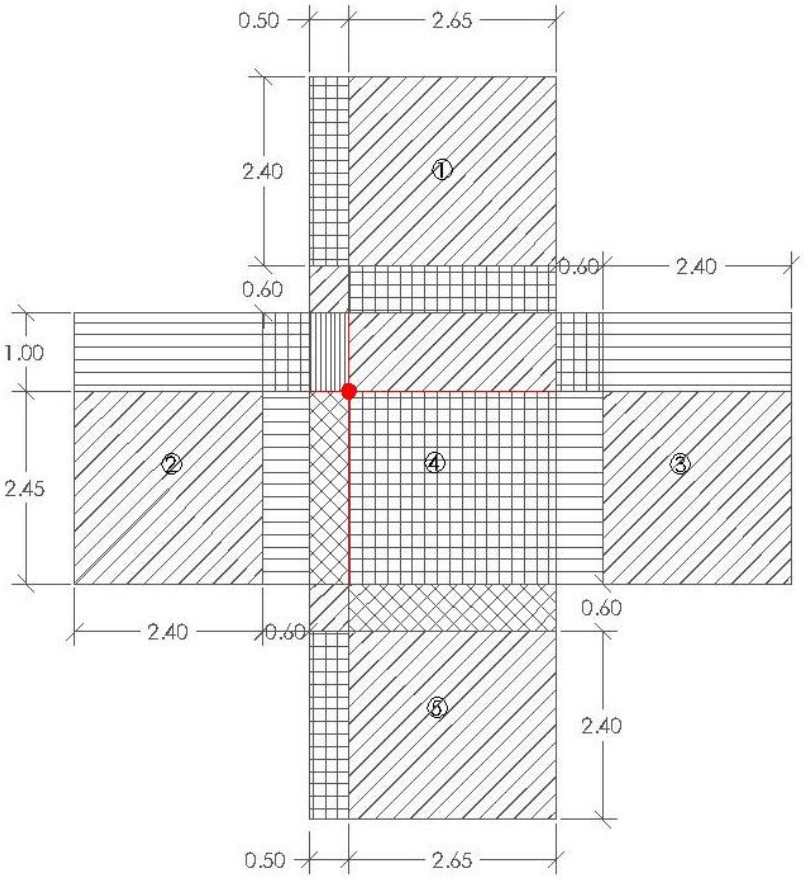
Where:

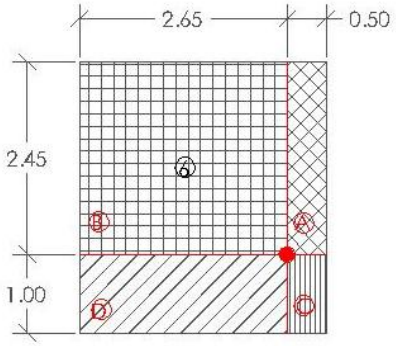
- **ti : are the indoor surface temperatures of the elements enclosing the space.**
- **Fv,i : are the shape factors of the different surfaces from a specific point of the room, and energy leaving the surface a by radiation and reaching the "surface" in P.**

Location of the room:

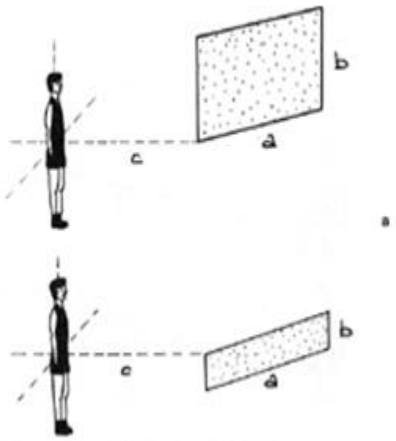


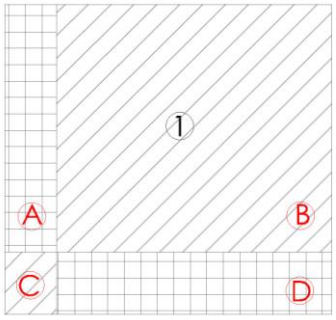
Decomposition of the room:





Shape 1: Internal Wall.





For the shape A:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\, a/c$$
$$\gamma = C + D\, b/c + E\, a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.50
b	2.40
c	1

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.03032

For the shape B:

The temperature in this shape is 20 ºC , because it's an interior wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	2.65
b	2.40
c	1

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.08266

For the shape C:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.50
b	0.60
c	1

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.01541

For the shape D:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\, a/c$$
$$\gamma = C + D\, b/c + E\, a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

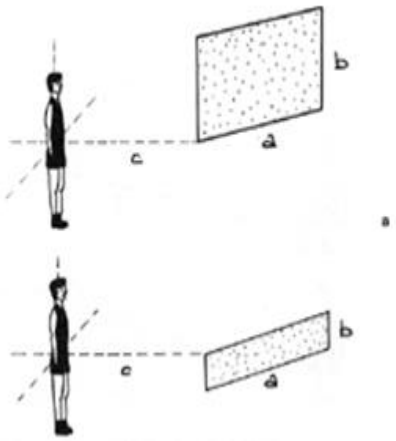
SURFACES	(m)
a	2.65
b	0.60
c	1

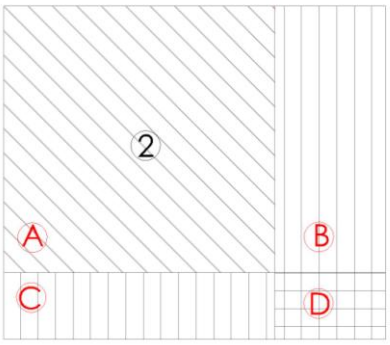
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.03994

SHAPES	$F_{p,i}$
A	0.03032
B	0.08266
C	0.01541
D	0.03994
∑=	0.16833

Shape 2: internal wall.





For the shape A:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\, a/c$$
$$\gamma = C + D\, b/c + E\, a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	2.45
b	2.40
c	0.50

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.10638

For the shape B:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	1
b	2.40
c	0.50

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.08444

For the shape C:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	2.45
b	0.60
c	0.50

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.06704

For the shape D:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

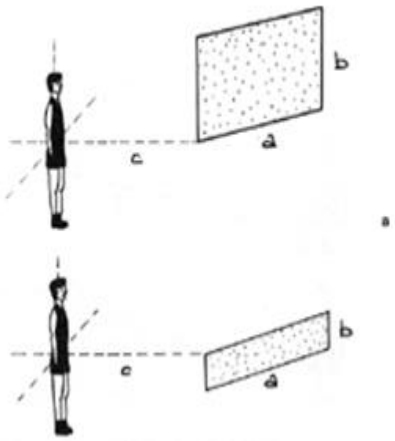
SURFACES	(m)
a	1
b	0.6
c	0.50

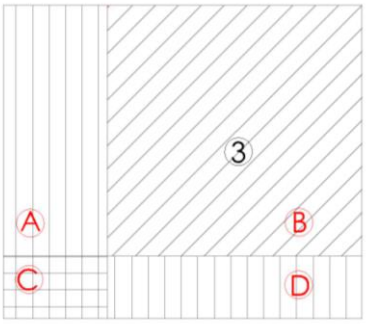
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.05658

SHAPES	$F_{p,i}$
A	0.10638
B	0.08444
C	0.06704
D	0.05658
∑=	0.31444

Shape 3: Interior Wall.





For the shape A:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\, a/c$$
$$\gamma = C + D\, b/c + E\, a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	1
b	2.40
c	2.65

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.01589

For the shape B:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	2.45
b	2.40
c	2.65

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.03183

For the shape C:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	1
b	0.60
c	2.65

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.00560

For the shape D:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

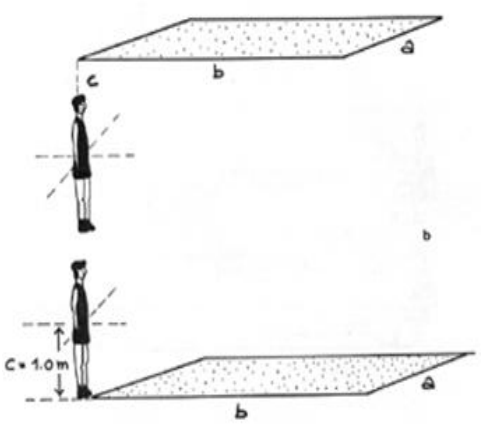
SURFACES	(m)
a	2.45
b	0.60
c	2.65

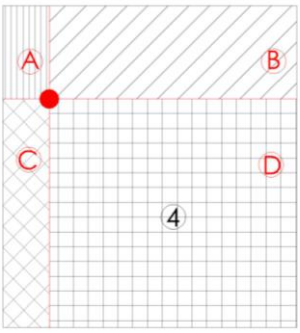
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.01112

SHAPES	$F_{p,i}$
A	0.01589
B	0.03183
C	0.00560
D	0.01112
∑=	0.06444

Shape 4: Floor.





For the shape A:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$

$\tau = A + B\ a/c$
$\gamma = C + D\ b/c + E\ a/c$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	0.50
b	1
c	0.60

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.04555

For the shape B:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	2.65
b	1
c	0.60

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.08259

For the shape C:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	0.50
b	2.45
c	0.60

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.05276

For the shape D:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

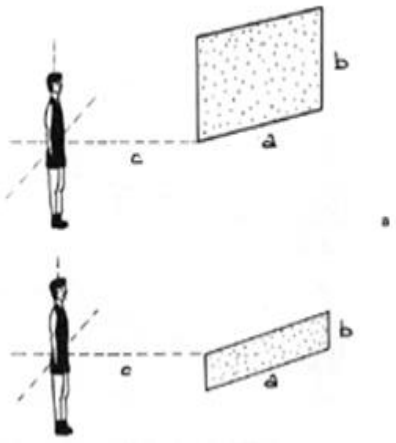
SURFACES	(m)
a	2.65
b	2.45
c	0.60

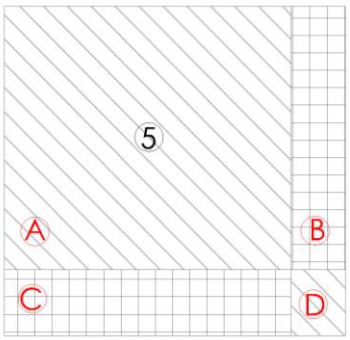
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.10096

SHAPES	$F_{p,i}$
A	0.04555
B	0.08259
C	0.05276
D	0.10096
∑=	0.28186

Shape 5: External Wall.





For the shape A:

The temperature in this shape is 12,72 °C , because it's an external wall.

T (°C)
12,72

To calculate the Fv, it's necessary apply this formula:

$$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\, a/c$$
$$\gamma = C + D\, b/c + E\, a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	2.65
b	2.40
c	2.45

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.03689

For the shape B:

The temperature in this shape is 12,72 °C , because it's an external wall.

T (°C)
12,72

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.50
b	2.40
c	2.45

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.00961

For the shape C:

The temperature in this shape is 12,72 °C , because it's an external wall.

T (°C)
12,72

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	2.65
b	0.60
c	2.45

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.03858

For the shape D:

The temperature in this shape is 12,72 ºC , because it's an external wall.

T (ºC)
12,72

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

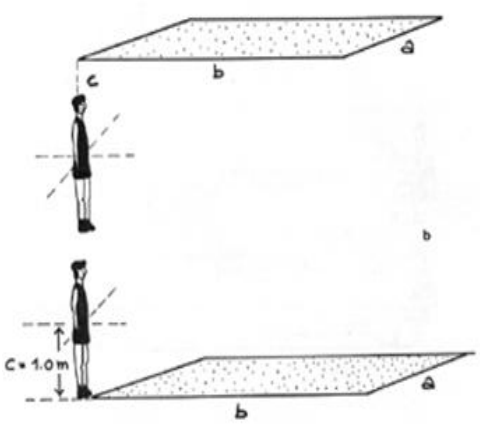
SURFACES	(m)
a	0.50
b	0.60
c	2.45

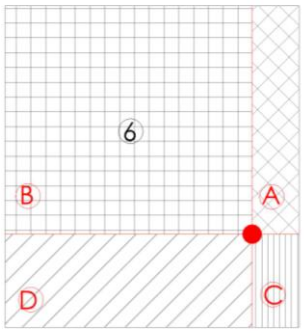
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.00348

SHAPES	$F_{p,i}$
B	0.03689
A	0.00961
D	0.03858
C	0.00348
∑=	0.08856

Shape 6: Ceiling.





For the shape A:

The temperature in this shape is 19,26 ºC , because it's an external wall.

T (ºC)
19,26

To calculate the Fv, it's necessary apply this formula:

$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$

$\tau = A + B\ a/c$
$\gamma = C + D\ b/c + E\ a/c$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	2.65
b	2.45
c	2.40

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.04457

For the shape B:

The temperature in this shape is 19,26 °C , because it's an external wall.

T (°C)
19,26

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	0.50
b	2.45
c	2.40

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.01291

For the shape C:

The temperature in this shape is 19,26 °C , because it's an external wall.

T (°C)
19,26

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	1
b	2.65
c	2.40

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.02394

For the shape D:

The temperature in this shape is 19,26 °C , because it's an external wall.

T (°C)
19,26

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	0.50
b	1
c	2.40

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0.00760

SHAPES	$F_{p,i}$
A	0.04457
B	0.01291
C	0.02394
D	0.00760
∑=	0.08902

	TEMPERATURE (°C)	Fp,i	MRTp
WALL 1	20	0.16833	3.3666
WALL 2	20	0.31444	6.2888
WALL 3	20	0.06444	1.2888
FLOOR 4	20	0.28186	5.6372
WALL 5	12,72	0.08856	1.1264832
CEILING 6	19,29	0.08902	1.7171958

∑=19.425079 °C

MRT= 19.4°C ≈ 19 °C

OPERATING TEMPERATURE:

Once MRT is known, it is possible to calculate the "operating temperature", that is a good indicator of thermal comfort.

Top = (DBT + MRT) / 2

Where DBT is the Dry Bulb Temperature and it's 20°C

Top = (20 + 19) /2 = 19.5 °C

Top = 19.5 °C 19 °C < Top < 20 °C