Basis for the total Hilbert space 2^L

L = chain size;
dim = dimension of the total Hilbert space, 2^L;
basis = each list (array) corresponds to a basis vector.

```
Clear[L, dim, basis];
L = 4;
dim = 2^L;

Do[
  basis[i] = IntegerDigits[i - 1, 2, L];
  Print["Basis vector ", i, " is ", basis[i]];
  , {i, 1, dim}];
```

```
Basis vector 1 is {0, 0, 0, 0}

Basis vector 2 is {0, 0, 0, 1}

Basis vector 3 is {0, 0, 1, 0}

Basis vector 4 is {0, 0, 1, 1}

Basis vector 5 is {0, 1, 0, 0}

Basis vector 6 is {0, 1, 0, 1}

Basis vector 7 is {0, 1, 1, 0}

Basis vector 8 is {0, 1, 1, 1}

Basis vector 9 is {1, 0, 0, 0}

Basis vector 10 is {1, 0, 0, 1}

Basis vector 11 is {1, 0, 1, 0}

Basis vector 12 is {1, 0, 1, 1}

Basis vector 13 is {1, 1, 0, 0}

Basis vector 14 is {1, 1, 0, 1}

Basis vector 15 is {1, 1, 1, 0}

Basis vector 16 is {1, 1, 1, 1}
```

EXERCISE 1:
Basis with a fixed number (L/2) of up-spins

L = chain size;
dim = dimension of the subspace with “upspins” spins pointing up in the z direction and “downspins” spin pointing down;
onebasisvector = a single basis vectors from all the possible ones;
basis = each list (array) corresponds to a basis vector.

```
Clear[L, upspins, downspins, dim];
L = 6;
upspins = L / 2;
downspins = L - upspins;
dim = L ! / (upspins ! downspins !);

(* BASIS *)
Clear[onebasisvector, basis];
onebasisvector = Flatten[{Table[1, {k, 1, upspins}], Table[0, {k, 1, downspins}]}];
basis = Permutations[onebasisvector];
Do[
  Print["Basis vector ", i, " is ", basis[[i]]];
  , {i, 1, dim}];
```

```
Basis vector 1 is {1, 1, 1, 0, 0, 0}

Basis vector 2 is {1, 1, 0, 1, 0, 0}

Basis vector 3 is {1, 1, 0, 0, 1, 0}

Basis vector 4 is {1, 1, 0, 0, 0, 1}

Basis vector 5 is {1, 0, 1, 1, 0, 0}

Basis vector 6 is {1, 0, 1, 0, 1, 0}

Basis vector 7 is {1, 0, 1, 0, 0, 1}

Basis vector 8 is {1, 0, 0, 1, 1, 0}

Basis vector 9 is {1, 0, 0, 1, 0, 1}

Basis vector 10 is {1, 0, 0, 0, 1, 1}

Basis vector 11 is {0, 1, 1, 1, 0, 0}

Basis vector 12 is {0, 1, 1, 0, 1, 0}

Basis vector 13 is {0, 1, 1, 0, 0, 1}

Basis vector 14 is {0, 1, 0, 1, 1, 0}

Basis vector 15 is {0, 1, 0, 1, 0, 1}

Basis vector 16 is {0, 1, 0, 0, 1, 1}

Basis vector 17 is {0, 0, 1, 1, 1, 0}

Basis vector 18 is {0, 0, 1, 1, 0, 1}

Basis vector 19 is {0, 0, 1, 0, 1, 1}

Basis vector 20 is {0, 0, 0, 1, 1, 1}
```