

1. Constraint to generate the pattern 0102030405.

```
1 module jk;
2 class abc;
3     rand int a[];
4     constraint size {a.size==10;}
5     constraint mirr { foreach(a[i])
6                         if(i%2==0)
7                             a[i]==0;
8                         else
9                             a[i]==(i+1)/2;
10                    }
11 endclass
12
13 abc m_h = new();
14
15 initial begin
16     m_h.randomize();
17     $display("\n\n");
18
19     $write("\t\t\t The required Pattern is: ");
20     foreach (m_h.a[i])
21         $write("%0d",m_h.a[i]);
22
23     $display("\n\n");
24 end
25
26 endmodule
```

SAMPLE OUTPUT:

The required Pattern is: 0102030405

RNQUIE: Simulation is complete.

2. Constraint to generate unique numbers between 99 to 100.

```
1 module JK();
2   class eve;
3       rand int val;
4       real out_val;
5
6       constraint a1 {val inside {[990:1000]}};
7
8       function void post_randomize();
9           out_val = val/10.0;
10          $display("\t\t\t Unique value is %2f", out_val);
11      endfunction
12
13  endclass
14
15  initial begin
16      eve p1=new();
17      repeat(20) begin
18          p1.randomize();
19      end
20  end
21 endmodule
```

SAMPLE OUTPUT:

```
Unique value is 99.600000
Unique value is 99.500000
Unique value is 99.000000
Unique value is 99.400000
Unique value is 99.900000
Unique value is 99.300000
Unique value is 99.300000
Unique value is 99.300000
Unique value is 99.700000
Unique value is 99.100000
Unique value is 99.100000
Unique value is 99.800000
Unique value is 99.300000
Unique value is 99.200000
Unique value is 99.700000
Unique value is 99.800000
Unique value is 99.100000
Unique value is 99.400000
Unique value is 99.200000
Unique value is 99.000000
```

NQUIE: Simulation is complete.

3. Constraint - divisible by 5.

```
1 class abc;
2   rand bit[7:0] a;
3   constraint divby5 {a%5 == 0;}
4 endclass
5
6 module jk;
7   abc m_h=new();
8
9   initial begin
10      repeat(15) begin
11          m_h.randomize();
12          $display("A%%5 = %0d",m_h.a);
13      end
14   end
15 endmodule
```

SAMPLE OUTPUT:

```
A%5 = 145
A%5 = 170
A%5 = 15
A%5 = 10
A%5 = 35
A%5 = 115
A%5 = 75
A%5 = 100
A%5 = 50
A%5 = 240
A%5 = 175
A%5 = 85
A%5 = 225
A%5 = 210
A%5 = 135
INFO: Simulation is complete.
```

4. Derive odd numbers within the range of 10 to 30 using SV constraint.

```
1 class abc;
2     rand bit[7:0] a;
3     constraint odd {a inside {[10:30]}};
4         a%2 == 1;
5     }
6 endclass
7
8 module jk;
9     abc m_h=new();
10
11 initial begin
12     repeat(15) begin
13         m_h.randomize;
14         if(m_h.a%2 == 1)
15             $display("\t\t\tODD number = %d",m_h.a);
16         else
17             $display("%0d is not an odd number",m_h.a);
18     end
19 end
20 endmodule
```

SAMPLE OUTPUT:

```
ODD number = 19
ODD number = 23
ODD number = 29
ODD number = 23
ODD number = 13
ODD number = 13
ODD number = 13
ODD number = 25
ODD number = 23
ODD number = 11
ODD number = 17
ODD number = 25
ODD number = 21
ODD number = 29
ODD number = 29
RNQUIE: Simulation is complete.
```

5. Write a constraint for 4-bit dynamic array. The size of the array should be in between 15 to 20. There should be even number in odd locations and odd number in even locations.

```
1 class abc;
2   rand bit[3:0] a[];
3   int i;
4   constraint arr_size {a.size() inside {[15:20]}};
5
6   constraint odd_pos { foreach (a[i]) {
7       if(i%2 == 0)
8           a[i]%2 == 1;
9       else
10          a[i]%2 == 0;
11    }
12  }
13
14 function void display();
15   $display("\t\t\t\t*-----size = %0d-----*\n",a.size());
16   foreach(a[i]) begin
17       if(i%2 == 0)
18           $write("\tindex = %0d(Even location)   ",i);
19       else
20           $write("\tindex = %0d(Odd location)   ",i);
21
22       if(a[i]%2 == 0)
23           $display(" value = %0d (EVEN Number)",a[i]);
24       else
25           $display(" value = %0d (ODD Number)",a[i]);
26   end
27 endfunction
28
29 endclass[]
30
31 module jk;
32   abc m_h=new();
33
34   initial begin
35       repeat(25) begin
36           m_h.randomize();
37           m_h.display();
38       end
39   end
40 endmodule[]
```

SAMPLE OUTPUT:

```
*-----size = 20-----*  
  
index = 0(Even location)      value = 15 (ODD Number)  
index = 1(Odd location)       value = 0 (EVEN Number)  
index = 2(Even location)      value = 7 (ODD Number)  
index = 3(Odd location)       value = 2 (EVEN Number)  
index = 4(Even location)      value = 7 (ODD Number)  
index = 5(Odd location)       value = 12 (EVEN Number)  
index = 6(Even location)      value = 11 (ODD Number)  
index = 7(Odd location)       value = 2 (EVEN Number)  
index = 8(Even location)      value = 9 (ODD Number)  
index = 9(Odd location)       value = 2 (EVEN Number)  
index = 10(Even location)     value = 5 (ODD Number)  
index = 11(Odd location)      value = 14 (EVEN Number)  
index = 12(Even location)     value = 13 (ODD Number)  
index = 13(Odd location)      value = 4 (EVEN Number)  
index = 14(Even location)     value = 13 (ODD Number)  
index = 15(Odd location)      value = 8 (EVEN Number)  
index = 16(Even location)     value = 13 (ODD Number)  
index = 17(Odd location)      value = 10 (EVEN Number)  
index = 18(Even location)     value = 11 (ODD Number)  
index = 19(Odd location)      value = 8 (EVEN Number)  
*W,RNQUIE: Simulation is complete.
```

6. Write a constraint for two random variables such that one variable should not match with the other & the total number of bits toggled in one variable should be 5 w.r.t the other.

```
1 class abc;
2   rand bit[7:0] datain;
3   rand bit[7:0] prev_data;
4
5   constraint d1 {datain != prev_data;}
6   constraint ones {$countones(datain) == 5;}
7
8 endclass
9
10 module jk;
11   abc m_h;
12
13   initial begin
14     m_h = new();
15     repeat(25) begin
16       m_h.randomize();
17       $display("\t\t\t\tPrevious_data = %0b", m_h.prev_data);
18       $display("\t\t\t\tdata          = %0b\n", m_h.datain);
19     end
20   end
21 endmodule
```

SAMPLE OUTPUT:

```
Previous_data = 1011101
data          = 1110011

Previous_data = 11
data          = 1101101

Previous_data = 1000100
data          = 10111010

Previous_data = 11110
data          = 111110

Previous_data = 10001101
data          = 10111001

Previous_data = 1110110
data          = 110111

Previous_data = 1001110
data          = 11010110

Previous_data = 10011
data          = 11010101
```

7. Write a constraint such that when rand bit[3:0] a is randomized, the value of “a” should not be same as 5 previous occurrences of the value of “a”.

```
1 class abc;
2   rand bit[3:0] a;
3   int queue[$:7];
4
5   constraint c1 {!(a inside {queue});}
6
7   function void post_randomize();
8       queue.push_front(a);
9       $display("value of a = %0d \n",a);
10      if(queue.size == 6)
11          queue.pop_back();
12      $display("PREV_OCCURENCES = %0p",queue);
13   endfunction
14 endclass
15
16 module jk;
17   abc m_h;
18   initial begin
19       m_h = new();
20       repeat(20) begin
21           m_h.randomize();
22       end
23   end
24 endmodule
```


SAMPLE OUTPUT:

```
PREV_OCCURENCES = '{7, 11, 12, 4, 13}'  
value of a = 0
```

```
PREV_OCCURENCES = '{0, 7, 11, 12, 4}'  
value of a = 8
```

```
PREV_OCCURENCES = '{8, 0, 7, 11, 12}'  
value of a = 2
```

```
PREV_OCCURENCES = '{2, 8, 0, 7, 11}'  
value of a = 1
```

```
PREV_OCCURENCES = '{1, 2, 8, 0, 7}'  
value of a = 3
```

```
PREV_OCCURENCES = '{3, 1, 2, 8, 0}'  
value of a = 11
```

```
PREV_OCCURENCES = '{11, 3, 1, 2, 8}'  
value of a = 5
```

```
PREV_OCCURENCES = '{5, 11, 3, 1, 2}'  
value of a = 14
```

8. Constraint to generate 0, 1, x and z randomly.

```
1 class rand_4_states;
2     typedef enum {s0, s1, s2, s3} states;
3
4     rand states ss;
5     logic a;
6     rand bit ctrl;
7     constraint ctrl_c {ctrl dist {0:=5, 1:=5}};
8
9     constraint c1 {
10         if(ctrl)
11             ss inside {s0, s1};
12         else
13             ss inside {s2, s3};
14     }
15
16     function void post_randomize();
17         case(ss)
18             s0: a = 0;
19             s1: a = 1;
20             s2: a = 'x;
21             s3: a = 'z;
22         endcase
23     endfunction
24
25 endclass
26
27 module tb;
28     rand_4_states c;
29     initial begin
30         c = new();
31         repeat(20) begin
32             c.randomize();
33             $display("\t\t\t State is %0d", c.a);
34         end
35     end
36 end
37 endmodule
```

SAMPLE OUTPUT:

```
State is 1  
State is 0  
State is x  
State is z  
State is 1  
State is 1  
State is 0  
State is x  
State is 1  
State is x  
State is 1  
State is x  
State is z  
State is 0  
State is x  
State is z  
State is x  
State is 1  
State is x  
State is z  
RNQUIE: Simulation is complete.
```

9. Write a program using dynamic array.

[i] array1: no. of elements should be between 30-40.

[ii] array2: sum of all elements should be < 100

[iii] array3: sum of all elements should be > 100

```
1 class jk;
2 rand int unsigned array1[];
3 rand bit[3:0] array2[];
4 rand int unsigned array3[];
5
6 constraint arr_size {array1.size() == 20;
7                     array2.size() == 30;
8                     array3.size() == 10;}
9
10 constraint c1 {foreach(array1[i])
11               array1[i] inside {[30:40]}};
12
13 function void display();
14     $display("SIZE Of: ARRAY1 = %0d, ARRAY2 = %0d, ARRAY3 = %0d\n",
15             array1.size, array2.size, array3.size);
16     $display(" ELEMENTS OF THE ARRAYS ARE:");
17     $display(" ARRAY1: %0p \n", array1);
18     $display(" ARRAY2: %0p \n", array2);
19     $display(" ARRAY3: %0p \n", array3);
20     $display(" SUM of: ARRAY2 = %0d (<100), ARRAY3 = %d(>100)",
21             array2.sum, array3.sum);
22 endfunction
23 endclass
24
25 module dyn_arr_scenario;
26 jk c_h;
27
28 initial begin
29     c_h = new();
30
31     $display("\n\n");
32     c_h.randomize() with{array2.sum < 100; array3.sum > 100;};
33     c_h.display();
34     $display("\n\n");
35
36 end
37 endmodule
```

SAMPLE OUTPUT:

SIZE Of: ARRAY1 = 20, ARRAY2 = 30, ARRAY3 = 10

ELEMENTS OF THE ARRAYS ARE:

ARRAY1: '{38, 36, 39, 36, 36, 38, 35, 38, 33, 37, 34, 39, 33, 40, 40, 34, 38, 38, 31, 38}'

ARRAY2: '{'hf, 'hc, 'h1, 'h3, 'hf, 'hd, 'h2, 'h5, 'h7, 'h7, 'hb, 'hf, 'h0, 'h0, 'h2, 'hb, 'h6, 'hf, 'hd, 'h3, 'hb, 'ha, 'h3, 'h9, 'h5, 'h7, 'hb, 'h6, 'hc}'

ARRAY3: '{210399718, 253838307, 2484355680, 101771165, 2602896096, 1926113199, 1444724051, 647300115, 521252630, 324844528}'

SUM of: ARRAY2 = 15 (<100), ARRAY3 = 2927560897(>100)

10. There are two constraints applied to same variable. One will generate the value within the range of [25:50] and another expression should be greater than 40. What should be the value generated, and what is the reason?

```
1 class con;
2   rand bit [7:0] data;
3   constraint Const_1 {data inside {[25:50]}};
4   constraint Const_2 {data > 40;}
5 endclass
6
7 module jk;
8   con con_h;
9   initial begin
10      con_h = new();
11
12      $display("\n\n");
13      repeat(10) begin
14          con_h.randomize();
15          $display("\t\t data = %0d", con_h.data);
16
17          if(con_h.data < 40)
18              $display("\t\t data = %0d (under [25:50])", con_h.data);
19          end
20      $display("\n\n");
21
22   end
23 endmodule
```

SAMPLE OUTPUT:

```
data = 43
data = 46
data = 49
data = 43
data = 45
data = 50
data = 47
data = 47
data = 49
data = 42
```

REASON: 'Since the above two constraints are solved with the constraint solver, the solver will work on all the constraints in parallel way because constraints are **bidirectional** in nature. Thus, the constraint solver tried to satisfy both the above two constraints'.

11. Constraint with array size of 5 to 10 values & the array values should be in ascending order.

```
1 class jk;
2   rand bit[4:0] array[];
3
4   constraint c_asc { array.size inside {[5:10]};
5                       foreach (array[i])
6                           if(i>0)
7                               array[i] > array[i-1];
8                       }
9
10  function void display();
11      $display("\t\t\t size is '%0d'", array.size());
12      $display("\t\t Index  Value");
13      foreach(array[i]) begin
14          $display("\t\t [%0d] | %0d", i, array[i]);
15      end
16      $display("\t Ascending_order array = %p",array);
17  $display("\n\n");
18  endfunction
19
20 endclass
21
22 module ascending;
23   jk c_h;
24   initial begin
25       c_h = new();
26       repeat(5) begin
27           c_h.randomize();
28           c_h.display();
29       end
30   end
31 endmodule
```

SAMPLE OUTPUT:

```
size is '5'
Index  Value
[0]    |    5
[1]    |    8
[2]    |   13
[3]    |   28
[4]    |   31
Ascending_order array = {'h5, 'h8, 'hd, 'h1c, 'h1f}
```

```
size is '10'
Index  Value
[0]    |    0
[1]    |    2
[2]    |    5
[3]    |    7
[4]    |   10
[5]    |   21
[6]    |   22
[7]    |   25
[8]    |   26
[9]    |   27
Ascending_order array = {'h0, 'h2, 'h5, 'h7, 'ha, 'h15, 'h16, 'h19, 'h1a, 'h1b}
```

12. Constraint with array size of 5 to 10 values & the array values should be in descending order.

```
1 class jk;
2   rand bit[5:0] array[];
3
4   constraint arr_size { array.size inside {[5:10]};}
5   constraint c_desc {foreach (array[i])
6                       if(i>0)
7                         array[i] < array[i-1];
8                       }
9
10  function void display();
11    $display("\t\t\t size is '%0d'", array.size());
12    $display("\t\t Index  Value");
13    foreach(array[i]) begin
14      $display("\t\t [%0d]  |  %0d", i, array[i]);
15    end
16    $display("\t Descending_order array = %p",array);
17  $display("\n");
18  endfunction
19
20 endclass
21
22 module ascending;
23   jk c_h;
24   initial begin
25     c_h = new();
26     repeat(5) begin
27       c_h.randomize();
28       c_h.display();
29     end
30   end
31 endmodule
```


SAMPLE OUTPUT:

```
size is '5'
Index Value
[0] | 48
[1] | 33
[2] | 25
[3] | 5
[4] | 3
Descending_order array = {'h30', 'h21', 'h19', 'h5', 'h3'}
```

```
size is '8'
Index Value
[0] | 60
[1] | 57
[2] | 49
[3] | 41
[4] | 28
[5] | 13
[6] | 8
[7] | 1
Descending_order array = {'h3c', 'h39', 'h31', 'h29', 'h1c', 'hd', 'h8', 'h1'}
```

13. Constraint - for 0-100 range 70% and for 101-255 range 30%

```
1 class abc;
2   rand bit[7:0] a;
3   constraint c_dist {a dist {[0:100] := 7, [101:255] := 3};}
4 endclass
5
6 module jk;
7   abc m_h=new();
8
9   initial begin
10     repeat(10) begin
11       m_h.randomize;
12       if(m_h.a < 100)
13         $display("\t\t\t a = %d (Under dist. [0:100])",m_h.a);
14       else
15         $display("\t\t\t a = %d (Under dist. [101:255])", m_h.a);
16     end
17   end
18 endmodule
```

SAMPLE OUTPUT:

```
a = 5 (Under dist. [0:100])
a = 153 (Under dist. [101:255])
a = 245 (Under dist. [101:255])
a = 6 (Under dist. [0:100])
a = 20 (Under dist. [0:100])
a = 158 (Under dist. [101:255])
a = 94 (Under dist. [0:100])
a = 34 (Under dist. [0:100])
a = 22 (Under dist. [0:100])
a = 43 (Under dist. [0:100])
```

14. Without inside operator generate random values for the range 34-43.

```
1 class con;
2
3   rand logic [7:0] a;
4
5   constraint c_range {(a > 34) && (a < 43);}
6 endclass
7
8
9 module jk;
10  con con_h;
11  initial begin
12      con_h = new();
13
14      $display("\n Value of a (>34 and <43) is: ");
15      repeat(15) begin
16          con_h.randomize();
17          $display("\t\t a = %0d",con_h.a);
18      end
19      $display("\n\n");
20  end
21 endmodule
```

SAMPLE OUTPUT:

```
Value of a (>34 and <43) is:
a = 39
a = 42
a = 35
a = 41
a = 37
a = 36
a = 39
a = 41
a = 41
a = 40
a = 37
a = 37
a = 40
a = 40
a = 39
```

15. Generate unique values without using rand or randc.

```
1 class con;
2
3     int data[15];
4
5     function new();
6         foreach (data[i]) begin
7             data[i] = i;
8         end
9     endfunction
10
11     function void display();
12         $display("\n\n");
13         $display("\t\t Unique Values = %p",data);
14         $display("\n\n");
15     endfunction
16
17     function void data_shuffle();
18         data.shuffle();
19     endfunction
20 endclass
21
22 module jk;
23     con con_h;
24     initial begin
25         con_h = new();
26         con_h.data_shuffle();
27         con_h.display();
28     end
29 endmodule
```

SAMPLE OUTPUT:

```
Unique Values = '{4, 0, 12, 7, 2, 3, 11, 6, 10, 8, 14, 13, 5, 9, 1}'
```

16. Randomize the below variables:

```
class randvar;  
    rand bit[7:0] var1, var2, var3, var4;  
endclass
```

- i) Randomize all variables.
- ii) Randomize only var2.
- iii) Randomize var1 & var4.
- iv) Randomize var1, var3 and var4.

```
1 class con;  
2     rand bit [7:0] var1, var2, var3, var4;  
3 endclass  
4  
5 module jk;  
6     con con_h;  
7     initial begin  
8         con_h = new();  
9  
10    $display("\n\n");  
11  
12    $display("\t\t ----i) Randomizing all variable-----");  
13    repeat(5) begin  
14        con_h.randomize();  
15        $display("\t\t var1 = %0d, var2 = %0d, var3 = %0d, var4 = %0d",  
16                con_h.var1, con_h.var2, con_h.var3, con_h.var4);  
17    end  
18    $display("\n");  
19  
20    $display("\t\t ----ii) Randomizing only var2 -----");  
21    repeat(5) begin  
22        con_h.randomize(var2);  
23        $display("\t\t var1 = %0d, var2 = %0d, var3 = %0d, var4 = %0d",  
24                con_h.var1, con_h.var2, con_h.var3, con_h.var4);  
25    end  
26    $display("\n");  
27  
28    $display("\t\t ----iii) Randomizing var1, var4 -----");  
29    repeat(5) begin  
30        con_h.randomize(var1, var4);  
31        $display("\t\t var1 = %0d, var2 = %0d, var3 = %0d, var4 = %0d",  
32                con_h.var1, con_h.var2, con_h.var3, con_h.var4);  
33    end  
34    $display("\n");  
35  
36    $display("\t\t ----iv) Randomizing var1, var3, var4 -----");  
37    repeat(5) begin  
38        con_h.randomize(var1, var3, var4);  
39        $display("\t\t var1 = %0d, var2 = %0d, var3 = %0d, var4 = %0d",  
40                con_h.var1, con_h.var2, con_h.var3, con_h.var4);  
41    end  
42  
43    $display("\n\n");  
44  
45    end  
46 endmodule
```

SAMPLE OUTPUT:

```
----i) Randomizing all variable-----  
var1 = 214, var2 = 104, var3 = 103, var4 = 172  
var1 = 70, var2 = 116, var3 = 185, var4 = 10  
var1 = 226, var2 = 10, var3 = 245, var4 = 230  
var1 = 244, var2 = 12, var3 = 245, var4 = 197  
var1 = 229, var2 = 29, var3 = 192, var4 = 195
```

```
----ii) Randomizing only var2 -----  
var1 = 229, var2 = 126, var3 = 192, var4 = 195  
var1 = 229, var2 = 46, var3 = 192, var4 = 195  
var1 = 229, var2 = 37, var3 = 192, var4 = 195  
var1 = 229, var2 = 211, var3 = 192, var4 = 195  
var1 = 229, var2 = 220, var3 = 192, var4 = 195
```

```
----iii) Randomizing var1, var4 -----  
var1 = 67, var2 = 220, var3 = 192, var4 = 98  
var1 = 138, var2 = 220, var3 = 192, var4 = 194  
var1 = 97, var2 = 220, var3 = 192, var4 = 102  
var1 = 63, var2 = 220, var3 = 192, var4 = 30  
var1 = 241, var2 = 220, var3 = 192, var4 = 208
```

```
----iv) Randomizing var1,var3,var4 -----  
var1 = 99, var2 = 220, var3 = 16, var4 = 2  
var1 = 180, var2 = 220, var3 = 80, var4 = 97  
var1 = 26, var2 = 220, var3 = 253, var4 = 171  
var1 = 108, var2 = 220, var3 = 173, var4 = 44  
var1 = 101, var2 = 220, var3 = 115, var4 = 192
```

17. Write a single constraint to generate random values for bit[8:0] variable in the below range: 1-34, 127, 129-156, 192-202, 257-260.

```
1 class con;
2   rand bit [8:0] data;
3   constraint v {data inside {
4       [1:34],
5       127,
6       [129:156],
7       [192:202],
8       [257:260]
9   };}
10  function void display();
11      if(data>=1 && data<=34) $display("\t\t data = %0d (under [1:34])",data);
12      else if(data>=129 && data<=156) $display("\t\t data = %0d (under [129:156])",data);
13      else if(data>=192 && data<=202) $display("\t\t data = %0d (under [192:202])",data);
14      else if(data>=257 && data<=260) $display("\t\t data = %0d (under [257:260])",data);
15      else $display("\t\t data = %0d",data);
16  endfunction
17
18 endclass
19
20 module jk;
21   con con_h;
22   initial begin
23       con_h = new();
24
25       repeat(20) begin
26           con_h.randomize();
27           con_h.display();
28       end
29   end
30 endmodule
```

SAMPLE OUTPUT:

```
data = 132 (under [129:156])
data = 131 (under [129:156])
data = 146 (under [129:156])
data = 144 (under [129:156])
data = 33 (under [1:34])
data = 260 (under [257:260])
data = 136 (under [129:156])
data = 257 (under [257:260])
data = 17 (under [1:34])
data = 28 (under [1:34])
data = 130 (under [129:156])
data = 15 (under [1:34])
data = 32 (under [1:34])
data = 133 (under [129:156])
data = 21 (under [1:34])
data = 195 (under [192:202])
data = 34 (under [1:34])
data = 259 (under [257:260])
data = 192 (under [192:202])
data = 149 (under [129:156])
```

RNQUIE: Simulation is complete.

18. Generate unique random values without using unique constraint.

```
1 class con;
2   bit[4:0] data[10];
3
4   function void pre_randomize();
5     data.shuffle();
6   endfunction
7
8   function void post_randomize();
9     $display("\n\n");
10    $display("\t\t Unique values = %p",data);
11    $display("\n\n");
12  endfunction
13
14  function new();
15    for(int i = 0; i< 20; i++)
16      data[i] = i;
17  endfunction
18 endclass
19
20
21 module jk;
22   con con_h;
23   initial begin
24     con_h = new();
25     con_h.randomize();
26   end
27 endmodule
```

SAMPLE OUTPUT:

```
Unique values = '{h4, 'h2, 'h7, 'h0, 'h5, 'h6, 'h9, 'h8, 'h3, 'h1}
```


19. What is wrong with the below code? What's the correct process to write the constraint?

```
class const;
    rand bit[7:0] low, mid, high;
    constraint const_1 {low<mid<high;}
endclass
```

Without Correction:

```
1 class con;
2   rand bit [7:0] low, mid, high;
3   constraint c1 {low < mid < high;}
4 endclass
5
6 module jk;
7   con con_h;
8   initial begin
9     con_h = new();
10
11   $display("\n\t For the given constraint without correction: ");
12   repeat(10) begin
13     con_h.randomize();
14     $display("\t\t low = %0d, mid = %0d, high = %0d",con_h.low, con_h.mid, con_h.high, );
15     if(con_h.high < con_h.mid)
16       $display("\t\t low = %0d, mid = %0d, high = %0d [HIGH < MID]",con_h.low, con_h.mid, con_h.high, );
17   end
18   $display("\n\n");
19
20 end
21 endmodule
```

SAMPLE OUTPUT:

```
For the given constraint without correction:
low = 251, mid = 177, high = 200
low = 209, mid = 28, high = 174
low = 134, mid = 207, high = 56
low = 134, mid = 207, high = 56 [HIGH < MID]
low = 41, mid = 133, high = 103
low = 41, mid = 133, high = 103 [HIGH < MID]
low = 41, mid = 156, high = 35
low = 41, mid = 156, high = 35 [HIGH < MID]
low = 33, mid = 235, high = 9
low = 33, mid = 235, high = 9 [HIGH < MID]
low = 62, mid = 35, high = 117
low = 86, mid = 237, high = 139
low = 86, mid = 237, high = 139 [HIGH < MID]
low = 229, mid = 119, high = 224
low = 226, mid = 246, high = 187
low = 226, mid = 246, high = 187 [HIGH < MID]
```

With Correction:

```
1 class con;
2   rand bit [7:0] low, mid, high;
3
4   constraint c1 {low < mid;
5                 mid < high;}
6 endclass
7
8 module jk;
9   con con_h;
10  initial begin
11    con_h = new();
12
13    $display("\n\t\t With Correction:");
14    repeat(10) begin
15      con_h.randomize();
16      $display("\t\t low = %0d, mid = %0d, high = %0d",con_h.low, con_h.mid, con_h.high, );
17      if(con_h.high < con_h.mid)
18        $display("\t\t low = %0d, mid = %0d, high = %0d [HIGH < MID]",con_h.low, con_h.mid, con_h.high, );
19    end
20  $display("\n\n");
21
22  end
23 endmodule
```

SAMPLE OUTPUT:

With Correction:

```
low = 169, mid = 182, high = 220
low = 54, mid = 74, high = 154
low = 65, mid = 185, high = 239
low = 182, mid = 223, high = 245
low = 17, mid = 19, high = 154
low = 172, mid = 190, high = 202
low = 206, mid = 223, high = 231
low = 23, mid = 100, high = 203
low = 153, mid = 186, high = 221
low = 117, mid = 175, high = 224
```

20. Write a constraint for 16-bit variable such that no two consecutive (continuous) ones should be generated.

```
1 class jk;
2   rand bit[15:0] value;
3
4   constraint c1 {foreach(value[i]) {
5       if(value[i] == 1 && i<15)
6           value[i+1] == 0;}}
7   endclass
8
9   module no_consecutive_ones;
10  jk c_h;
11
12  initial begin
13      c_h = new();
14
15      $display("\n\n");
16      $display("\t\t\t binary-format \t\t corresponding decimal");
17      repeat(10) begin
18          c_h.randomize();
19          $display("\t\t\t a = %b \t->\t %d",c_h.value, c_h.value);
20      end
21      $display("\n\n");
22
23  end
24  endmodule
```

SAMPLE OUTPUT:

	binary-format		corresponding decimal
a =	0010101001001010	->	10826
a =	1000000101000001	->	33089
a =	0010010001010010	->	9298
a =	1010001010010010	->	41618
a =	1010101000000101	->	43525
a =	0010000100000101	->	8453
a =	1010100010101000	->	43176
a =	0000000100010000	->	272
a =	1000100001000001	->	34881
a =	1001000100000001	->	37121

21. Write a constraint using \$countones.

```
1 class jk;
2   rand bit[15:0] data;
3   constraint ones {$countones(data);}
4 endclass
5
6 module jk;
7   jk c_h;
8   initial begin
9     c_h = new();
10
11     $display("\t\t\t\t binary format \t\t\t\tCorresponding decimal format");
12     repeat(20) begin
13       c_h.randomize();
14       $display("\t\t\t\t data = %b ->\t\t\t\t%0d", c_h.data, c_h.data);
15     end
16     $display("\n\n");
17   end
18 endmodule
```

SAMPLE OUTPUT:

binary format	Corresponding decimal format
data = 0110110000111011 ->	27707
data = 1011000111111011 ->	45563
data = 0111001011100110 ->	29414
data = 0110010011011011 ->	25819
data = 1011011100010111 ->	46871
data = 0111101010010011 ->	31379
data = 0101000000110010 ->	20530
data = 1100111101101001 ->	53097
data = 0011101110010110 ->	15254
data = 1000011001010100 ->	34388
data = 0011111000100101 ->	15909
data = 0110110110010011 ->	28051
data = 1001110001010100 ->	40020
data = 0001110001010001 ->	7249
data = 0001110011011100 ->	7388
data = 1110101001010000 ->	59984
data = 1111111100111111 ->	65343
data = 0110110001101010 ->	27754
data = 0111010010010101 ->	29845
data = 0100010101101011 ->	17771

22. Generate 32-bit random number with only one bit set (should not use \$countones).

```

1 class jk;
2   rand bit[31:0] number;
3   rand bit[4:0] shift;
4   constraint c1 {number == 1 << shift;}
5 endclass
6
7 module no_countones;
8   jk c_h;
9
10  initial begin
11      c_h = new();
12
13      $display("\n\n");
14      $display("\t\t\t\t\tONE BIT HIGH SET \t\t\t\t\tCORRESPONDING DECIMAL FORMAT");
15      repeat(20) begin
16          c_h.randomize();
17          $display("\t number = %b ->\t %0d",c_h.number, c_h.number);
18      end
19      $display("\n\n");
20
21  end
22 endmodule

```

SAMPLE OUTPUT:

[illegible]

23. Having 16-bit of variable, only single bit high values need to be accessed. Write a constraint for that.

```
1 class jk;
2   rand bit[15:0] data;
3   constraint ones {$onehot(data);}
4 endclass
5
6 module jk;
7   jk c_h;
8   initial begin
9     c_h = new();
10
11     $display("\t\t\t\t binary format \t\t\t\tCorresponding decimal format");
12     repeat(20) begin
13       c_h.randomize();
14       $display("\t\t\t\t data = %b ->\t\t\t\t%0d", c_h.data, c_h.data);
15     end
16     $display("\n\n");
17   end
18 endmodule
```

SAMPLE OUTPUT:

binary format	Corresponding decimal format
data = 0000000001000000 ->	64
data = 0000001000000000 ->	512
data = 0000010000000000 ->	1024
data = 0000000100000000 ->	256
data = 0000000000000100 ->	8
data = 0000100000000000 ->	2048
data = 0000100000000000 ->	2048
data = 0000000000000010 ->	2
data = 0000000000000100 ->	4
data = 0000000000001000 ->	16
data = 0000100000000000 ->	2048
data = 0000001000000000 ->	512
data = 0000000010000000 ->	128
data = 0000000100000000 ->	256
data = 0000100000000000 ->	2048
data = 0000000000000100 ->	8
data = 0000000000001000 ->	16
data = 0100000000000000 ->	16384
data = 0000000000000010 ->	2
data = 0000000100000000 ->	256

24. Write a constraint to generate random values for var1[7:0] within 50 and var2 [7:0] with the non-repeated value in every randomization.

```
1 class con;
2   rand logic [7:0] var1;
3   rand logic [7:0] var2;
4
5   constraint c1 {var1 inside {[0:50]};
6                 unique{var2};}
7 endclass
8
9 module jk;
10  con con_h;
11  initial begin
12    con_h = new();
13
14    $display("\n\n");
15    repeat(5) begin
16      con_h.randomize();
17      $display("\t\t var1 = %d (UNDER [0:50]) | var2 = %d",
18              con_h.var1, con_h.var2);
19
20    end
21    $display("\n\n");
22  end
23 endmodule
```

SAMPLE OUTPUT:

```
var1 = 35 (UNDER [0:50]) | var2 = 103
var1 = 10 (UNDER [0:50]) | var2 = 214
var1 = 38 (UNDER [0:50]) | var2 = 185
var1 = 6 (UNDER [0:50]) | var2 = 70
var1 = 31 (UNDER [0:50]) | var2 = 245
```

25. Write a constraint to randomly generate unique prime numbers in an array between 1 and 200. The generated prime numbers should have 7 in it (Eg.: 7, 17, 37..)

```
1 class prime;
2   rand int a[];
3   rand int b[$];
4   constraint c1 {a.size() == 200;}
5   constraint c2 {foreach(a[i])
6                   a[i] == prime(i);}
7
8   function integer prime(int val);
9       if(val <= 1)
10          return 2;
11
12       for(int i=2; i<val; i++) begin
13           if(val%i == 0)
14               return 2;
15       end
16
17       prime = val;
18   endfunction
19
20   function void post_randomize();
21       for(int i=0; i<a.size(); i++) begin
22           if(a[i]%10 == 7)
23               b.push_back(a[i]);
24       end
25   endfunction
26
27 endclass
28
29 module jk;
30   prime c_h;
31   initial begin
32       c_h = new();
33       $display("\n\n");
34       c_h.randomize();
35       $display("\t Required Prime Nos. = %0p",c_h.b);
36       $display("\n\n");
37   end
38 endmodule
```


SAMPLE OUTPUT:

```
Required Prime Nos. = '{7, 17, 37, 47, 67, 97, 107, 127, 137, 157, 167, 197}'
```

```
*W,RNQUIE: Simulation is complete.
```

26. Write a constraint to generate multiples of power 2.

```
1 class power_of_2;
2   rand logic[7:0] a;
3   rand logic[4:0] power;
4   constraint d1 {a == 2**power;}
5 endclass
6
7 module jk;
8   power_of_2 c_h;
9
10  initial begin
11    c_h = new();
12
13    $display("\n\n");
14    repeat(20) begin
15      c_h.randomize();
16      $display("\t\t Power = %d -> a = %d (2^%0d)",
17              c_h.power, c_h.a, c_h.power);
18    end
19    $display("\n\n");
20 end
21 endmodule
```

SAMPLE OUTPUT:

```
Power = 4 -> a = 16 (2^4)
Power = 3 -> a = 8 (2^3)
Power = 7 -> a = 128 (2^7)
Power = 7 -> a = 128 (2^7)
Power = 2 -> a = 4 (2^2)
Power = 3 -> a = 8 (2^3)
Power = 6 -> a = 64 (2^6)
Power = 5 -> a = 32 (2^5)
Power = 5 -> a = 32 (2^5)
Power = 3 -> a = 8 (2^3)
Power = 6 -> a = 64 (2^6)
Power = 2 -> a = 4 (2^2)
Power = 6 -> a = 64 (2^6)
Power = 0 -> a = 1 (2^0)
Power = 3 -> a = 8 (2^3)
Power = 2 -> a = 4 (2^2)
Power = 0 -> a = 1 (2^0)
Power = 0 -> a = 1 (2^0)
Power = 7 -> a = 128 (2^7)
Power = 3 -> a = 8 (2^3)
```

Alternate Method:

```
1 class power_of_2;
2   rand logic[5:0] a;
3   constraint d1 {a != 0;
4                 (a & (a-1)) == 0;}
5 endclass
6
7 module jk;
8   power_of_2 c_h;
9
10  initial begin
11    c_h = new();
12
13    $display("\n\n");
14    $display("\t\t value\t\t Corresponding binary format");
15    repeat(15) begin
16      c_h.randomize();
17      $display("\t\t a = %d \t->\t %b",c_h.a, c_h.a);
18    end
19    $display("\n\n");
20 end
21 endmodule
```

SAMPLE OUTPUT:

value	Corresponding binary format
a = 16	-> 010000
a = 32	-> 100000
a = 8	-> 001000
a = 8	-> 001000
a = 16	-> 010000
a = 4	-> 000100
a = 4	-> 000100
a = 8	-> 001000
a = 1	-> 000001
a = 16	-> 010000
a = 8	-> 001000
a = 16	-> 010000
a = 2	-> 000010
a = 4	-> 000100
a = 4	-> 000100

THANK YOU

