

TEST CASE OUTPUT

1.

```
begin(T1)
begin(T2)
W(T1,x1,101)
W(T2,x2,202)
W(T1,x2,102)
W(T2,x1,201)
end(T1)
dump()
```

OUTPUT

```
begin: T1
Began Tx T1 with time_stamp 1
```

```
begin: T2
Began Tx T2 with time_stamp 2
```

```
W: T1 x1 101
Wrote var x1 for txn T1 at time_stamp 3
```

```
W: T2 x2 202
Wrote var x2 for txn T2 at time_stamp 3
```

```
W: T1 x2 102
Waitlisted Tx T1 at time_stamp 4
```

```
W: T2 x1 201
Aborted Tx T2 at time_stamp 4
```

```
Wrote var x2 for txn T1 at time_stamp 4
```

```
end: T1
Ended Tx T1 at time_stamp 5
```

```
dump:
{'1': {'x10': 100,
      'x12': 120,
      'x14': 140,
      'x16': 160,
      'x18': 180,
      'x2': ['T1', 102],
      'x20': 200,
      'x4': 40,
      'x6': 60,
```

```
'x8': 80},
'10': {'x10': 100,
      'x12': 120,
      'x14': 140,
      'x16': 160,
      'x18': 180,
      'x19': 190,
      'x2': ['T1', 102],
      'x20': 200,
      'x4': 40,
      'x6': 60,
      'x8': 80,
      'x9': 90},
'2': {'x1': ['T1', 101],
      'x10': 100,
      'x11': 110,
      'x12': 120,
      'x14': 140,
      'x16': 160,
      'x18': 180,
      'x2': ['T1', 102],
      'x20': 200,
      'x4': 40,
      'x6': 60,
      'x8': 80},
'3': {'x10': 100,
      'x12': 120,
      'x14': 140,
      'x16': 160,
      'x18': 180,
      'x2': ['T1', 102],
      'x20': 200,
      'x4': 40,
      'x6': 60,
      'x8': 80},
'4': {'x10': 100,
      'x12': 120,
      'x13': 130,
      'x14': 140,
      'x16': 160,
      'x18': 180,
      'x2': ['T1', 102],
      'x20': 200,
      'x3': 30,
      'x4': 40,
      'x6': 60,
      'x8': 80},
'5': {'x10': 100,
      'x12': 120,
      'x14': 140,
      'x16': 160,
      'x18': 180,
      'x2': ['T1', 102],
      'x20': 200,
      'x4': 40,
      'x6': 60,
      'x8': 80},
'6': {'x10': 100,
      'x12': 120,
      'x14': 140,
      'x15': 150,
      'x16': 160,
      'x18': 180,
      'x2': ['T1', 102],
      'x20': 200,
```

```
'x4': 40,  
'x5': 50,  
'x6': 60,  
'x8': 80},  
'7': {'x10': 100,  
'x12': 120,  
'x14': 140,  
'x16': 160,  
'x18': 180,  
'x2': ['T1', 102],  
'x20': 200,  
'x4': 40,  
'x6': 60,  
'x8': 80},  
'8': {'x10': 100,  
'x12': 120,  
'x14': 140,  
'x16': 160,  
'x17': 170,  
'x18': 180,  
'x2': ['T1', 102],  
'x20': 200,  
'x4': 40,  
'x6': 60,  
'x7': 70,  
'x8': 80},  
'9': {'x10': 100,  
'x12': 120,  
'x14': 140,  
'x16': 160,  
'x18': 180,  
'x2': ['T1', 102],  
'x20': 200,  
'x4': 40,  
'x6': 60,  
'x8': 80}}
```

2.

```
begin(T1)
beginRO(T2)
W(T1,x1,101)
R(T2,x2)
W(T1,x2,102)
R(T2,x1)
end(T1)
end(T2)
dump()
```

OUTPUT

begin: T1
Began Tx T1 with time_stamp 1

beginRO: T2
Began read-only Tx T2 with time_stamp 2

W: T1 x1 101
Wrote var x1 for txn T1 at time_stamp 3

R: T2 x2
Read var x2 for Tx T2 at time_stamp 4, value: 20

W: T1 x2 102
Wrote var x2 for txn T1 at time_stamp 5

R: T2 x1
Read var x1 for Tx T2 at time_stamp 6, value: 10

end: T1
Ended Tx T1 at time_stamp 7

end: T2
Ended txn T2 at time_stamp 8

dump:

```
{'1': {'x10': 100,
      'x12': 120,
      'x14': 140,
      'x16': 160,
      'x18': 180,
      'x2': ['T1', 102],
      'x20': 200,
      'x4': 40,
      'x6': 60,
      'x8': 80},
 '10': {'x10': 100,
        'x12': 120,
        'x14': 140,
        'x16': 160,
        'x18': 180,
        'x19': 190,
        'x2': ['T1', 102],
        'x20': 200,
        'x4': 40,
        'x6': 60,
        'x8': 80,
        'x9': 90},
 '2': {'x1': ['T1', 101],
        'x10': 100,
        'x11': 110,
        'x12': 120,
        'x14': 140,
        'x16': 160,
        'x18': 180,
        'x2': ['T1', 102],
        'x20': 200,
        'x4': 40,
        'x6': 60,
        'x8': 80},
 '3': {'x10': 100,
        'x12': 120,
        'x14': 140,
        'x16': 160,
        'x18': 180,
        'x2': ['T1', 102],
        'x20': 200,
        'x4': 40,
        'x6': 60,
        'x8': 80},
 '4': {'x10': 100,
        'x12': 120,
        'x13': 130,
        'x14': 140,
        'x16': 160,
        'x18': 180,
        'x2': ['T1', 102],
        'x20': 200,
        'x3': 30,
        'x4': 40,
        'x6': 60,
        'x8': 80},
 '5': {'x10': 100,
        'x12': 120,
        'x14': 140,
        'x16': 160,
        'x18': 180,
        'x2': ['T1', 102],
        'x20': 200,
        'x4': 40,
```

```
'x6': 60,  
'x8': 80},  
'6': {'x10': 100,  
'x12': 120,  
'x14': 140,  
'x15': 150,  
'x16': 160,  
'x18': 180,  
'x2': ['T1', 102],  
'x20': 200,  
'x4': 40,  
'x5': 50,  
'x6': 60,  
'x8': 80},  
'7': {'x10': 100,  
'x12': 120,  
'x14': 140,  
'x16': 160,  
'x18': 180,  
'x2': ['T1', 102],  
'x20': 200,  
'x4': 40,  
'x6': 60,  
'x8': 80},  
'8': {'x10': 100,  
'x12': 120,  
'x14': 140,  
'x16': 160,  
'x17': 170,  
'x18': 180,  
'x2': ['T1', 102],  
'x20': 200,  
'x4': 40,  
'x6': 60,  
'x7': 70,  
'x8': 80},  
'9': {'x10': 100,  
'x12': 120,  
'x14': 140,  
'x16': 160,  
'x18': 180,  
'x2': ['T1', 102],  
'x20': 200,  
'x4': 40,  
'x6': 60,  
'x8': 80}}
```

3.

```
begin(T1)
begin(T2)
R(T1,x3)
fail(2)
W(T2,x8,88)
R(T2,x3)
W(T1, x5,91)
end(T2)
recover(2)
end(T1)
```

OUTPUT

begin: T1
Began Tx T1 with time_stamp 1

begin: T2
Began Tx T2 with time_stamp 2

R: T1 x3
Read var x3 for Tx T1 at time_stamp 3, value: 30

fail: 2
Site 2 failed at time_stamp 4

W: T2 x8 88
Wrote var x8 for txn T2 at time_stamp 5

R: T2 x3

Read var x3 for Tx T2 at time_stamp 6, value: 30

W: T1 x5 91

Wrote var x5 for txn T1 at time_stamp 7

end: T2

Ended Tx T2 at time_stamp 8

recover: 2

Site 2 recovered at time_stamp 9

end: T1

Ended Tx T1 at time_stamp 10

4.

begin(T1)

begin(T2)

R(T1,x1)

fail(2)

W(T2,x8,88)

R(T2,x3)

R(T1, x5)

end(T2)

recover(2)

end(T1)

OUTPUT

begin: T1

Began Tx T1 with time_stamp 1

begin: T2

Began Tx T2 with time_stamp 2

R: T1 x1

Read var x1 for Tx T1 at time_stamp 3, value: 10

fail: 2

Site 2 failed at time_stamp 4

Aborted Tx T1 at time_stamp 4

W: T2 x8 88

Wrote var x8 for txn T2 at time_stamp 5

R: T2 x3
Read var x3 for Tx T2 at time_stamp 6, value: 30

R: T1 x5
Tx T1 is in aborted state

end: T2
Ended Tx T2 at time_stamp 8

recover: 2
Site 2 recovered at time_stamp 9

end: T1
Tx T1 is in aborted state

5.

begin(T1)
begin(T2)
W(T1,x6,66)
fail(2)
W(T2,x8,88)
R(T2,x3)
R(T1, x5)
end(T2)
recover(2)
end(T1)

OUTPUT

begin: T1
Began Tx T1 with time_stamp 1

begin: T2
Began Tx T2 with time_stamp 2

W: T1 x6 66
Wrote var x6 for txn T1 at time_stamp 3

fail: 2
Site 2 failed at time_stamp 4
Aborted Tx T1 at time_stamp 4

W: T2 x8 88
Wrote var x8 for txn T2 at time_stamp 5

R: T2 x3
Read var x3 for Tx T2 at time_stamp 6, value: 30

R: T1 x5
Tx T1 is in aborted state

end: T2
Ended Tx T2 at time_stamp 8

recover: 2
Site 2 recovered at time_stamp 9

end: T1
Tx T1 is in aborted state

6.

begin(T1)
begin(T2)
fail(3)
fail(4)
R(T1,x1)
W(T2,x8,88)
end(T1)
recover(4)
recover(3)
R(T2,x3)
end(T2)

OUTPUT

begin: T1
Began Tx T1 with time_stamp 1

begin: T2
Began Tx T2 with time_stamp 2

fail: 3
Site 3 failed at time_stamp 3

fail: 4

Site 4 failed at time_stamp 4

R: T1 x1
Read var x1 for Tx T1 at time_stamp 5, value: 10

W: T2 x8 88
Wrote var x8 for txn T2 at time_stamp 6

end: T1
Ended Tx T1 at time_stamp 7

recover: 4
Site 4 recovered at time_stamp 8

recover: 3
Site 3 recovered at time_stamp 9

R: T2 x3
Read var x3 for Tx T2 at time_stamp 10, value: 30

end: T2
Ended Tx T2 at time_stamp 11

7.

begin(T1)
beginRO(T2)
R(T2,x1)
R(T2,x2)
W(T1,x3,33)
end(T1)
R(T2,x3)
end(T2)

OUTPUT

begin: T1
Began Tx T1 with time_stamp 1

beginRO: T2
Began read-only Tx T2 with time_stamp 2

R: T2 x1
Read var x1 for Tx T2 at time_stamp 3, value: 10

R: T2 x2
Read var x2 for Tx T2 at time_stamp 4, value: 20

W: T1 x3 33
Wrote var x3 for txn T1 at time_stamp 5

end: T1
Ended Tx T1 at time_stamp 6

R: T2 x3
Read var x3 for Tx T2 at time_stamp 7, value: 30

end: T2
Ended txn T2 at time_stamp 8

8.

begin(T1)
beginRO(T2)
R(T2,x1)
R(T2,x2)
W(T1,x3,33)
end(T1)
beginRO(T3)
R(T3,x3)
R(T2,x3)
end(T2)
end(T3)

OUTPUT

begin: T1
Began Tx T1 with time_stamp 1

beginRO: T2
Began read-only Tx T2 with time_stamp 2

R: T2 x1
Read var x1 for Tx T2 at time_stamp 3, value: 10

R: T2 x2
Read var x2 for Tx T2 at time_stamp 4, value: 20

W: T1 x3 33
Wrote var x3 for txn T1 at time_stamp 5

end: T1
Ended Tx T1 at time_stamp 6

beginRO: T3
Began read-only Tx T3 with time_stamp 7

R: T3 x3
Read var x3 for Tx T3 at time_stamp 8, value: ['T1', 33]

R: T2 x3
Read var x3 for Tx T2 at time_stamp 9, value: 30

end: T2
Ended txn T2 at time_stamp 10

end: T3
Ended txn T3 at time_stamp 11

9.

begin(T3)
begin(T1)
begin(T2)
W(T3,x2,22)
W(T2,x4,44)
R(T3,x4)
end(T2)
end(T3)
R(T1,x2)
end(T1)

OUTPUT

begin: T3
Began Tx T3 with time_stamp 1

begin: T1
Began Tx T1 with time_stamp 2

begin: T2
Began Tx T2 with time_stamp 3

W: T3 x2 22
Wrote var x2 for txn T3 at time_stamp 4

W: T2 x4 44
Wrote var x4 for txn T2 at time_stamp 5

R: T3 x4
Waitlisted Tx T3 at time_stamp 6

end: T2
Ended Tx T2 at time_stamp 7

Read var x4 for Tx T3 at time_stamp 7, value: ['T2', 44]

end: T3
Ended Tx T3 at time_stamp 8

R: T1 x2
Read var x2 for Tx T1 at time_stamp 9, value: ['T3', 22]

end: T1
Ended Tx T1 at time_stamp 10

10.

begin(T1)
begin(T2)
begin(T3)
W(T3,x2,22)
W(T2,x4,44)
R(T3,x4)
end(T2)
end(T3)
R(T1,x2)
end(T1)

OUTPUT

begin: T1
Began Tx T1 with time_stamp 1

begin: T2
Began Tx T2 with time_stamp 2

begin: T3
Began Tx T3 with time_stamp 3

W: T3 x2 22
Wrote var x2 for txn T3 at time_stamp 4

W: T2 x4 44
Wrote var x4 for txn T2 at time_stamp 5

R: T3 x4
Waitlisted Tx T3 at time_stamp 6

end: T2
Ended Tx T2 at time_stamp 7

Read var x4 for Tx T3 at time_stamp 7, value: ['T2', 44]

end: T3
Ended Tx T3 at time_stamp 8

R: T1 x2
Read var x2 for Tx T1 at time_stamp 9, value: ['T3', 22]

end: T1
Ended Tx T1 at time_stamp 10

11.

begin(T1)
begin(T2)
R(T1,x2)
R(T2,x2)
W(T2,x2,10)
end(T1)
end(T2)

OUTPUT

begin: T1
Began Tx T1 with time_stamp 1

begin: T2

Began Tx T2 with time_stamp 2

R: T1 x2

Read var x2 for Tx T1 at time_stamp 3, value: 20

R: T2 x2

Read var x2 for Tx T2 at time_stamp 4, value: 20

W: T2 x2 10

Waitlisted transaction T2 at time_stamp 5

end: T1

Ended Tx T1 at time_stamp 6

Wrote var x2 for txn T2 at time_stamp 6

end: T2

Ended Tx T2 at time_stamp 7

12.

begin(T1)

begin(T2)

R(T1,x2)

R(T2,x2)

end(T1)

W(T2,x2,10)

end(T2)

OUTPUT

begin: T1

Began Tx T1 with time_stamp 1

begin: T2
Began Tx T2 with time_stamp 2

R: T1 x2
Read var x2 for Tx T1 at time_stamp 3, value: 20

R: T2 x2
Read var x2 for Tx T2 at time_stamp 4, value: 20

end: T1
Ended Tx T1 at time_stamp 5

W: T2 x2 10
Wrote var x2 for txn T2 at time_stamp 6

end: T2
Ended Tx T2 at time_stamp 7

13.

begin(T1)
begin(T2)
begin(T3)
W(T3,x2,10)
W(T2,x2,10)
W(T1,x2,10)
end(T3)
end(T2)
end(T1)

OUTPUT

begin: T1
Began Tx T1 with time_stamp 1

begin: T2
Began Tx T2 with time_stamp 2

begin: T3
Began Tx T3 with time_stamp 3

W: T3 x2 10
Wrote var x2 for txn T3 at time_stamp 4

W: T2 x2 10
Waitlisted Tx T2 at time_stamp 5

W: T1 x2 10
Waitlisted Tx T1 at time_stamp 6

end: T3
Ended Tx T3 at time_stamp 7

Wrote var x2 for txn T2 at time_stamp 7
Waitlisted Tx T1 at time_stamp 7

end: T2
Ended Tx T2 at time_stamp 8

Wrote var x2 for txn T1 at time_stamp 8

end: T1
Ended Tx T1 at time_stamp 9

14.

begin(T1)
begin(T2)
begin(T3)
W(T3,x2,10)
W(T1,x2,10)
W(T2,x2,10)
end(T3)
end(T1)
end(T2)

OUTPUT

begin: T1
Began Tx T1 with time_stamp 1

begin: T2
Began Tx T2 with time_stamp 2

begin: T3
Began Tx T3 with time_stamp 3

W: T3 x2 10
Wrote var x2 for txn T3 at time_stamp 4

W: T1 x2 10
Waitlisted Tx T1 at time_stamp 5

W: T2 x2 10
Waitlisted Tx T2 at time_stamp 6

end: T3
Ended Tx T3 at time_stamp 7

Wrote var x2 for txn T1 at time_stamp 7
Waitlisted Tx T2 at time_stamp 7

end: T1
Ended Tx T1 at time_stamp 8

Wrote var x2 for txn T2 at time_stamp 8

end: T2
Ended Tx T2 at time_stamp 9

15.

begin(T5)
begin(T4)
begin(T3)
begin(T2)
begin(T1)
W(T1,x4, 5)
fail(2)
W(T2,x4,44)
recover(2)
W(T3,x4,55)

W(T4,x4,66)
W(T5,x4,77)
end(T1)
end(T2)
end(T3)
end(T4)
end(T5)

OUTPUT

begin: T5
Began Tx T5 with time_stamp 1

begin: T4
Began Tx T4 with time_stamp 2

begin: T3
Began Tx T3 with time_stamp 3

begin: T2
Began Tx T2 with time_stamp 4

begin: T1
Began Tx T1 with time_stamp 5

W: T1 x4 5
Wrote var x4 for txn T1 at time_stamp 6

fail: 2
Site 2 failed at time_stamp 7
Aborted Tx T1 at time_stamp 7

W: T2 x4 44
Wrote var x4 for txn T2 at time_stamp 8

recover: 2
Site 2 recovered at time_stamp 9

W: T3 x4 55
Waitlisted Tx T3 at time_stamp 10

W: T4 x4 66
Waitlisted Tx T4 at time_stamp 11

W: T5 x4 77
Waitlisted Tx T5 at time_stamp 12

end: T1
Tx T1 is in aborted state

end: T2
Ended Tx T2 at time_stamp 14

Wrote var x4 for txn T3 at time_stamp 14
Waitlisted Tx T4 at time_stamp 14
Waitlisted Tx T5 at time_stamp 14

end: T3
Ended Tx T3 at time_stamp 15

Wrote var x4 for txn T4 at time_stamp 15
Waitlisted Tx T5 at time_stamp 15

end: T4
Ended Tx T4 at time_stamp 16

Wrote var x4 for txn T5 at time_stamp 16

end: T5
Ended Tx T5 at time_stamp 17

16.

begin(T3)
begin(T1)
begin(T2)
W(T3,x2,22)
W(T2,x4,44)

R(T3,x4)
end(T2)
end(T3)
R(T1,x2)
end(T1)

OUTPUT

begin: T3
Began Tx T3 with time_stamp 1

begin: T1
Began Tx T1 with time_stamp 2

begin: T2
Began Tx T2 with time_stamp 3

W: T3 x2 22
Wrote var x2 for txn T3 at time_stamp 4

W: T2 x4 44
Wrote var x4 for txn T2 at time_stamp 5

R: T3 x4
Waitlisted Tx T3 at time_stamp 6

end: T2
Ended Tx T2 at time_stamp 7

Read var x4 for Tx T3 at time_stamp 7, value: ['T2', 44]

end: T3
Ended Tx T3 at time_stamp 8

R: T1 x2
Read var x2 for Tx T1 at time_stamp 9, value: ['T3', 22]

end: T1
Ended Tx T1 at time_stamp 10