

Question: 2

a)

Threads Process	allocation				Max need				available			
	A	B	C	D	A	B	C	D	A	B	C	D
T ₀	3	1	4	1	6	4	7	3	2	2	2	4
T ₁	2	1	0	2	4	2	3	2				
T ₂	2	4	1	3	2	5	3	3				
T ₃	4	1	1	0	6	3	3	2				
T ₄	2	2	2	1	5	6	7	5				

Remaining need
(max - allocation)

	A	B	C	D
T ₀	3	3	3	2
T ₁	2	1	3	0
T ₂	0	1	2	0
T ₃	2	2	2	2
T ₄	3	4	5	4

Now, \therefore remaining need \nless available
we will check it for every thread to check the sequence -

For T₀;

$$3 \ 3 \ 3 \ 2 \leq 2 \ 2 \ 2 \ 4 \text{ (false)}$$

T₁;

$$2 \ 1 \ 3 \ 0 \leq 2 \ 2 \ 2 \ 4 \text{ (false)}$$

T₂;

$$0 \ 1 \ 2 \ 0 \leq 2 \ 2 \ 2 \ 4 \text{ (True)}$$

Now it is true process will terminate its allocation will be added in available.

$$\begin{array}{r}
 2 \quad 2 \quad 2 \quad 4 \\
 + \quad 2 \quad 4 \quad 1 \quad 3 \\
 \hline
 4 \quad 6 \quad 3 \quad 7
 \end{array}$$

$T_3;$

$$2 \quad 2 \quad 2 \quad 2 \leq 4 \quad 6 \quad 3 \quad 7 \quad (\text{True})$$

again, adding allocation and remaining of T_3

$$\begin{array}{r}
 4 \quad 6 \quad 3 \quad 7 \\
 + \quad 4 \quad 1 \quad 1 \quad 0 \\
 \hline
 8 \quad 7 \quad 4 \quad 7
 \end{array}$$

$T_4;$

$$3 \quad 4 \quad 5 \quad 4 \leq 8 \quad 7 \quad 4 \quad 7 \quad (\text{false})$$

$T_1;$

$$8 \quad 7 \quad 4 \quad 7 \geq 2 \quad 1 \quad 3 \quad 0 \quad (\text{true})$$

$$\begin{array}{r}
 8 \quad 7 \quad 4 \quad 7 \\
 + \quad 2 \quad 1 \quad 0 \quad 2 \\
 \hline
 10 \quad 8 \quad 4 \quad 9
 \end{array}$$

$T_0;$

$$3 \quad 3 \quad 3 \quad 2 \leq 10 \quad 8 \quad 4 \quad 9 \quad (\text{true})$$

$$\begin{array}{r}
 10 \quad 8 \quad 4 \quad 9 \\
 3 \quad 1 \quad 4 \quad 1 \\
 \hline
 13 \quad 9 \quad 8 \quad 10
 \end{array}$$

T_4 ;

$$3 \quad 4 \quad 5 \quad 4 \leq 13 \quad 9 \quad 8 \quad 10 \quad (\text{true})$$

$$\begin{array}{cccc} 13 & 9 & 8 & 10 \\ 2 & 2 & 2 & 1 \\ \hline 15 & 11 & 10 & 11 \end{array}$$

Sequence;

$$< T_2, T_3, T_1, T_0, T_4 >$$

The system will be in safe state.

Question: 2(b)

T_4 arrives for (2 2 2 4)

request \leq need (Remaining)

$$2 \quad 2 \quad 2 \quad 4 \leq 3 \quad 4 \quad 5 \quad 4 \quad (\text{true})$$

request \leq available

$$2 \quad 2 \quad 2 \quad 4 \leq 2 \quad 2 \quad 2 \quad 4 \quad (\text{true})$$

= request - available

$$= 2 \quad 2 \quad 2 \quad 4$$

$$- 2 \quad 2 \quad 2 \quad 4$$

$$\hline 0 \quad 0 \quad 0 \quad 0$$

new allocation = allocation + request

$$= (2 \quad 2 \quad 2 \quad 1) + (2 \quad 2 \quad 2 \quad 4)$$

$$= 4 \quad 4 \quad 4 \quad 5$$

new need = remaining need - request

$$3 \quad 4 \quad 5 \quad 4$$

$$- 2 \quad 2 \quad 2 \quad 4$$

$$\hline 1 \quad 2 \quad 3 \quad 0$$

So, here

$$1 \ 2 \ 3 \ 0 \leq 0 \ 0 \ 0 \ 0 \text{ (false)}$$

→ sequence is false.

Question: 2(c)

T_2 arrives for (0 1 1 0)

now;

$$0 \ 1 \ 1 \ 0 \leq 0 \ 1 \ 2 \ 0 \text{ (true)}$$

$$0 \ 1 \ 1 \ 0 \leq 2 \ 2 \ 2 \ 4 \text{ (true)}$$

$$\begin{array}{r} \text{available} = 2 \ 2 \ 2 \ 4 \\ - 0 \ 1 \ 1 \ 0 \\ \hline 2 \ 1 \ 1 \ 4 \end{array}$$

$$\begin{array}{r} \text{allocation} = 2 \ 4 \ 1 \ 3 \ - \ 0 \ 1 \\ + 0 \ 1 \ 1 \ 0 \\ \hline 2 \ 5 \ 2 \ 3 \end{array}$$

$$\begin{array}{r} \text{need} = 0 \ 1 \ 2 \ 0 \\ 0 \ 1 \ 1 \ 0 \\ \hline 0 \ 0 \ 1 \ 0 \end{array}$$

	allocations				Remaining need				available			
	A	B	C	D	A	B	C	D	A	B	C	D
T_0	3	1	4	1	3	3	3	2	2	1	1	4
T_1	2	1	0	2	2	1	3	0				
T_2	2	5	2	3	0	0	1	0				
T_3	4	1	1	0	2	2	2	2				
T_4	2	2	2	1	3	4	5	4				

T_0 ;

$$3 \ 3 \ 3 \ 2 \leq 2 \ 1 \ 1 \ 4 \quad (\text{false})$$

T_2 ;

$$0 \ 0 \ 1 \ 0 \leq 2 \ 1 \ 1 \ 4 \quad (\text{true})$$

$$\begin{array}{r} 2 \ 1 \ 1 \ 4 \\ + 0 \ 5 \ 2 \ 3 \\ \hline 2 \ 6 \ 3 \ 7 \end{array}$$

T_3 ;

$$2 \ 2 \ 2 \ 2 \leq 2 \ 6 \ 3 \ 7 \quad (\text{true})$$

$$\begin{array}{r} 2 \ 6 \ 3 \ 7 \\ + 4 \ 1 \ 1 \ 0 \\ \hline 6 \ 7 \ 4 \ 7 \end{array}$$

T_4 ;

$$3 \ 4 \ 5 \ 4 \leq 6 \ 7 \ 4 \ 7 \quad (\text{false})$$

T_0 ;

$$3 \ 3 \ 3 \ 2 \leq 6 \ 7 \ 4 \ 7 \quad (\text{true})$$

$$\begin{array}{r} 6 \ 7 \ 4 \ 7 \\ + 3 \ 1 \ 4 \ 1 \\ \hline 9 \ 8 \ 8 \ 8 \end{array}$$

T_1 ;

$$2 \ 1 \ 3 \ 0 \leq 9 \ 8 \ 8 \ 8 \quad (\text{true})$$

$$\begin{array}{r} 2 \ 1 \ 3 \ 0 \\ + 9 \ 8 \ 8 \ 8 \\ \hline 11 \ 9 \ 8 \ 10 \end{array}$$

T_4 ;

$$3 \ 4 \ 5 \ 4 \leq 11 \ 9 \ 8 \ 10 \quad (\text{true})$$

$$\begin{array}{r} 2 \ 2 \ 2 \ 1 \\ 11 \ 9 \ 8 \ 10 \\ \hline 13 \ 11 \ 10 \ 11 \end{array}$$

sequence is;

$\langle T_2, T_3, T_0, T_1, T_4 \rangle$

Question: 2(d)

T_3 arrives for (2, 2 1 2)

request \leq need

2 2 1 2 \leq 2 2 2 2 (true)

request \leq available

2 2 1 2 \leq 2 2 2 4 (true)

available = 2 2 2 4

$\begin{array}{r} 2 \ 2 \ 1 \ 2 \\ - \\ 0 \ 0 \ 1 \ 2 \end{array}$

allocation = 4 1 1 0

$\begin{array}{r} 2 \ 2 \ 1 \ 2 \\ - \\ 6 \ 3 \ 2 \ 2 \end{array}$

need = 2 2 2 2

$\begin{array}{r} 2 \ 2 \ 1 \ 2 \\ - \\ 0 \ 0 \ 1 \ 0 \end{array}$

	allocation				need				available			
	A	B	C	D	A	B	C	D	A	B	C	D
T_0	3	1	4	1	3	3	3	2	0	0	1	2
T_1	2	1	0	2	2	1	3	0				
T_2	2	4	1	3	0	1	2	0				
T_3	6	3	2	2	0	0	1	0				
T_4	2	2	2	1	3	4	5	4				

$T_0;$

$$3 \ 3 \ 3 \ 2 \leq 0 \ 0 \ 1 \ 2 \quad (\text{false})$$

$T_1;$

$$2 \ 1 \ 3 \ 0 \leq 0 \ 0 \ 1 \ 2 \quad (\text{false})$$

$T_2;$

$$0 \ 1 \ 2 \ 0 \leq 0 \ 0 \ 1 \ 2 \quad (\text{false})$$

$T_3;$

$$0 \ 0 \ 1 \ 0 \leq 0 \ 0 \ 1 \ 2 \quad (\text{true})$$

$$\begin{array}{r} \text{available} = \quad 0 \quad 0 \quad 1 \quad 2 \\ + \quad 6 \quad 3 \quad 2 \quad 2 \\ \hline \quad 6 \quad 3 \quad 3 \quad 4 \end{array}$$

$T_4;$

$$3 \ 4 \ 5 \ 4 \leq 6 \ 3 \ 3 \ 4 \quad (\text{false})$$

$T_0;$

$$3 \ 3 \ 3 \ 2 \leq 6 \ 3 \ 3 \ 4 \quad (\text{true})$$

$$\begin{array}{r} \text{available} = \quad 6 \quad 3 \quad 3 \quad 4 \\ + \quad 3 \quad 1 \quad 4 \quad 1 \\ \hline \quad 9 \quad 4 \quad 7 \quad 5 \end{array}$$

$T_1;$

$$2 \ 1 \ 3 \ 0 \leq 9 \ 4 \ 7 \ 5 \quad (\text{true})$$

$$\begin{array}{r} \text{available} = \quad 9 \quad 4 \quad 7 \quad 5 \\ + \quad 2 \quad 1 \quad 0 \quad 2 \\ \hline \quad 11 \quad 5 \quad 7 \quad 7 \end{array}$$

T_2 ;

$$0 \ 1 \ 2 \ 0 \leq 11 \ 5 \ 7 \ 7 \text{ (true)}$$

$$\begin{array}{r} \text{available} = \quad 11 \quad 5 \quad 7 \quad 7 \\ + \quad 2 \quad 4 \quad 1 \quad 3 \\ \hline 13 \quad 9 \quad 8 \quad 10 \end{array}$$

T_4 ;

$$3 \ 4 \ 5 \ 4 \leq 13 \ 9 \ 8 \ 10 \text{ (true)}$$

$$\begin{array}{r} \text{available} = \quad 13 \quad 9 \quad 8 \quad 10 \\ + \quad 2 \quad 2 \quad 2 \quad 1 \\ \hline 15 \quad 11 \quad 10 \quad 11 \end{array}$$

Sequence is $\langle T_3, T_0, T_1, T_2, T_4 \rangle$

Question: 03

Solution:

	allocation				Request				
	R ₁	R ₂	R ₃	R ₄	R ₁	R ₂	R ₃	R ₄	
P ₁	1	0	0	0	0	1	0	0	④
P ₂	0	1	0	0	0	0	1	0	⑤
P ₃	0	0	1	0	0	0	0	1	③
P ₄	0	1	0	1	1	0	0	0	①
P ₅	0	0	0	1	0	0	0	0	②

Current availability:

	R ₁	R ₂	R ₃	R ₄	
	2	0	0	0	(allocation) P ₄
+	0	1	0	1	
<hr/>					
	2	1	0	1	
+	0	0	0	0	(allocation) P ₅
<hr/>					
	2	1	0	1	
+	0	0	1	0	(allocation) P ₃
<hr/>					
	2	1	1	1	
+	1	0	0	0	(allocation) P ₁
<hr/>					
	3	1	1	1	
+	0	1	0	0	(allocation) P ₂
<hr/>					
	3	2	1	1	

→ No deadlock will occur

→ Sequence: < P₄, P₅, P₃, P₁, P₂ >

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FA19-BSE-022

OPERATING SYSTEM

ASSIGNMENT 3

QS:1

Sol:

```
while (true){
    wait(mutex);
    read_count++;
    if (read_count == 1) /* first reader */
        wait(rw_mutex);

    signal(mutex);

    ...
    /* reading is performed */

    ...

    wait(mutex);
    read count--;
    if (read_count == 0) /* last reader */
        signal(rw_mutex);

    signal(mutex);
}
```

this was the code