Department of Computer Science and Engineering
Final Examination Spring 2023
CSE 321: Operating Systems

A

Duration: 2 Hours **Total Marks:** 40

Answer the following questions.
Figures in the right margin indicate marks.

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2. **CO4**

a) Consider the following snapshot of a system:

		Allocation				MAX		
		A	**B**	**C**		**A**	**B**	**C**
P0		0	3	3		10	10	9
P1		4	2	3		5	9	8
P2		4	4	4		9	6	7
P3		5	4	4		5	5	8
P4		0	3	3		10	9	7

Available		
A	**B**	**C**
8	5	6

i. Is the system in a safe state? **Apply Banker's safety algorithm** to find out the safe sequence. You need to calculate the need matrix. [4]

ii. $\mathbf{P_0}$ requests for **(1 4 1), check** the validity of the request. If the request is valid, does the system enter a **deadlock**? [1+4]

b) Suppose, in a workplace, we have a set of resource types, R = {R1, R2, R3, R4} and a set of processes, P = {P1, P2, P3, P4, P5}. **R1, R2, R3, and R4** have **2, 3, 1, and 2** instances respectively.

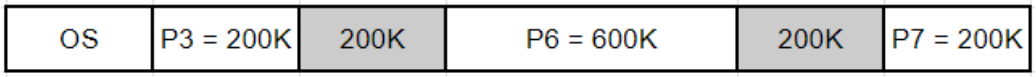
- P1 is holding 1 instance of R4 and 1 instance of R1
- P1 requests 1 instance of R2
- P2 requests for 1 instance of R4
- P2 is holding 2 instances of R2 and 1 instance of R3
- P3 requests for 1 instance of R1
- P3 is holding 1 instance of R2
- P4 is holding 1 instance of R3
- P4 requests 2 instances of R2
- P5 is holding 1 instance of R1
- P5 requests 1 instance of R4

Construct a resource allocation graph for the above scenario. **Mention** the number of cycles found and **identify** whether there is a deadlock or not. [4]

3. **CO5**

a) Given fixed size memory partitions of 300k, 480k, 110k, 200k, 360k, and 550k **(in order, bottom to top**), **apply** first-fit and best-fit algorithms to place processes with the space requirement of 426k, 300k, 125k, 104k, 475 and 340k (in order). Which algorithm makes the most effective use of memory? Is there any external fragmentation? [4+1+1]

b) Considering in Dynamic memory management technique at a certain time the memory looks like the following figure: [2]



cant

Where gray portions of the memory are free spaces. A process P5 = 300K arrives in the ready queue. How can you accommodate P5 in the memory? **Justify** your answer.

c) If the page size is **3 KB**, **how many** frames will be needed in Main memory for a process size of **32,167 Bytes**? Is there any **internal fragmentation**? - If yes, **calculate** the value. [1 KB = 1024 Bytes] [2]

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4. **CO5**

a) Suppose there are two processes **P1 (16 B)** and **P2 (12 B)** with a page size of **4 B**. The main memory size is **40 B.** The page table for P1 and P2 are given below:

Page#	Frame#	Contents
0	7	CSE110
1	4	CSE111
2	6	CSE221
3	5	CSE321

Page table: P1

Page#	Frame#	Contents
0	8	CSE110
1	0	CSE111
2	3	CSE220

Page table: P2

i. **Draw** the memory representations consisting of the contents for both P1 and P2. [2]

ii. **Find** the corresponding physical addresses of the following logical addresses: [2]
   a) Address 1010 of P1 26
   b) Address 0111 of P2 3

iii. **How** can you make efficient use of the main memory in this scenario? [1]

b) Consider a computer with a main memory that has 4 frames and page reference string of 0-7 pages: **[2, 5, 7, 5, 2, 0, 2, 5, 6, 2, 6, 6]**. The page reference string represents the order in which the pages are accessed by a program. **Apply FIFO** & **OPT** algorithm to **simulate** the page replacement that occurs when the main memory can hold at most 4 pages at a time. **Record** the number of **page faults** and compare the result. **Mention** which algorithm performs better in this scenario. [4+1]

Department of Computer Science and Engineering
Final Examination Spring 2023
CSE 321: Operating Systems

B

Duration: 2 Hours **Total Marks:** 40

Answer the following questions.
Figures in the right margin indicate marks.

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1. CO4 **a)** In a restaurant, there are 3 washrooms available for male guests and 1 washroom available for female guests. There is a strict rule maintained by the authorities that neither men can use the female washroom nor women can use any of the male washrooms. On a random day during lunchtime, 4 female guests needed to use washroom facilities at the very same time. But none of them were allowed to use any of the male washrooms although two of them were vacant. Therefore, only 1 guest was able to get access to the washroom at a time and others had to wait while maintaining a queue. If the washroom gets vacant, a guest from the queue can get access to that. Logically **explain** which synchronization method has been used here. [3]

b) For Peterson's problem below conditions will be applied.

- There are two processes: P_1 and P_2.
- Each Statement takes 5ms to execute, P_1 gets executed first
- Context Switch will occur after 20ms.
- Critical section contains 2 statements.
- Remainder section contains 4 statements.
- For P_1: i = 0 and j = 1
- For P_2: i = 1 and j = 0
- turn=0
- flag[0] = FALSE, flag[1] = TRUE

The structure of process Pi in Peterson's solution:

```
do{
      flag[i] = true;
      turn = j;
      while(flag[j] == true && turn == 1){
            //busy wait
      }
      //critical section
      flag[i] = false;
      //remainder section
}while(true);
```

Complete the table given below for processes P_1 and P_2 using **Peterson's solution.** [4]

Process 1: i = 0, j = 1	Process 2: i = 1, j = 0
⬇	

2. CO4 **a)** Consider the following snapshot of a system:

		Allocation				MAX		
		A	**B**	**C**		**A**	**B**	**C**
P0		5	2	3		9	9	8
P1		3	2	0		9	9	10
P2		5	3	3		6	8	5
P3		3	0	0		6	7	9
P4		4	2	1		5	7	6

Available		
A	**B**	**C**
7	10	5

i. Is the system in a safe state? **Apply Banker's safety algorithm** to find out the safe sequence. You need to calculate the need matrix. [4]

ii. $\mathbf{P_4}$ requests for **(0 3 1**), **check** the validity of the request. If the request is valid, does the system enter a **deadlock**? [1+4]

b) Suppose, in a workplace, we have a set of resource types, R = {R1, R2, R3, R4} and a set of processes, P = {P1, P2, P3, P4, P5}. **R1, R2, R3, and R4** have **2, 3, 1, and 2** instances respectively.

- P1 is holding 1 instance of R1
- P1 requests 1 instance of R4
- P2 is holding 1 instance of R3
- P2 requests 2 instances of R2
- P3 requests for 1 instance of R1
- P3 is holding 1 instance of R2
- P4 requests for 1 instance of R4
- P4 is holding 2 instances of R2 and 1 instance of R3
- P5 is holding 1 instance of R4 and 1 instance of R1
- P5 requests 1 instance of R2

Construct a resource allocation graph for the above scenario. **Mention** the number of cycles found and **identify** whether there is a deadlock or not. [4]

3. CO5 **a)** Given fixed size memory partitions of 210k, 350k,250k,190k, 250k and 452k **(in order, bottom to top**), **apply** first-fit and best-fit algorithms to place processes with the space requirement of 250k, 425k, 212k, 160k, 210 and 440k (in order). **Which** algorithm makes the most effective use of memory? **Is there** any external fragmentation? [4+1+1]

b) Considering in Dynamic memory management technique at a certain time the memory looks like the following figure: [2]

OS	P3 = 150K	150K	P6 = 300K	150K	P7 = 150K

Where gray portions of the memory are free spaces. A process P5 = 150K arrives in the ready queue. How can you accommodate P5 in the memory? **Justify** your answer.

c) If the page size is **3 KB**, **how many** frames will be needed in Main memory for a process size of **79,071 Bytes**? Is there any **internal fragmentation**? - If yes, **calculate** the value. [1 KB = 1024 Bytes] [2]

4. CO5 **a)** Suppose there are two processes **P1 (16 B)** and **P2 (12 B)** with a page size of **4 B**. The main memory size is **40 B.** The page table for P1 and P2 are given below:

Page#	Frame#	Contents
0	9	UB2
1	0	UB8
2	2	UB1
3	7	UB7

Page table: P1

Page#	Frame#	Contents
0	4	UB2
1	3	UB1
2	6	UB4

Page table: P2

i. **Draw** the memory representations consisting of the contents for both P1 and P2. [2]

ii. **Find** the corresponding physical addresses of the following logical addresses: [2]
   a) Address 1010 of P1
   b) Address 0111 of P2

iii. **How** can you make efficient use of the main memory in this scenario? [1]

b) Consider a computer with a main memory that has 4 frames and page reference string of 0-7 pages: **[5, 0, 3, 3, 2, 3, 7, 5, 2, 6, 3, 7]**. The page reference string represents the order in which the pages are accessed by a program. **Apply FIFO** & **OPT** algorithm to **simulate** the page replacement that occurs when the main memory can hold at most 4 pages at a time. **Record** the number of **page faults** and compare the result. **Mention** which algorithm performs better in this scenario. [4+1]

Department of Computer Science and Engineering
Final Examination Summer 2023
CSE 321: Operating Systems

A

Duration: 1 Hour 50 Minutes **Total Marks:** 40

Answer the following questions.
Figures in the right margin indicate marks.

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2. **CO4**

a) Consider the following snapshot of a system:

	Max				Allocation			
	A	**B**	**C**	**D**	**A**	**B**	**C**	**D**
P1	7	0	1	3	7	0	0	2
P2	2	7	5	0	2	1	0	0
P3	2	12	5	6	0	6	3	3
P4	1	6	5	6	0	2	1	2

Available			
A	**B**	**C**	**D**
1	6	4	4

i. **Calculate** the Need Matrix. Is this system in a **safe state**? If yes, then find the safe sequence using Banker's Safety algorithm otherwise, provide the necessary explanation. [1+3]

ii. What happens if the process **P4** requests at this moment for **(0, 4, 2, 0)?** Whether Banker's algorithm grants the request or not? [5]

b) Suppose, in a workplace, we have a set of resource types, R = {R1, R2, R3, R4} and a set of processes, P = {P1, P2, P3, P4, P5}. **R1, R2, R3, and R4** have **3, 2, 3, and 2** instances respectively.

- P1 is holding 2 instances of R1
- P2 is holding 1 instance of R3
- P3 is holding 1 instance of R4
- P5 requests 2 instances of R3
- P4 is holding1 instance of R4
- P3 requests 1 instance of R2
- P2 requests 1 instance of R1
- P2 is holding 1 instance of R2
- P1 is requesting 1 instance of R4
- P3 is holding 1 instance of R3
- P4 is holding 1 instance of R2

Construct a resource allocation graph for the above scenario and **identify the cycle (if any) and decide** whether there is a deadlock or not. [4]

3. **CO5**

a) Given variable size memory (dynamic) partitions of **8 MB, 29 MB, 35 MB, and 48 MB** (in order, top to bottom), **apply** best-fit and worst-fit algorithms to place processes with the space requirement of **5 MB, 15 MB, 10 MB, 5 MB, 10 MB, 20 MB, 25 MB, and 15 MB** (in order). Which algorithm makes the most effective use of memory? [4+1]

b) How is paging efficiently used in main memory to increase throughput? Justify with necessary examples. [3]

c) Compare the following systems in terms of performance: [3]

1. A system with a hit ratio of 93%, associative lookup time of 32ns, and memory access time of 72ns.
2. A system with a hit ratio of 62%, associative lookup time of 9ns, and memory access time of 133ns.

4. **CO5**

a) Suppose there are two processes **P1 (32 B)** and **P2 (40 B)** with a page size of **8 B**. The main memory size is **96 B.** The page table for P1 and P2 are given below:

Page#	Frame#
0	3
1	10
2	2
3	0

Page table: P1

Page#	Frame#
0	5
1	8
2	11
3	1
4	6

Page table: P2

Find the corresponding physical addresses of the following logical addresses: [3]

a) Address 011010 of P1
b) Address 111110 of P2
c) Address 011001 of P2

b) Consider a computer with a main memory that has 5 frames and page reference string of 0-7 page **[2, 2, 2, 6, 5, 5, 4, 2, 0, 0, 6, 1, 5, 5, 3, 0, 0, 2, 6, 5]**. The page reference string represents the order in which the pages are accessed by a program. **Apply LRU** & **OPT** algorithm to **simulate** the page replacement that occurs when the main memory can hold at most 5 pages at a time. **Record** the number of **page faults** and compare the result. **Mention** which algorithm performs better in this scenario. [4+1]

Department of Computer Science and Engineering
Final Examination Summer 2023
CSE 321: Operating Systems

B

Duration: 1 Hour 50 Minutes **Total Marks:** 40

Answer the following questions.
Figures in the right margin indicate marks.

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1. **CO4**

a) Imagine a computer lab with multiple computers, and equipped with printers. Students use these computers for various tasks and may want to print documents. However, there are only a limited number of printers available. How do you solve this issue using semaphore? Your answer should have the steps associated in solving the given scenario. [3]

b) How do semaphores and mutexes differ in their implementation. [1.5]

c) For Peterson's problem below conditions will be applied.

- There are two processes: P1 and P2. P2 gets to execute first.
- Each Statement takes 4ms to execute.
- Context Switch will occur after 12ms.
- Critical section contains 4 statements.
- Remainder section contains 3 statements.
- For P1: i=0 and j=1
- For P2: i=1 and j=0
- turn=0
- flag[0] = FALSE, flag[1] = TRUE

The structure of process Pi in Peterson's solution:

```
do{
      flag[i] = true;
      turn = j;
      while(flag[j] == true && turn == 1){
            //busy wait
      }
      //critical section
      flag[i] = false;
      //remainder section
}while(true);
```

Complete the table below for processes P_1 and P_2 using **Peterson's solution.** [3.5]

Process 1: i = 0, j = 1	Process 2: i = 1, j = 0
⬇	

2. **CO4**

a) Consider the following snapshot of a system:

	Allocation			Max			Available		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
P0	5	2	2	9	9	8	7	10	5
P1	3	2	0	9	9	10			
P2	5	3	3	6	8	5			
P3	3	0	0	6	7	9			
P4	4	2	1	5	7	6			

i. **Calculate** the Need Matrix. Is this system in a **safe state**? If yes, then find the safe sequence using Banker's Safety algorithm otherwise, provide the necessary explanation. [1+3]

ii. What happens if the process **P4** requests at this moment for **(0, 3, 1)?** Whether Banker's algorithm grants the request or not? [5]

b) Suppose, in a workplace, we have a set of resource types, R = {R1, R2, R3, R4} and a set of processes, P = {P1, P2, P3, P4, P5}. **R1, R2, R3, and R4** have **3, 1, 4, and 2** instances respectively.

- P1 is holding 2 instances of R1
- P2 is holding 1 instance of R3
- P3 is holding 1 instance of R4
- P5 requests 2 instances of R3
- P4 is holding 1 instance of R4
- P3 requests 1 instance of R2
- P2 requests 1 instance of R1
- P2 is holding 1 instance of R2
- P1 is requesting 1 instance of R4
- P3 is holding 1 instance of R3
- P4 is holding 1 instance of R3.

Construct a resource allocation graph for the above scenario and **identify the cycle (if any) and decide** whether there is a deadlock or not. [4]

3. **CO5**

a) Given variable size memory (dynamic) partitions of **10 MB, 16 MB, 45 MB, and 49 MB** (in order, top to bottom), **apply** best-fit and worst-fit algorithms to place processes with the space requirement of **5 MB, 15 MB, 10 MB, 5 MB, 10 MB, 20 MB, 25 MB, and 15 MB** (in order). Which algorithm makes the most effective use of memory? [4+1]

b) How cache memory can be used to design an efficient paging hardware. Your answer should have the required diagram with the necessary justification. [3]

associative memory tld

c) Compare the following systems in terms of performance: [3]

1. A system with a hit ratio of 72%, associative lookup time of 24ns, and memory access time of 56ns.

2. A system with a hit ratio of 65%, associative lookup time of 6ns, and memory access time of 133ns.

4. CO5

a) Suppose there are two processes **P1 (32 B)** and **P2 (40 B)** with a page size of **8 B**. The main memory size is **96 B.** The page table for P1 and P2 are given below:

Page#	Frame#
0	3
1	10
2	2
3	0

Page table: P1

Page#	Frame#
0	5
1	8
2	11
3	1
4	6

Page table: P2

Find the corresponding physical addresses of the following logical addresses: [3]

a) Address 000001 of P1
b) Address 001001 of P2
c) Address 101001 of P2

b) Consider a computer with a main memory that has 5 frames and page reference string of 0-7 page **[6, 5, 3, 6, 4, 5, 0, 5, 5, 1, 1, 5, 0, 5, 4, 6, 3, 5, 1, 5]**. The page reference string represents the order in which the pages are accessed by a program. **Apply LRU** & **OPT** algorithm to **simulate** the page replacement that occurs when the main memory can hold at most 5 pages at a time. **Record** the number of **page faults** and compare the result. **Mention** which algorithm performs better in this scenario. [4+1]

Department of Computer Science and Engineering
Final Examination Fall 2023
CSE 321: Operating Systems

A

Duration: 1 Hour 45 Minutes **Total Marks:** 40

Answer the following questions.
Figures in the right margin indicate marks.

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1. CO4

a) A super shop has launched year-end sales on all their products. To avail the offer so many customers went there and purchased products as per their preferences. The issue occurred when they started the procedure of bill payment. There are 3 counters for paying bills but the number of customers waiting for completing payment is 50. [3]

Explain with proper logic, what issue has been raised in the above scenario and what will be the approach to provide proper synchronization to the issue according to the problem statement.

b) For the upcoming PMCO finals team "xyz" has arranged training sessions for players. In a training session a player needs to use a set of headphones and a mobile device together. The team can only facilitate a set of headphones and a mobile device to players for training. In a particular session 1 hour left for 2 players Alex and Zyoll. Each will get a 30 mins slot. But somehow Alex has captured the device and Zyoll has captured headphones at the same time and that is why nobody is able to make any progress in the training session. [2]

Logically explain what issue has occurred in the above scenario

c) In a system, following conditions are present.

- There are 3 processes: P1, P2 and P3.
- There is a semaphore, s=2.
- Ready queue is in the following order, [P1, P2, P3].
- CPU allocation is managed by round robin scheduling algorithm with the time quantum of 6 ms.
- Each statement takes 2 ms to execute.
- Critical section contains 3 statements.
- Remainder section contains 2 statements.

The structure of process Pi in solution using Semaphore:

```
wait(s){
   while(s<=0)
     ;//busy wait
   s--;
}

signal(s){
   s++;
}
```

```
do{
   wait(s);
   //critical section
   signal(s);
   //remainder section
}while(true);
```

Complete the table given below for processes P1, P2 and P3 using semaphore. [5]

Process 1	Process 2	Process 3

2. CO4 **a)** We have various ways to overcome deadlock in a system. Among these approaches is the strategy of ignoring it and relying on system restarts to resolve the deadlock. Despite the need for restarting the system, this method remains popular. **Discuss** why this strategy is commonly employed and **mention** the type of system that may utilize this method [3]

b) Suppose, in a workplace, we have a set of resource types, R = {R1, R2, R3, R4} and a set of processes, P = {P1, P2, P3, P4}. **R1, R2, R3, and R4** have **2, 2, 2, and 2** instances respectively.

- P1 is holding 1 instance of R4
- P2 is holding 1 instance of R1
- P3 is holding 1 instance of R1
- P4 is holding 1 instance of R4
- P4 holding 1 instance of R2
- P2 requests 1 instance of R3
- P2 is holding 1 instance of R2
- P1 is requests 1 instance of R1
- P3 is holding 1 instance of R3
- P4 is holding 1 instance of R3
- P3 requests 1 instance of R4
- P4 requests 2 instances of R1

Construct a resource allocation graph for the above scenario and **identify the cycle (if any) and decide** whether there is a deadlock or not. [4]

3. CO5 **a)** Arrays are stored in contiguous memory locations to optimize access to array elements, yet allocating processes in contiguous memory locations is discouraged. **Explain** why this is not recommended in terms of space complexity. [3]

b) A system with an associative lookup time of 7ns, and memory access time of 59ns, what should be the approximate hit ratio to achieve Effective Access Time of 92ns? [3]

c) Assume that, page size of a process is **8 bytes** and size of the main memory is **72 bytes**. Logical memory and page table of the process are given below.

Logical Memory

Page #	Data
P0	ab
P1	bc
P2	cd
P3	de
P4	ef
P5	fi

PMT

Page #	Frame #
P0	2
P1	6
P2	7
P3	13
P4	11
P5	5

Main memory

i. **How** can the user's view of memory be mapped into the main memory? [1]

ii. **Find out** corresponding physical addresses of the following logical addresses – **18(10010), 44(101100) and 27(11011)** [3]

d) If the page size is **9 KB**, **how many** frames will be needed in Main memory for a process size of **83,645 Bytes**? Is there any **internal fragmentation**? - If yes, **calculate** the value. [1 KB = 1024 Bytes] [2]

e) In a particular time, the snapshot of Main memory given below for dynamic partitioning where gray portions of the memory are representing occupied spaces. Apply worst fit and first fit algorithms to place processes with the space requirement of **P1=600k, P2=400k, P3=348k, P4=200k, P5=52k, P6= 100k and P7=72k** (in order). Explain which algorithm makes the most effective use of memory? [5]

800K	600K	120K	100K	400K	522K

4. CO5 **a)** Consider a computer with a main memory that has 3 frames and page reference string of 0-7 page **[0, 1, 6, 6, 4, 0, 0, 5, 5, 4]**. The page reference string represents the order in which the pages are accessed by a program. **Apply LRU** & **OPT** algorithm to **simulate** the page replacement that occurs when the main memory can hold at most 3 pages at a time. **Record** the number of **page faults** and compare the result. **Mention** which algorithm performs better in this scenario. [6]

Department of Computer Science and Engineering
Final Examination Fall 2023
CSE 321: Operating Systems

B

Duration: 1 Hour 45 Minutes **Total Marks:** 40

Answer the following questions.
Figures in the right margin indicate marks.

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1. CO4 **a)** In an office there are 10 employees. All the computers of the offices are connected to the internet by wired connectivity. But due to the limitation of bandwidth, office authorities allow only 5 devices to be connected with the wifi at the same time. On a particular day, 2 devices are already connected to the wifi and 6 more employees are trying to connect their devices to the wifi at the same time. **Explain** with proper logic, what issue has been raised in the above scenario and what will be the approach to provide proper synchronization to the issue according to the problem statement. [3]

b) For the upcoming PMCO finals team "xyz" has arranged training sessions for players. In a training session a player needs to use a set of headphones and a mobile device together. The team can only facilitate a set of headphones and a mobile device to players for training. In a particular session a 30 mins slot has been allotted for each player. 4 players of the team have arrived for the session and a queue has been fixed based on the ascending order of their arrival times. According to the criteria mentioned above the order of the players in the queue is Action, Top, Icy and Nirzed. But they were called for the training according to the following order: Nirzed, Icy, Top and Action. Therefore, after waiting for a long period Action left the training arena out of annoyance. **Logically explain** what issue has occurred in the above scenario. [2]

c) In a system, following conditions are present.

- There are 3 processes: P1, P2 and P3.
- There is a semaphore, s=2.
- Ready queue is in the following order, [P2, P3, P1].
- CPU allocation is managed by round robin scheduling algorithm with the time quantum of 9 ms.
- Each statement takes 3 ms to execute.
- Critical section contains 2 statements.
- Remainder section contains 3 statements.

The structure of process Pi in solution using Semaphore:

```
wait(s){
   while(s<=0)
     ;//busy wait
   s--;
}

signal(s){
   s++;
}
```

```
do{
   wait(s);
   //critical section
   signal(s);
   //remainder section
}while(true);
```

Complete the table given below for processes P1, P2 and P3 using semaphore. [5]

Process 1	Process 2	Process 3

2. CO4 **a)** We have various ways to overcome deadlock in a system. Among these approaches is the strategy of ignoring it and relying on system restarts to resolve the deadlock. Despite the need for restarting the system, this method remains popular. **Discuss** why this strategy is commonly employed and **mention** the type of system that may utilize this method [3]

b) Suppose, in a workplace, we have a set of resource types, R = {R1, R2, R3, R4} and a set of processes, P = {P1, P2, P3, P4}. **R1, R2, R3, and R4** have **2, 3, 2, and 3** instances respectively.

- P1 is holding 1 instance of R2
- P2 is holding 2 instances of R2
- P3 is holding 1 instance of R1
- P3 requests 1 instance of R2
- P4 holding 2 instances of R4
- P2 holding 1 instance of R1
- P1 requests 1 instance of R1
- P4 requests 1 instance of R3
- P3 holding 1 instance of R3
- P1 holding 1 instance of R3
- P3 holding 1 instance of R4

Construct a resource allocation graph for the above scenario and **identify the cycle (if any) and decide** whether there is a deadlock or not. [4]

3. CO5

a) Arrays are stored in contiguous memory locations to optimize access to array elements, yet allocating processes in contiguous memory locations is discouraged. **Explain** why this is not recommended in terms of space complexity. [3]

b) A system with an associative lookup time of 2ns, and memory access time of 72ns, what should be the approximate hit ratio to achieve Effective Access Time of 95ns? [3]

c) Assume that, page size of a process is **8 bytes** and size of the main memory is **72 bytes**. Logical memory and page table of the process are given below.

Logical Memory

Page #	Data
P0	ij
P1	jk
P2	kl
P3	lm
P4	mn
P5	no

PMT

Page #	Frame #
P0	5
P1	16
P2	7
P3	3
P4	6
P5	12

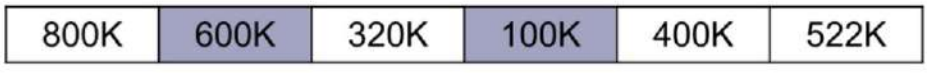
Main memory

i. **How** can the user's view of memory be mapped into the main memory? [1]

ii. **Find out** corresponding physical addresses of the following logical addresses – **25(11001), 37(100101) and 23(10111)** [3]

d) If the page size is **10 KB**, how many frames will be needed in Main memory for a process size of **31,110 Bytes**? Is there any internal fragmentation? - If yes, **calculate** the value. [1 KB = 1024 Bytes] [2]

e) In a particular time, the snapshot of Main memory given below for dynamic partitioning where gray portions of the memory are representing occupied spaces. Apply worst fit and first fit algorithms to place processes with the space requirement of **P1=600k, P2=400k, P3=298k, P4=292k, P5=200k, P6= 100k, P7=44k and P8=58k** (in order). Explain which algorithm makes the most effective use of memory? [5]



4. **a)** Consider a computer with a main memory that has 3 frames and page reference string of 0-7 page **[5, 5, 3, 1, 7, 3, 3, 5, 2, 0]**. The page reference string represents the order in which the pages are accessed by a program. **Apply LRU** & **OPT** algorithm to **simulate** the page replacement that occurs when the main memory can hold at most 3 pages at a time. **Record** the number of **page faults** and compare the result. **Mention** which algorithm performs better in this scenario. [6]

CO5

Department of Computer Science and Engineering
Final Examination Fall 2023
CSE 321: Operating Systems

C

Duration: 1 Hour 45 Minutes **Total Marks:** 40

Answer the following questions.
Figures in the right margin indicate marks.

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1. CO4

a) In the research lab of a university there is a high-performing computer which can be used for research works on parallel computing. In a particular semester, four research groups are working on separate projects on parallel computing. One day four groups came together at the lab and were willing to use the high-performing computer at the same time. [3]
Explain with proper logic, what issue has been raised in the above scenario and what will be the approach to provide proper synchronization to the issue according to the problem statement.

b) In a certain match of PMCO two players from team "xyz" Action and Top started a debate over the sniping role of the team. Both of them are good in long range and in the match, Top found out a sniper weapon but he has no scopes. As a result, he is unable to use the sniper for the long range. On the contrary, Action has an 8x scope but he does not have any sniper weapon. Which means he is unable to use the scope. Both of them are willing to play as a sniper and for that Top is demanding the scope from Action and Action is demanding the sniper weapon from Top. But nobody is willing to make the compromise. Therefore, neither of them can play as a sniper. [2]
Logically explain what issue has occurred in the above scenario.

c) In a system, following conditions are present.

- There are 3 processes: P1, P2 and P3.
- There is a mutex lock, available=true.
- Ready queue is in the following order, [P3, P1, P2].
- CPU allocation is managed by round robin scheduling algorithm with the time quantum of 12 ms.
- Each statement takes 4 ms to execute.
- Critical section contains 3 statements.
- Remainder section contains 2 statements.

The structure of process Pi in solution using mutex lock:

```
acquire(){
   while(!available)
     ;//busy wait
   available=false;
}

release(){
   available=true;
}
```

```
do{
   acquire();
   //critical section
   release();
   //remainder section
}while(true);
```

Complete the table given below for processes P1, P2 and P3 using mutex lock. [5]

Process 1	Process 2	Process 3

2. CO4 **a)** We have various ways to overcome deadlock in a system. Among these approaches is the strategy of ignoring it and relying on system restarts to resolve the deadlock. Despite the need for restarting the system, this method remains popular. **Discuss** why this strategy is commonly employed and **mention** the type of system that may utilize this method [3]

b) Suppose, in a workplace, we have a set of resource types, R = {R1, R2, R3, R4} and a set of processes, P = {P1, P2, P3, P4, P5}. **R1, R2, R3, and R4** have **3, 2, 4, and 2** instances respectively.

- P1 is holding 2 instances of R1
- P2 is holding 1 instance of R3
- P3 is holding 1 instance of R4
- P5 requests 2 instances of R3
- P4 is holding 1 instance of R4
- P3 requests 1 instance of R2
- P2 requests 1 instance of R1
- P2 is holding 1 instance of R2
- P1 is requesting 1 instance of R4
- P3 is holding 1 instance of R3
- P4 is holding 1 instance of R3
- P5 holding 1 instance of R2

Construct a resource allocation graph for the above scenario and **identify the cycle (if any) and decide** whether there is a deadlock or not. [4]

3. CO5 **a)** Arrays are stored in contiguous memory locations to optimize access to array elements, yet allocating processes in contiguous memory locations is discouraged. **Explain** why this is not recommended in terms of space complexity. [3]

b) A system with an associative lookup time of 5ns, and memory access time of 85ns, what should be the approximate hit ratio to achieve Effective Access Time of 146ns? [3]

c) Assume that, page size of a process is **8 bytes** and size of the main memory is **72 bytes**. Logical memory and page table of the process are given below.

Logical Memory

Page #	Data
P0	op
P1	pq
P2	qr
P3	rs
P4	st
P5	tu

PMT

Page #	Frame #
P0	10
P1	2
P2	4
P3	11
P4	8
P5	3

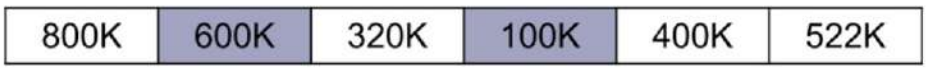
Main memory

i. **How** can the user's view of memory be mapped into the main memory? [1]

ii. **Find out** corresponding physical addresses of the following logical addresses – **11(1011), 4(100) and 21(10101)** [3]

d) If the page size is **7 KB**, how many frames will be needed in Main memory for a process size of **93,600 Bytes**? Is there any internal fragmentation? - If yes, **calculate** the value. [1 KB = 1024 Bytes] [2]

e) In a particular time, the snapshot of Main memory given below for dynamic partitioning where gray portions of the memory are representing occupied spaces. Apply worst fit and first fit algorithms to place processes with the space requirement of **P1=600k, P2=400k, P3=298k, P4=292k, P5=200k, P6= 100k, P7=44k and P8=58k** (in order). Explain which algorithm makes the most effective use of memory? [5]



4. CO5 **a)** Consider a computer with a main memory that has 3 frames and page reference string of 0-7 page **[3, 5, 4, 6, 7, 4, 2, 6, 7, 6]**. The page reference string represents the order in which the pages are accessed by a program. **Apply LRU** & **OPT** algorithm to **simulate** the page replacement that occurs when the main memory can hold at most 3 pages at a time. **Record** the number of **page faults** and compare the result. **Mention** which algorithm performs better in this scenario. [6]

A

Department of Computer Science and Engineering
Final Examination Fall 2022
CSE 321: Operating Systems

Duration: 2 Hours **Total Marks:** 40

Answer the following questions.
Figures in the right margin indicate marks.

---

2. CO5

3. CO5

a) Consider the following snapshot of a system:

		Allocation					MAX			
		A	**B**	**C**	**D**		**A**	**B**	**C**	**D**
P0		5	1	1	4		10	5	10	5
P1		2	2	6	2		5	9	10	3
P2		2	8	6	4		9	12	9	10
P3		4	6	8	2		4	6	8	3

[4]

Available			
1	1	0	3

[2+3]

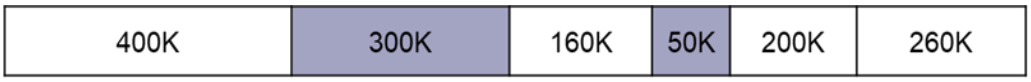
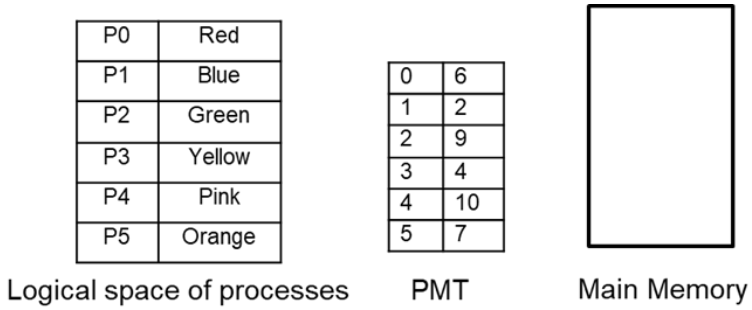
i. Is the system in a safe state? **Apply Banker's safety algorithm** to find out the safe sequence. You need to **calculate** the need matrix.

ii. $\mathbf{P_1}$ requests for **(1 0 0 1)**. **Check** the validity of the request. If the request is valid, does the system enter a **deadlock**?

b) Suppose, in an office, we have a set of resource types, R = {R1, R2, R3} and a set of processes, P = {P1, P2, P3, P4, P5}. **R1, R2, and R3** have **3, 2, and 1** instance respectively.

- P1 requests for 1 instance of R3
- P1 is holding 2 instances of R2
- P2 requests for 1 instance of R2
- P2 is holding 1 instance of R1
- P3 is holding 1 instance of R3

[3]

	• P3 requests 1 instance of R1 • P4 is holding 1 instance of R1 • P5 is holding 1 instance of R1 • P5 requests 1 instance of R2 **Construct** a resource allocation graph for the above scenario. **Mention** the number of cycles found and **identify** whether there is a deadlock or not.	
4. **CO6**	**a)** At a particular time, the snapshot of the Main memory is given below for dynamic partitioning where gray portions of the memory represent occupied spaces. **Apply worst fit** and **first fit** algorithms to place processes with the space requirement of P1=300k, P2=200k, P3=149k, P4=146k, P5=100k, P6= 50k, P7=22k and P8=29k (in order). **Explain** which algorithm makes the most effective use of memory.  **b)** Assume that the page size is 3 bytes and the Physical Memory size is 36 bytes. **Show** the users' view of memory which is mapped into physical memory.  **c)** If the page size is **2 KB**, **how many** frames will be needed in Main memory for a process size of **38,767 Bytes**? Is there any **internal fragmentation**? - If yes, **calculate** the value. [1 KB = 1024 Bytes]	[2+2+1] [2] [2]
	d) What are the **differences** between **static** and **dynamic** techniques for partitioning main memory?	[3]
5. **CO6**	Consider a computer with a main memory that has 3 frames and page reference string of 0-7 pages: **[7 0 6 4 2 6 1 2 0 5 1]**. The page reference string represents the order in which the pages are accessed by a program. **Apply FIFO** & **LRU** algorithm to **simulate** the page replacement that occurs when the main memory can hold at most 3 pages at a time. **Record** the number of **page faults** and compare the result. **Mention** which algorithm performs better in this scenario.	[4+1+1]

Department of Computer Science and Engineering
Final Examination Fall 2022
CSE 321: Operating Systems

B

Duration: 2 Hours **Total Marks:** 40

Answer the following questions.
Figures in the right margin indicate marks.

---

1. CO4

a) A system has processes to execute of which **30%** is serial. If the number of cores is increased from **1** to **3**, what will be the **increase** in performance? [2]

b) Distinguish between **many-to-one** and **one-to-one** multithreading models**.** [2]

2. CO5

a) Suppose a medical center is providing Covid vaccination. In that center maximum of 6 people can take vaccines at a time in separate booths. But approximately 50 people went there to take vaccines on a particular day. Therefore, the authorities have decided that they will provide vaccines to 6 people at a time and keep others waiting in a queue. If any of the vaccine booths get free a person from the queue will be taken to that booth according to the first come first serve manner for vaccination. **Logically explain** which synchronization method has been used here [2]

b) For Peterson's problem below conditions will be applied.

- There are two processes: P1 and P2.
- Each Statement takes 4ms to execute.
- Context Switch will occur after 12ms.
- Both the Critical & Remainder section contains 3 statements.
- For P1: i=0 and j=1
- For P2: i=1 and j=0
- turn=0
- flag[0] = FALSE, flag[1] = FALSE

The structure of process P_i in Peterson's solution:

```
do{
        flag[i] = true;
        turn = j;
        while(flag[j] == true && turn == 1){
                //busy wait
        }
        //critical section
        flag[i] = false;
        //remainder section
}while(true);
```

[4]

Complete the table given below for processes P1 and P2 using **Peterson's solution.**

Process 1: i=0, j=1	Process 2: i=1, j=0

3. CO5 **a)** Consider the following snapshot of a system:

		Allocation					MAX			
		A	**B**	**C**	**D**		**A**	**B**	**C**	**D**
P_0		5	1	1	4		10	5	10	11
P_1		2	8	6	4		9	12	9	10
P_2		2	2	6	2		5	9	10	3
P_3		4	6	8	2		4	6	8	3

Available			
4	4	6	4

[4]

i. Is the system in a safe state? **Apply Banker's safety algorithm** to find out the safe sequence. You need to calculate the need matrix. [2+3]

ii. **P_0** requests for **(3 3 6 1**), **check** the validity of the request. If the request is valid, does the system enter a **deadlock**?

b) Suppose, in an office, we have a set of resource types, R = {R1, R2, R3} and a set of processes, P = {P1, P2, P3, P4, P5}. **R1, R2, and R3** have **3, 2, and 1** instance respectively.

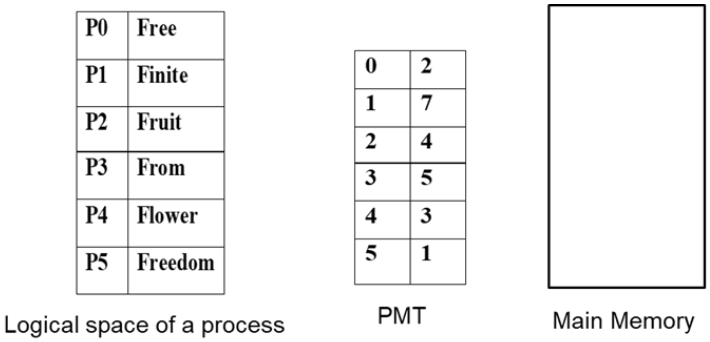
- P1 is holding 1 instance of R3
- P1 requests 1 instance of R1
- P3 requests for 1 instance of R3
- P3 is holding 2 instances of R2
- P2 requests for 1 instance of R2
- P2 is holding 1 instance of R1
- P4 is holding 1 instance of R1
- P4 requests 1 instance of R2
- P5 is holding 1 instance of R1

[3]

Construct a resource allocation graph for the above scenario. **Mention** the number of cycles found and **identify** whether there is a deadlock or not.

4. CO6 **a)** At a particular time, the snapshot of the Main memory is given below for dynamic partitioning where gray portions of the memory represent occupied spaces. **Apply worst fit** and **first fit** algorithms to place processes with the space requirement of P1=300k, P2=200k, P3=149k, P4=146k, P5=100k, P6= 50k, P7=22k and P8=29k (in order). **Explain** which algorithm makes the most effective use of memory. [2+2+1]

b) Assume that in a paged memory management system the page size for processes is 4 bytes and the Physical Memory size is 36 bytes. **Show** the users' view of memory which is mapped into physical memory. [2]



c) If the page size is **6 KB**, **how many** frames will be needed in Main memory for a process size of **102,506 Bytes**? Is there any **internal fragmentation**? - If yes, **calculate** the value. [1 KB = 1024 Bytes] [2]

d) Discuss the purpose of **MMU**. [3]

5. CO6 Consider a computer with a main memory that has 3 frames and page reference string of 0-7 pages: **[3 0 6 4 2 6 7 2 0 1 7]**. The page reference string represents the order in which the pages are accessed by a program. **Apply FIFO** & **LRU** algorithm to simulate the page replacement that occurs when the main memory can hold at most 3 pages at a time. **Record** the number of **page faults** and compare the result. **Mention** which algorithm performs better in this scenario. [4+1+1]

BRAC UNIVERSITY
Department of Computer Science and Engineering

Examination: Final | Semester: Spring 2022
Duration: 2 Hours | Full Marks: 40

CSE 321: Operating Systems

Answer the following questions.
Figures in the right margin indicate marks.

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2. **CO5**

a) **Explain** how Banker's algorithm can help to find the processes that are causing a deadlock in a system. [2]

b) **Describe** some strategies for deadlock prevention that can break the hold-and-wait condition. [2]

c) Suppose, in an office, we have a set of resource types, R = {R1, R2, R3} and a set of processes, P = {P1, P2, P3, P4}. R1, R2, and R3 have 4, 2, and 2 instances respectively.

i) P1 is holding 2 instances of R1,

ii) P2 requests 1 instance of R3

iii) P3 requests 2 instances of R2

iv) P2 requests 1 instance of R1

v) P2 is holding 1 instance of R2

vi) P3 is holding 1 instance of R3 [3]

Construct a resource allocation graph for the above scenario and **identify** whether there is a deadlock or not.

d) Consider the following snapshot of a system:

		Allocation					**Max**			
		A	**B**	**C**	**D**		**A**	**B**	**C**	**D**
P1		0	0	1	2		0	0	2	3
P2		1	0	0	0		1	2	2	0
P3		1	3	5	4		2	3	5	6
P4		0	0	0	1		2	2	0	1

Available			
1	2	2	0

[3]

[2]

i. Is the system in a safe state? [3]

ii. Can P3's request (1 0 0 0) be safely granted immediately?

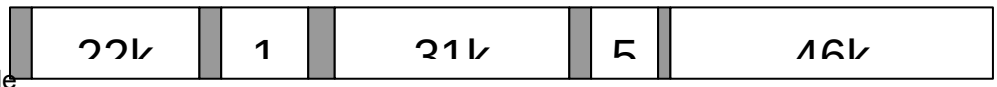
iii. If P3's request is granted immediately, does the system enter a deadlock?

3. **CO6**

a) **Explain** the disadvantage of using Contiguous allocation and how Paging is more beneficial than Contiguous allocation. [3]

b) **Explain** how the operating system's behavior and hardware mechanism for logical to physical address translation ensure that one process cannot access the memory allocated for another process. [2]

c) At a particular time, the snapshot of the Main memory is given below for dynamic partition. Gray portions of the memory are occupied space.

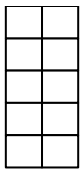


if OS givenn this side top which bottom /up/ right?

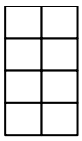
i) **Apply** worst-fit and best-fit algorithms to allocate processes with the space requirement of P1(26k), P2(30k), P3(15k), P4(20k), and P5(6k). [4]

ii) **Explain** which algorithm makes the most effective use of memory? [2]

d) Suppose, in a system, there are two processes - P1 (16 bytes) and P2 (12 bytes) with a page size of 4 bytes. The main memory size of the system is 32 bytes. Page tables of both processes are given below.



Page Table of P1



Page Table of P2

Find the corresponding physical address of the following logical addresses - [4]

i. address 1011 of P1
ii. address 0100 of P1
iii. address 0111 of P2
iv. address 1010 of P2

BRAC UNIVERSITY
Department of Computer Science and Engineering

Examination: Semester Final **Semester :Summer 2019**
Duration: 2 Hours 30 minutes **Full Marks:64**

CSE 321: Operating Systems

Answer the following questions.
Figures in the right margin indicate marks.

Name:	ID:	Section:

Section-A [CO6] [Answer any Two (2)]

1. a) Assume that page size = 3KB and Physical Memory = 36KB. If CPU generates logical addresses 5, 9, 2 and 16 respectively then **developed** the users' view of memory which is mapped into physical memory? 4

P0	CSE101
P1	CSE220
P2	CSE110
P3	CSE330
P4	CSE420
P5	CSE321

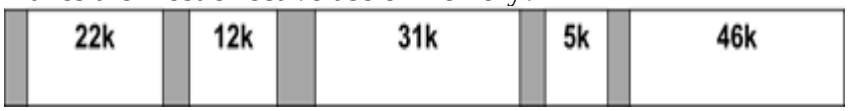
Logical Address Space

0	6
1	2
2	9
3	4
4	11
5	7

PMT

Main Memory

b) In a particular time the snapshot of Main memory given below for dynamic partition. Apply worst fit and best fit algorithms to place processes with the space requirement of 26k, 30k, 15k, 20k, and 6k. **Explain** which algorithm makes the most effective use of memory? 4



2. a) **Explain** in which term Paging is more beneficial than Contiguous allocation. **Illustrate** page fault steps and describe briefly. 2+4

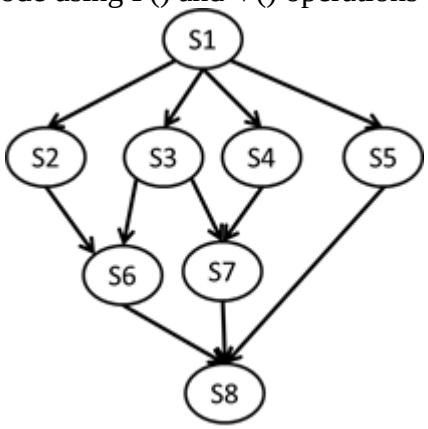
b) **List** disadvantage of Static and Dynamic memory allocation. 2

3. a) CPU generates page no sequences are as follows: 3, 0, 0, 1, 1, 7, 0, 3, 0, 4, 4, 3, 4, 2, 1, 2, 0, 4, 3, 1, 7, 0, 4, 3, 1, 1, 7, 0 and there are only 5 frames to accommodate. **Calculate** he number of page fault for optimal and LRU Page replacement algorithm. Also find the efficiency for both of the page replacement algorithm. 6

b) **Define** demand paging. 2

Section-B [Answer All Questions]

4. CO5 a) **Solve** the graph of process synchronization drawn below using semaphore variables. [Note: Each node represents a statement (S) which is running independently. Write code using P() and V() operations only] 4



b) Suppose, in our office, we have a set of resource types, R = {R_1, R_2, R_3, R_4} and a set of processes, P = {P_1, P_2, P_3, P_4, P_5}. All the resource types in R have 3, 1, 4, and 2 instances respectively. Processes are organized such that P_1 is holding 2 instances of R_1, P_2 is holding 1 instance of R_3, P_3 is holding 1 instance of R_4, P_5 requests 2 instances of R_3, P_4 requests 1 instance of R_4, P_3 requests 1 instance of R_2, P_2 requests 1 instance of R_1, P_2 is holding 1 instance of R_2, P_1 is requesting 1 instance of R_4, P_3 is holding 1 instances of R_3.**Construct** a resource allocation graph for the above scenario and **identify** weather there is deadlock or not. 4

5. CO5 Suppose, we have the following scenario in an OS. There are <u>five</u> processes and <u>four</u> resource types. Answer the following questions using Banker's Algorithm. 2+3 +3

Processes	Max				Allocation				Available			
	A	B	C	D	A	B	C	D	A	B	C	D
P1	4	2	3	3	2	2	1	0				
P2	3	4	2	0	1	2	0	0				
P3	1	4	3	1	1	2	2	0	1	1	2	1
P4	3	3	0	2	1	1	0	2				
P5	2	1	4	2	1	1	3	2				

a) **Calculate** Need matrix
b) Is this system in safe state? If yes, then **show** the safe sequence or if no, then provide necessary explaination?
c) If a request (0,1,1,0) from process P3 arrives for additional resources, **analyze** whether Banker's algorithm can grant the request or not.

1+4
+3

7. CO1	a)	**Write** five major activities of an operating system in regard to process management.	4+4
	b)	**Write** what is the main advantage for an operating system designer of using virtual machine architecture? How does the guest operating system function on the host operating system? [Hint: VMWare].	
8. CO2	a)	Can a process make a transition from the running to the ready and waiting state? **Explain** why or why not?	4+4
	b)	**Define** IPC? **Discuss** two models of IPC.	
9. CO4	a)	In a multithreading program state **write** how a thread can be canceled.	3+5
	b)	**Define** the resources that are used in thread creation and how do they **differentiate** from those resources used when a process is created?	

END