Q1. a) Compare the following: **[10] [CO1]**

i) CPU Utilization and I/O Utilization 2.5

ii) Long Term Scheduler and Medium Term Scheduler 2.5

iii) Assymmetric Multiprocessing and Symmetric Multiprocessing 2.5

iv) IPC and RPC 2.5

b) Give the benefits of multithreading. What resources are used when a thread is created? How do they differ from those used when a process is created? **[5][CO1]**

c) What are the factors that need to be considered to determine the degree of multiprogramming in a system? **[3][CO1]**

Q2. a) Discuss the primary and secondary requirements which need to be followed to achieve synchronization in the operating systems. **[4] [CO2]**

b) Explain *Decker's algorithm* for two processes. **[4] [CO2]**
Analyze the algorithm to prove:
i) Mutual Exclusion is satisfied
ii) Progress is violated. **[4] [CO2]**

c) Considering two process *Peterson's method* to achieve synchronization, process P_0 executes the line of code *interested [process] = TRUE* and gets preempted, Process P_1 takes over and executes the line of code *interested [process] = TRUE* and *turn=process* and gets preempted. P_0 resumes the execution and executes the line of code *turn=process*. Which among the two processes (P_0, P_1) will enter the critical section first and why? **[6][CO2]**

Q3. a) Consider a system with three processes P_1, P_2, P_3, and P_4 – the peak demand of each process for the resource R is: 5, 88, 76, and 24 respectively. Discuss what is the minimum number of resources required to ensure deadlock-free operation? **[4][CO4]**

b) What is basic motivation behind the existence of Semaphores and why are semaphores implemented in the Kernel mode only? **[3,3][CO2]**

c) Consider a system with 4 processes and 3 resource types A, B, C with the parameters given as:

Processes	Maximum Need				Current Allocation				Current Available		
	A	B	C		A	B	C		A	B	C

P_0	6	5	4		0	3	4		4	3	1
P_1	3	4	2		2	1	2				
P_2	1	0	4		0	0	2				
P_3	3	2	5		1	2	1				

Find the remaining resources needed of the given processes from the information available in the table and check whether the system is in *Safe State* or not?

[8][CO4]

Q4. Consider four CPU-intensive processes, which require 7, 4, 1 and 4 time units and arrive at times 0.0, 2.0, 4.0 and 6.0, respectively.

a) Draw the Gantt chart illustrating the execution of these processes using the following scheduling algorithms: FCFS, SJF, SRTF, priority scheduling (pre-emptive and non-pre-emptive), round robin (time quantum =1), longest time remaining first and highest response ratio first scheduling. **[4][CO3]**

Process Id	Burst time	Arrival time	Priority
1	7	0.0	4
2	4	2.0	2
3	1	4.0	1
4	4	6.0	3

0.5 each

Note: Smallest priority number has the highest priority

b) Compute the turnaround time and waiting time for all these algorithms, and fill in the table given below. **[12][CO3]**

FCFS		SJF		SRTF		RR		Priority based (pre-emptive)		Priority based (non-pre-emptive)		LRTF		Highest response ratio	
1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5	
T.T	W.T	T.T	W.T	T.T	W.T	T.T	W.T	T.T	W.T	T.T	W.T	T.T	W.T	T.T	W.T

c) Which algorithm gives the minimum average waiting time? **[2][CO3]**

Q5. a) i) On a system with paging, a process cannot access memory that it does not own; why? How can an Operating System allow access to other memory? Explain whether it should be allowed or not and why ?

ii) What is the purpose of paging the page tables?

[4,3.5][CO5]

b) Most systems allow programs to allocate more memory to its address space during execution. Data allocated in the heap segments of programs are an example of such allocated memory. What is required to support dynamic memory allocation in the following schemes: **[4.5][CO5]**

i. contiguous-memory allocation

ii. pure segmentation

iii. pure paging

c) Consider a logical address space of 32 pages with 1024 words per page; mapped onto a physical memory of 16 frames.

i. How many bits are required in the logical address?

ii. How many bits are required in the physical address? **[3,3][CO5]**

Q6. a) Given five memory partitions of 100Kb, 500Kb, 200Kb, 300Kb, 600Kb (in order), Show with neat sketch how would the first-fit, best-fit, and worst-fit algorithms place processes of 212 Kb, 417 Kb, 112 Kb, and 426 Kb (in order)? In this example, which algorithm makes the most efficient use of memory?

[4,2][CO5]

b) State the effect of Thrashing on an Operating System. **[4][CO5]**

c) Explain the difference between Internal and External fragmentation using an example. What is the solution for both ? Explain the circumstances where one might be preferred over the other. **[3,3,2][CO5]**

End of Paper