Instructions: Answer all questions.
Time   : 1 hour and 30 minutes

Q1.   a)   Describe the differences between *deadlock* and *starvation* and give **ONE (1)** real-world example for each.   (6 marks)

b)   *First-Fit* and *Best-Fit* are memory allocation techniques. Explain with example when:

(i)   *First-Fit* is more appropriate to be used over *Best-Fit*   (3 marks)

(ii)   *Best-Fit* is more appropriate to be used over *First-Fit*   (3 marks)

Q2.   The following metric shown the arrival time, the CPU time and the priority for a particular process in milliseconds (ms).

Process	Arrival Time (ms)	CPU cycle (ms)	Priority
A	0	11	1
B	3	5	2
C	6	3	3
D	9	9	3
E	12	6	1

(Assume a smaller priority number implies a higher priority)

Draw a Gantt chart illustrating the execution of the above processes, and calculate the *average turnaround time* and *average waiting time* based on each of the following algorithms:

a)   Shortest Remaining Time First (Preemptive)   (4 marks)
b)   Non-Preemptive Priority   (4 marks)

c)   Round Robin (Time Quantum = 3ms)   (4 marks)

Q3.   A system has five processes named **P0**, **P1**, **P2, P3** and **P4** running. The current state of the system is described as below:

- **P0** has acquired a tape drive **A** and a printer **B** and is currently waiting on a CD drive **C**.
- **P1** has acquired a CD Drive **C** and is waiting on both the tape drive **A** and the scanner **K**.
- **P2** has acquired a scanner **K** and is waiting on a projector **S**.
- **P3** has acquired a projector **S**, and is waiting on a monitor **M**.
- **P4** has acquired a monitor **M**, and is waiting on a printer **B**.

a)   Draw a directed resources allocation graph to represent the above system state.   (6 marks)

b)   Determine whether the system is in a deadlock state and justify your answer.

(2 marks)

Q4.   Given memory partitions of 200KB, 100KB, 340KB, 500KB and 420KB (in order), how would each of the First-Fit and Best-Fit algorithms place processes of 212KB, 410KB, 50KB and 340KB (in order)? Show your answers using the following table format.

Table format:

Partition Size	Process Size	Internal Fragmentation

a)   First-Fit memory allocation algorithm.   (3 marks)

b)   Best-Fit memory allocation algorithm.   (3 marks)

Q5.   Consider the following page reference string:
                3, 4, 1, 4, 2, 5, 1, 3, 6, 2, 1, 3, 4, 2, 5, 1, 2, 3, 5, 1

Conduct a *page trace analysis* to indicate the number of page faults and then compute the *numbers of page faults* by using the following page replacement algorithms. Assuming **FOUR (4)** page frames are used and all frames are initially empty.

a)   First-In-First-Out (FIFO).   (3 marks)

b)   Least Recent Used (LRU).   (3 marks)

Q6.   A simple paging system consists of 64 pages of logical address space and 2048 pages of physical address space. The system has a page size of 1024 bytes.

a)   How many bits are there in the physical address space and the logical address space?   (4 mark)

b)   How many bits are there in the logical address specify the page number?

(2 marks)

[Total: 50 marks]