INSTRUCTIONS
• Do not write anything on the question paper.
• Please write your name, roll number and other details very clearly on the front page of the answer sheet.
• If you are using multiple answer sheets, ensure that they are safely stapled together.
• Any attempt to cheat in any manner will result in automatic expulsion.
• If you need any kind of help please raise your hand.
Good luck and all the best.

NOTES TO STUDENTS
• This test lasts for 90 minutes and consists of 150 marks, and for pass your exam you have to score at least 60 marks. Budget your time accordingly.
• This test has 11 questions and 12 pages. Check that you have all pages before starting.
• Write in pen, no pencils.
• Write your answer on this “question and answer” paper, in the spaces provided. Be concise. In general, the amount of space provided is an upper bound on the “size” of answer that is expected. If necessary, use space where available and provide explicit pointers.

1. Tick the correct questions. (10 points, 1 point each)
   a. Which statement about resource is FALSE?
      i. A process must request a resource before using it.
      ii. The operating system can provide resources.
iii. A process must be blocked before requesting a resource.

iv. A process must stop its operation until a requested resource is allocated.

b. Round Robin scheduling is essentially the preemptive version of

   i. FIFO
   ii. SJF
   iii. Shortest Remaining Time Next

c. Basic process states include the following EXCEPT

   i. Blocked
   ii. Running
   iii. Ready
   iv. Killed

d. Regardless of the type of the computer system, all scheduling algorithms are measured to see if they

   i. Are fair
   ii. Are nice
   iii. Have good response time
   iv. Meet deadlines

e. Non preemptive scheduling strategies include the following EXCEPT

   i. FCFS
   ii. Shortest Job Next
   iii. Priority
   iv. Worst Fit

f. Which of the following is NOT a transition between process states?

   i. Ready to blocked
   ii. Ready to running
   iii. Running to blocked
iv. Running to ready

g. In the reader writer problem processes p and q are allowed to simultaneously access the shared resource if and only if
   i. p and q both are reading
   ii. p and q both are writing
   iii. p is reading and q is writing or vice versa
   iv. None of the above

h. Round Robin scheduling is essentially the preemptive version of
   i. FIFO
   ii. SJF
   iii. Shortest Time Remaining First

i. Switching the CPU to another Process requires to save state of the old process and loading new process state is called as
   i. Process Blocking
   ii. Context Switch
   iii. Time Sharing
   iv. None of the above

j. Concurrency on a uniprocessor is achieved by
   i. Critical section
   ii. Message passing
   iii. Time sharing
   iv. None of the above

2. Suppose three peoples are in a line waiting for a department store to open for “the big sale”. When the door opens, all three rush the door, but the door is not big enough for all them to pass through at once. Describe a solution for addressing this deadlock that will allow three peoples to pass through the door. Which of the 4 necessary deadlock conditions does your solution break? [4]
3. Consider the following set of processes, with the length of CPU burst time given in milliseconds.

<table>
<thead>
<tr>
<th>Processes</th>
<th>Arrival time</th>
<th>CPU Burst time</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

a. Draw four Gantt charts illustrating the execution of these processes using FCFS, SJF, Priority (a smaller priority number implies a higher priority), RR (Quantum = 5 units). (10 points)

b. What is the turnaround time for each process for each of the scheduling algorithm in part (4.a)? (10 points)
c. What is the waiting time of each process for each of the scheduling algorithm in part (4.a)? (10 points)

d. Which of the schedule results minimal average waiting time? [5]

4. Given the following scenario involving three processes P1, P2 and P3 and three resources R1, R2 and R3.

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>P1 request the printer R1</td>
</tr>
<tr>
<td>2</td>
<td>R1 is allocated to P1</td>
</tr>
<tr>
<td>3</td>
<td>P1 requests the tape drive R2</td>
</tr>
<tr>
<td>4</td>
<td>R2 is allocated to P1</td>
</tr>
<tr>
<td>5</td>
<td>P2 requests R2</td>
</tr>
<tr>
<td>6</td>
<td>P2 requests R3</td>
</tr>
<tr>
<td>7</td>
<td>P3 requests the tape drive R2</td>
</tr>
</tbody>
</table>

a. Draw a directed graph of the above requests and allocations. (10 points)
b. Is the system in deadlock Yes / No________ (2 points)

c. What are the four conditions necessary to have a deadlock? (4 points)

i.

ii.

iii.

iv.

5. Consider the following snapshot of a system.

<table>
<thead>
<tr>
<th>Allocation</th>
<th>Max</th>
<th>Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>A B C D</td>
<td>A B C D</td>
<td>A B C D</td>
</tr>
<tr>
<td>P0 0 0 1 2</td>
<td>0 0 1 2</td>
<td>1 5 2 0</td>
</tr>
<tr>
<td>P1 1 0 0 0</td>
<td>1 7 5 0</td>
<td></td>
</tr>
<tr>
<td>P2 1 3 5 4</td>
<td>2 3 5 6</td>
<td></td>
</tr>
<tr>
<td>P3 0 6 3 2</td>
<td>0 6 5 2</td>
<td></td>
</tr>
<tr>
<td>P4 0 0 1 4</td>
<td>0 6 5 6</td>
<td></td>
</tr>
</tbody>
</table>

Answer the following questions using the banker’s algorithm.

a. What is the content of matrix Need? (10 points)
b. Is the system in a safe state? If yes give the sequence. (5 points)

c. If a request from process from P1 arrives for (0, 4, 2, 0), can the request be granted immediately? (10 points)

6. Examine the following memory allocation recorded as a linked list.
a. Using the NEXT fit algorithm to allocate memory, redraw the above linked list after the allocation memory for two processes. The first process requires 5 units of memory and the second process requires 3 units of memory. (5 points)

b. Redraw the original diagram for this question after allocating memory using the FIRST fit algorithm for two processes. The first process requires 5 units of memory and the second process requires 3 units of memory. (5 points)

c. Redraw the original linked list shown in 6.a as a bitmap. (5 points)
7. Joe Smart says “If you want to schedule processes to minimize the TOTAL wait time of all processes, it is quite easy. Just use the shortest Job First rule.” First explain what Joe means. Then prove or argue why Joe is right. Finally discuss the issues raised by this Smart idea and how we can resolve them. (15 points)

8. For the following statements, specify whether they are TRUE or FALSE. (10 points, 2 points each)

   a. Race condition cannot occur in uniprocessor. ____

   b. SJF can be implemented as a priority algorithm, where the priority is determined by the arrival time of the job. ______

   c. A process in the Ready state can only transition to running state. ____

   d. In paging external fragmentation cannot occur. ______

   e. The value of a semaphore represents how many processes are waiting for a common
9. Explain the advantages of monitors over semaphores. (5 points)

10. What is the meaning of the term busy waiting? Can busy waiting be avoided? (5 points)

11. Using the page references string shown below, find the numbers of page faults for following algorithm with 4 page frames. Initially all the page frames are empty. (10 points, 5 points each)

A, B, C, D, B, E, C, G, D, A, G, D, B, E, C

a. OPT

b. LRU