CSN-232: Operating Systems
[End-Term Examination]
Max Marks: 50

Instructions:
- **Each question is of 1 mark.**
- **Questions may have more than one correct answer/option.**
- **Evaluation is binary (0 or 1).**
- **Closed Book exam.**
- **Calculators are allowed.**

1) Which of the following is not a valid deadlock prevention scheme?
   a. Release all resources before requesting a new resource.
   b. Number the resources uniquely and never request a lower numbered resource than the last one requested.
   c. Never request a resource after releasing any resource.
   d. Request and all required resources be allocated before execution.

2) Consider a virtual memory system with a FIFO page replacement policy. For an arbitrary page access pattern, increasing the number of page frames in the main memory will
   a. Always decrease the number of page faults
   b. Always increase the number of page faults
   c. Sometimes increase the number of page faults
   d. Never affect the number of page faults

3) Suppose the time to service a page fault is on average 10 milliseconds, while a memory access takes 1 microsecond. Then a 99.99% hit ratio results in an average memory access time of
   a. 1.9999 milliseconds
   b. 1 millisecond
   c. 9.999 microseconds
   d. 1.9999 microseconds

4) Which of the following need not necessarily be saved on a context switch between processes?
   a. General purpose registers
   b. Translation look-aside buffer
   c. Program counter
   d. All of the above

5) For hard disk drives, using a larger block size in a fixed block size file system leads to
   a. better disk throughput but poorer disk space utilization
   b. better disk throughput and better disk space utilization
   c. poorer disk throughput but better disk space utilization
   d. poorer disk throughput and poorer disk space utilization

6) Consider the 3 processes, P1, P2 and P3 shown in the table

Process	Arrival time	Time unit required
P1	0	5
P2	1	7
P3	3	4

   The completion order of the 3 processes under the policies FCFS and RRS (round robin scheduling with CPU quantum of 2 time units) are
   a. FCFS: P1, P2, P3 RR2: P1, P2, P3
   b. FCFS: P1, P3, P2 RR2: P1, P3, P2
   c. FCFS: P1, P2, P3 RR2: P1, P3, P2
   d. FCFS: P1, P3, P2 RR2: P1, P2, P3

7) In a system with 32 bit virtual addresses and 1 KB page size, use of one-level page tables for virtual to physical address translation is not practical because of
   a. the large amount of internal fragmentation
   b. the large amount of external fragmentation
   c. the large memory overhead in maintaining page tables
   d. the large computation overhead in the translation process

8) A thread is usually defined as a 'light weight process' because an operating system (OS) maintains smaller data structures for a thread than for a process. In relation to this, which of the following is/are TRUE?
   a. On per-thread basis, the OS maintains only CPU register state
   b. The OS does not maintain a separate stack for each thread
   c. On per-thread basis, the OS does not maintain virtual memory state
   d. On per thread basis, the OS maintains only scheduling and accounting information.

9) Let the page fault service time be 10ms in a computer with average memory access time being 20ns. If one page fault is generated for every 10^6 memory accesses, what is the effective access time for the memory?
   a. 21ns
   b. 30ns
   c. 23ns
   d. 35ns

10) Consider the following table of arrival time and burst time for three processes P0, P1 and P2.

Process	Arrival time	Burst Time
P0	0 ms	9 ms
P1	1 ms	4 ms
P2	2 ms	9 ms

   The pre-emptive shortest job first scheduling algorithm is used. Scheduling is carried out only at arrival or completion of processes. What is the average waiting time for the three processes?
   a. 5.0 ms
   b. 4.33 ms
   c. 6.33 ms
   d. 7.33 ms

11) A system uses FIFO policy for page replacement. It has 4 page frames with no pages loaded to begin with. The system first accesses 100 distinct pages in some order and then accesses the same 100 pages but now in the reverse order. How many page faults will occur?
   a. 196
   b. 192
   c. 197
   d. 195

12) Which of the following statements are true?
   I. Shortest remaining time first scheduling may cause starvation.
   II. Preemptive scheduling may cause starvation.
   III. Round robin is better than FCFS in terms of response time.
   a. I only
   b. I and III only
   c. II and III only
   d. I, II and III

13) Consider the methods used by processes P1 and P2 for accessing their critical sections whenever needed, as given below. The initial values of shared boolean variables S1 and S2 are randomly assigned.

   ```
   Method Used by P1

   while (S1 == S2) ;
   Critical Section
   S1 = S2;


   Method Used by P2

   while (S1 != S2) ;
   Critical Section
   S2 = not (S1);
   ```

   Which one of the following statements describes the properties achieved?
   a. Mutual exclusion but not progress
   b. Progress but not mutual exclusion
   c. Neither mutual exclusion nor progress
   d. Both mutual exclusion and progress

14) In which one of the following page replacement policies, Belady's anomaly may occur?
   a. FIFO
   b. Optimal
   c. LRU
   d. MRU

15) The essential content(s) in each entry of a page table is / are
   a. Virtual page number
   b. Page frame number
   c. Both of the above
   d. Access right information

16) Consider a disk system with 100 cylinders. The requests to access the cylinders occur in following sequence:
   4, 34, 10, 7, 19, 73, 2, 15, 6, 20
   Assuming that the head is currently at cylinder 50, what is the time taken to satisfy all requests if it takes 1ms to move from one cylinder to adjacent one and shortest seek time first policy is used?
   a. 95ms
   b. 119ms
   c. 233ms
   d. 276ms

17) A multilevel page table is preferred in comparison to a single level page table for translating virtual address to physical address because
   a. It reduces the memory access time to read or write a memory location.
   b. It helps to reduce the size of page table needed to implement the virtual address space of a process.
   c. It is required by the translation lookaside buffer.
   d. It helps to reduce the number of page faults in page replacement algorithms.

18) Which of the following is NOT true of deadlock prevention and deadlock avoidance schemes?
   a. In deadlock prevention, the request for resources is always granted if the resulting state is safe
   b. In deadlock avoidance, the request for resources is always granted if the result state is safe
   c. Deadlock avoidance is less restrictive than deadlock prevention
   d. Deadlock avoidance requires knowledge of resource requirements a priori

19) A processor uses 36 bit physical addresses and 32 bit virtual addresses, with a page frame size of 4 Kbytes. Each page table entry is of size 4 bytes. A three level page table is used for virtual to physical address translation, where the virtual address is used as follows:
   • Bits 30-31 are used to index into the first level page table
   • Bits 21-29 are used to index into the second level page table
   • Bits 12-20 are used to index into the third level page table, and
   • Bits 0-11 are used as offset within the page
   The number of bits required for addressing the next level page table (or page frame) in the page table entry of the first, second and third level page tables are respectively

a. 20, 20 and 20
b. 24, 24 and 24
c. 24, 24 and 20
d. **25, 25 and 24**

20) Consider a disk pack with 16 surfaces, 128 tracks per surface and 256 sectors per track. 512 bytes of data are stored in a bit serial manner in a sector. The capacity of the disk pack and the number of bits required to specify a particular sector in the disk are respectively:

a. **256 Mbyte, 19 bits**
b. 256 Mbyte, 28 bits
c. 512 Mbyte, 20 bits
d. 64 Gbyte, 28 bits

21) An operating system uses Shortest Remaining Time first (SRT) process scheduling algorithm. Consider the arrival times and execution times for the following processes:

Process	Execution time	Arrival time
P1	20	0
P2	25	15
P3	10	30
P4	15	45

What is the total waiting time for process P2?
a. 5
b. **15**
c. 40
d. 55

22) Consider the following code fragment:
if (fork() == 0)
{ a = a + 5; printf("%d,%d\n", a, &a); }
else { a = a −5; printf("%d, %d\n", a, &a); }
Let u, v be the values printed by the parent process, and x, y be the values printed by the child process. Which one of the following is TRUE?
a. u = x + 10 and v = y
b. u = x + 10 and v != y
c. **u + 10 = x and v = y**
d. u + 10 = x and v != y

23) Suppose there are n processes, $P1, ...Pn$ and m identical resource units. These resources can be reserved and released one at a time. The maximum resource requirement of process Pi is S_i, where $S_i > 0$. Which one of the following is a sufficient condition for ensuring that deadlock does not occur?
a. $\forall i, S_i < m$
b. $\forall i, S_i < n$
c. **$\sum_i^n S_i < (m + n)$**
d. $\sum_i^n S_i < (m * n)$

24) Consider three processes, all arriving at time zero, with total execution time of 10, 20 and 30 units, respectively. Each process spends the first 20% of execution time doing I/O, the next 70% of time doing computation, and the last 10% of time doing I/O again.

The operating system uses a shortest remaining compute time first scheduling algorithm and schedules a new process either when the running process gets blocked on I/O or when the running process finishes its compute burst. Assume that all I/O operations can be overlapped as much as possible. For what percentage of time does the CPU remain idle?
a. 0%
b. **10.6%**
c. 30.0%
d. 89.4%

25) Consider the virtual page reference string
1, 2, 3, 2, 4, 1, 3, 2, 4, 1
On a demand paged virtual memory system running on a computer system that main memory size of 3 pages frames which are initially empty. Let LRU, FIFO and OPTIMAL denote the number of page faults under the corresponding page replacements policy. Then
a. OPTIMAL < LRU < FIFO
b. **OPTIMAL < FIFO < LRU**
c. OPTIMAL = LRU
d. OPTIMAL = FIFO

[Scenario S] Suppose that the following processes arrive for execution at the times indicated. Each process will run for the amount of time listed. In answering the questions 26-27, use non-preemptive scheduling, and base all decisions on the information you have at the time the decision must be made.

Process	Arrival Time	Burst Time
P_1	0.0	8
P_2	0.4	4
P_3	1.0	1

26) What is the average turnaround time for these processes with the SJF scheduling algorithm?
a. 10.53
b. **9.53**
c. 6.87
d. 5.87

27) The SJF algorithm is supposed to improve performance but notice that we chose to run process P1 at time 0 because we did not know that two shorter processes would arrive soon. Compute what the average turnaround time will be if the CPU is left idle for the first 1 unit and then SJF scheduling is used. Remember that processes P1 and P2 are waiting during this idle time, so their waiting time may increase.
a. 10.53
b. 9.53
c. **6.87**
d. 5.87

28) Consider four processes P, Q, R and S scheduled on a CPU as per round robin algorithm with a time quantum of 4 units. The processes arrive in the order P, Q, R, S, all at time t = 0. There is exactly one context switch from S to Q, exactly one context switch from R to Q, and exactly two context switches from Q to R. There is no context switch from S to P. Switching to a ready process after the termination of another

process is also considered a context switch. Which one of the following is NOT possible as CPU burst time (in time units) of these processes?
a. P=4,Q=12,R=5,S=4
b. P=4,Q=10,R=6,S=2
c. P=2,Q=9,R=5,S=1
d. **P=3,Q=7,R=7,S=3**

29) Consider an arbitrary set of CPU-bound processes with unequal CPU-burst lengths submitted at the same time to a computer system. Which one of the following process scheduling algorithms would minimize the average waiting time in the ready queue?
a. Round-robin with time quantum less than the shortest CPU burst
b. Uniform random
c. Highest priority first with priority proportional to CPU burst length
d. **Shortest remaining time first**

30) Consider three processes (process id 0, 1, and 2) with compute time bursts 2, 4, and 8 time units, respectively. All processes arrive at time zero. Consider the longest remaining time first (LRTF) scheduling algorithm. In LRTF ties are broken by giving priority to the process with the lowest process id. The average turn around time is
a. 14 units
b. 15 units
c. **13 units**
d. 16 units

31) Consider n processes sharing the CPU in a round-robin fashion. Assuming that each process switch takes s seconds, what must be the quantum size q such that the overhead resulting from process switching is minimized but, at the same time each process is guaranteed to get its turn at the CPU at least every t seconds?
a. $q \geq \frac{t-ns}{n-1}$
b. **$q \leq \frac{t-ns}{n-1}$**
c. $q \geq \frac{t-ns}{n+1}$
d. $q \leq \frac{t-ns}{n+1}$

32) Consider a demand paging system with four page frames (initially empty) and LRU page replacement policy. For the following page reference string
7, 2, 7, 3, 2, 5, 3, 4, 6, 7, 7, 1, 5, 6, 1
the page fault rate, defined as the ratio of number of page faults to the number of memory accesses (rounded off to two decimal place) is
a. 0.53
b. **0.60**
c. 0.67
d. 0.64

33) Consider a process executing on an operating system that uses demand paging. The average time for a memory access in the system is M units if the corresponding memory page is available in memory, and D units if the memory access causes a page fault. It has been experimentally measured that the

average time taken for a memory access in the process is X units. Which one of the following is the correct expression for the page fault rate experienced by the process?
a. (D - M) / (X - M)
b. **(X - M) / (D - M)**
c. (D - X) / (D - M)
d. (X - M) / (D - X)

34) Consider a hard disk that has 63 sectors/track. It has 10 platters each – 2 recording surfaces & 1000 cylinders. A sector's address is displayed as a triple (c, h, s). Here, c refers to the cylinder number, h refers to the surface number, and s refers to the sector number. The 0th sector here is addressed as (0, 0, 0), then the 1st sector will be addressed as (0, 0, 1), and so on. According to this, the address (400,16,29) would correspond to the sector number:
a. 505038
b. **505037**
c. 505036
d. 505035

35) In a computer system that consists of n number of CPUs, the maximum processes that can exist in the Ready State would be:
a. **Independent of n**
b. 2n
c. n^2
d. n

36) Consider the following snapshot of a system running n processes. Process i is holding Xi instances of a resource R, 1 <= i <= n. currently, all instances of R are occupied. Further, for all i, process i has placed a request for an additional Yi instances while holding the Xi instances it already has. There are exactly two processes p and q such that Yp = Yq = 0. Which one of the following can serve as a necessary condition to guarantee that the system is not approaching a deadlock?
a. min (Xp, Xq) < max (Yk) where k != p and k != q
b. **Xp + Xq >= min (Yk) where k != p and k != q**
c. max (Xp, Xq) > 1
d. min (Xp, Xq) > 1

37) Consider the following threads, T1, T2 and T3 executing on a single processor, synchronized using three binary semaphore variables, S1, S2 and S3, operated upon using standard wait() and signal(). The threads can be context switched in any order and at any time.

T1	T2	T3
While(true) {	While(true) {	While(true) {
Wait(S3);	Wait(S1);	Wait(S2);
Print("C");	Print("B");	Print("A");
Signal (S2); }	Signal (S3); }	Signal (S1); }

Which initialization of the semaphores would print the sequence BCABCABCA....?
a. S1 = 1; S2 = 1; S3 = 1
b. S1 = 1; S2 = 1; S3 = 0
c. **S1 = 1; S2 = 0; S3 = 0**
d. S1 = 0; S2 = 1; S3 = 1

38) A system has 6 identical resources and N processes competing for them. Each process can request atmost 2 resources. Which one of the following values of N could lead to a deadlock?
   a. 1   b. 2
   c. 3   d. 6
39) Which one of the following statements is FALSE?
   a. The TLB performs an associative search in parallel on all its valid entries using the page number of the incoming virtual addresses.
   b. If the virtual address of a word given by the CPU has a TLB hit, but the subsequent search for the word results in a cache miss, then the word will always be present in the main memory
   c. The memory access time using a given inverted page table is always the same for all incoming virtual addresses.
   d. In a system that uses hashed page tables, if two distinct virtual addresses V1 and V2 map to the same value while hashing, then the memory access time of these addresses will not be the same.
40) What is dirty bit used to show?
   a. Page with corrupted data
   b. Wrong page
   c. Page with low frequency occurrence
   d. Page that is modified after being loaded into cache memory
41) Three CPU-bound tasks, with execution times of 15, 12 and 5 time units respectively arrive at times 0, t and 8, respectively. If the operating system implements a shortest remaining time first scheduling algorithm, what should be the value of t to have 4 context switches? Ignore the context switches at time 0 and at the end.
   a. $0 < t < 3$ b. t = 0
   c. t <= 3   d. $3 < t < 8$
42) When a process has been allocated 3-page frames, none of the pages of the process are available in the memory initially. The process makes the following sequence of page references (reference string): 1, 2, 1, 3, 7, 4, 5, 6, 3, 1. Least Recently Used (LRU) page replacement policy is a practical approximation to optimal page replacement. For the above reference string, how many more page faults occur with LRU than with the optimal page replacement policy?
   a. 1   b. 0
   c. 2   d. 3
43) Consider allocation of memory to a new process. Assume that none of the existing holes in the memory will exactly fit the process's memory requirement. Hence, a new hole of smaller size will be created if allocation is made in any of the existing

holes. Which one of the following statements is TRUE?
   a. The hole created by first fit is always larger than the hole created by next fit.
   b. The hole created by worst fit is always larger than the hole created by first fit.
   c. The hole created by best fit is never larger than the hole created by first fit.
   d. The hole created by next fit is never larger than the hole created by best fit.
44) Let the page fault service time be 10 ms in a computer with average memory access time being 20ns. If one page fault is generated for every 10^6 memory accesses, what is the effective access time for the memory?
   a. 30 ns   b. 21 ns
   c. 23 ns   d. 35 ns
45) The head of a moving head disk with 200 tracks, numbered 0 to 199, has just finished a request at track 125, and is currently serving a request at track 143. The queue of requests is given in the FIFO order as 86, 147, 91, 177, 94, 150, 102, 175, 130. What will be the total number of head movements required to satisfy these requests for SCAN algorithm?
   a. 259 cylinders   b. 169 cylinders
   c. 154 cylinders   d. 264 cylinders
46) An OS follows round-robin scheduling with time quantum of 4ms. Assuming that the CPU is free now and there are 20 processes waiting in the ready queue, the maximum amount of time that a process waits before getting into the CPU is
   a. 80 ms   b. 76 ms
   c. 84 ms   d. None of the above
47) Consider a single processor system with four processes A, B, C, and D, represented as given below, where for each process the first value is its arrival time, and the second value is its CPU burst time.
   A (0, 10), B (2, 6), C (4, 3), and D (6, 7).
   Which one of the following options gives the average waiting times when preemptive Shortest Remaining Time First (SRTF) and Non-Preemptive Shortest Job First (NP-SJF) CPU scheduling algorithms are applied to the processes?
   a. SRTF = 6, NP-SJF = 7
   b. SRTF = 6, NP-SJF = 7.5
   c. SRTF = 7, NP-SJF = 7.5
   d. SRTF = 7, NP-SJF = 8.5
48) Page replacement becomes necessary when:
   I. Page faults occur and there are no free page frames in the memory.
   II. Page faults occur and there are free page frames in the memory.

III. Page faults would arise if the replaced page is referenced again.
IV. It is important to replace a page that is not likely to be referenced again in the immediate future.
   a. I only   b. I and III only
   c. I, II and IV only   d. I, III and IV only
49) In multiprogramming with fixed partitions, if a process requires more memory than is available in a partition, it may lead to:
   a. Fragmentation   b. Deadlock
   c. Priority inversion   d. Starvation
50) Contiguous memory allocation is the classical memory allocation model in which
   a. Same process is allocated in a different area in the memory
   b. All the process is allocated a single contiguous area in the memory
   c. Each process is allocated a single contiguous area in the memory
   d. All of the above

===== END =====