

Answer any five questions, each question carries 20 marks

1. a) Convert the following infix expression to reverse polish notation: 3
 $A*B+A*(B*D+C*E)$
- b) Assume that the exclusive-OR gate has a propagation delay of 10 ns and that the AND or OR gates have a propagation delay of 5 ns each. What is the total propagation delay time in a four-bit ripple adder circuit? 3
- c) Implement a J-K flip-flop using a D flip-flop. Demonstrate the combined excitation table and K-map. 6
- d) Design a 4X2 Line priority encoder considering the following truth table— 8

Input				Output		
D ₀	D ₁	D ₂	D ₃	x	y	v
0	0	0	0	X	X	0
1	0	0	0	0	0	1
X	1	0	0	0	1	1
X	X	1	0	1	0	1
X	X	X	1	1	1	1

2. a) Implement the following Boolean function using a 8X1 line multiplexer— 7
 $F(A, B, C, D) = \sum(1, 3, 4, 11, 12, 13, 14, 15)$
- b) A processor supports a main memory of 64 KB and a page size of 1 KB. How many bits are required for the page number and offset fields in the logical address? 3
- c) Execute Booth Multiplication Algorithm stepwise for: $(-9) \times (-13)$. Also demonstrate the flowchart. 10
3. a) With a proper block diagram, demonstrate how One level paging is done along with a Translation Lookaside Buffer (TLB). Further calculate the effective memory access time if physical memory access time is x ms and TLB search time is y ms. Consider the system having 60% hit ratio. 6
- b) A computer has a clock cycle time of 2 ns. Calculate the CPU execution time for a program with 10^6 instructions and an average CPI (Cycles per Instruction) of 3. 4
- c) What is the difference between programmed I/O and interrupt initiated I/O? 4
- d) Why *NO-OP* instruction is used in instruction pipeline. Explain with an example. 6
4. a) **Input:** Request sequence = {126, 42, 34, 62, 96, 11, 41, 180}
Initial head position = 52 (after serving 49)
Disk starts at = 0
Disk ends at = 199
Calculate the following using SSTF and C-SCAN disk scheduling algorithms for the above data.
i) Total number of seek operations ii) Seek Sequence 8
- b) The following reference string of memory pages is given for a process: 12
{7, 0, 1, 2, 0, 3, 0, 4, 2, 3, 0, 3, 2, 1, 2, 0}
The system has 3-page frames in main memory. Calculate the number of page faults for the following page replacement algorithms:
i) FIFO (First In First Out), ii) LRU (Least Recently Used), iii) Optimal
Also, show the page replacement steps in tabular form for each algorithm.

5. a) With a proper block diagram, demonstrate how demand paging is done if a requested page reference is not found in logical memory. 7
- b) Calculate the average waiting time of all the processes according to Round Robin (RR) and Longest Remaining Time First (LRTF) scheduling algorithms. 5+5
- For Round Robin scheduling, assume each time slice is 3 ms.

PROCESS	BURST TIME (ms)	ARRIVAL TIME (ms)
P1	6	0
P2	2	2
P3	3	4
P4	5	6

- c) A system is having 12 resource instances and three processes: P0, P1, P2. What will be the safe sequence if the following situation holds true? 3

PROCESS	Maximum Needs	Currently Holding
P0	10	5
P1	4	2
P2	9	2

6. a) Consider a system having a database in sharable mode, among a few readers and writer processes. Write reader and writer process pseudo code to ensure the following synchronization objectives. 6
- i) A reader process R_1 and a writer process W_1 cannot access the database simultaneously.
- ii) Two writer process W_1 and W_2 cannot access the database simultaneously.
- iii) Two reader process R_1 and R_2 can access the database simultaneously.

- b) What are the necessary conditions for a *deadlock*? 4
- c) A system has 5 processes P_0, P_1, P_2, P_3, P_4 and 4 resource types A, B, C, D . Total resources: $A=10, B=7, C=9$ and $D=8$. Is the below system in safe state? If yes, what will be the safe sequence? 10

Process	Allocation				Max			
	A	B	C	D	A	B	C	D
P_0	1	0	2	1	3	2	3	2
P_1	2	1	0	2	3	2	1	3
P_2	3	1	1	0	5	1	3	2
P_3	2	0	2	1	3	2	3	3
P_4	0	1	1	0	4	3	2	2