

Answer all questions

Scanned (10, name, ~)

1. (a). Assume we have the following application that models soccer teams, the games they play, and the players in each team. In the design, we want to capture the following: (5)

- We have a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs.
- Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses.
- Teams play matches, in each match there is a host team and a guest team. The match takes place in the stadium of the host team.
- For each match we need to keep track of the following:

I. The date on which the game is played;

II. The final result of the match;

III. The players participated in the match. For each player, how many goals he scored, whether or not he took yellow card, and whether or not he took red card;

IV. During the match, one player may substitute another player; We want to capture this substitution and the time at which it took place.

V. Each match has exactly three referees. For each referee we have an ID (unique identifier), name, DoB, years of experience. One referee is the main referee and the other two are assistant referee.

(i). Design an ER diagram to capture the above requirements. State any assumptions you have that affects your design. Make sure cardinalities and primary keys are clear.

(ii). Map the ERD to create the relational model corresponding to the described application. Basically, list the CREATE TABLE statements with the attribute names, and appropriate data types. Also make sure to have the primary keys and foreign keys clearly defined.

(b). Draw and explain the various components of Database Architecture in detail. (5)

2. Consider an online bookshop which sometimes promotes books by displaying them on the front page of their website. Create the table with the following constraints. (5)

- Id → NOT NULL AND UNIQUE
- Category → Text
- Price → Float && Price >0
- Promoted → Default value of True

(i). Create a new VIEW called "PromotionSummary" which outputs 3 columns named "category", "minprice" and "maxprice" containing the category name, minimum price of all promoted books and maximum price of all promoted books. A promoted book has its "promoted" attribute set to True.

(ii). Create a trigger so that, when a tuple from the "PromotionSummary" view is deleted, all Books from the corresponding category have their "promoted" attribute set to False. E.g. if the entry in "PromotionSummary" for category "Novel" is deleted, all entries in "Books" with category "Novel" have their "promoted" attribute set to False.

(b). Consider the following relations:

Doctor (SSN, FirstName, LastName, Specialty, YearsOfExperience, PhoneNum)

Patient (SSN, FirstName, LastName, Address, DOB, PrimaryDoctor_SSN)

Medicine (TradeName, UnitPrice, GenericFlag)

Prescription (Id, Date, Doctor_SSN, Patient_SSN)

Prescription_Medicine (Prescription Id, TradeName, NumOfUnits)

Write the relational algebra expressions for the following queries:

- List the trade name of generic medicine with unit price less than \$50.
- List the first and last name of patients whose primary doctor named 'John Smith'.
- List the first and last name of doctors who are not primary doctors to any patient.
- For medicines written in more than 20 prescriptions, report the trade name and the total number of units prescribed.
- List the SSN of patients who have 'Aspirin' and 'Vitamin' trade names in one prescription.

3. (a). Consider the relation shown in the following Figure:

(2)

X	Y	Z
x ₁	y ₁	z ₁
x ₁	y ₁	z ₂
x ₂	y ₁	z ₁
x ₂	y ₁	z ₃

(i). List all the functional dependencies that this relation instance satisfies.

(ii). Assume that the value of attribute Z of the last record in the relation is changed from z₃ to z₂.

Now list all the functional dependencies that this relation instance satisfies.

(b) Suppose you are given a relation R with four attributes ABCD. For the FD set $ABC \rightarrow D$, $D \rightarrow A$, do the following: (i) Identify the candidate key(s) for R. (ii) Identify the best normal form that R satisfies (1NF, 2NF, 3NF, or BCNF). (iii) If R is not in BCNF, decompose it into a set of BCNF relations that preserve the dependencies.

(3)

(c) Consider two sets of FDs, F and G, $F = \{A \rightarrow B, B \rightarrow C, AC \rightarrow D\}$ and $G = \{A \rightarrow B, B \rightarrow C, A \rightarrow D\}$ Are F and G equivalent?

(5)

4.(a). (i). For the given schedule S: r1(A), r3(B), r2(C), w1(B), w3(C), w2(D), assume that shared locks are requested immediately before each read action, and exclusive locks are requested immediately before every write action. Also, unlocks occur immediately after the final action that a transaction executes. Tell what actions are denied, and whether deadlock occurs. Also tell how the waits-for graph evolves during the execution of the actions. If there are deadlocks, pick a transaction to abort, and show how the sequence of actions continues.

A

(ii). For the same schedule (the same as in the previous question), tell what happens under the wait-die and wound-wait deadlock avoidance system. Assume the order of deadlock-timestamps is the same as the order of subscripts for the transactions, that is, T₁, T₂, T₃. Also assume that transactions that need to restart do so in the order that they were rolled back.

(6)

(b). Consider the following classes of schedules: conflict-serializable, view-serializable, recoverable, Cascadeless Schedules. For the following schedule, state which of the preceding classes it belongs to. The actions are listed in the order they are scheduled and prefixed with the transaction name.

S : R₂(A); W₂(A); R₃(C); W₂(B); W₃(A); W₃(C); R₁(A); R₁(B); Commit (T₂), W₁(A); Commit (T₃); W₁(B); Commit (T₁);

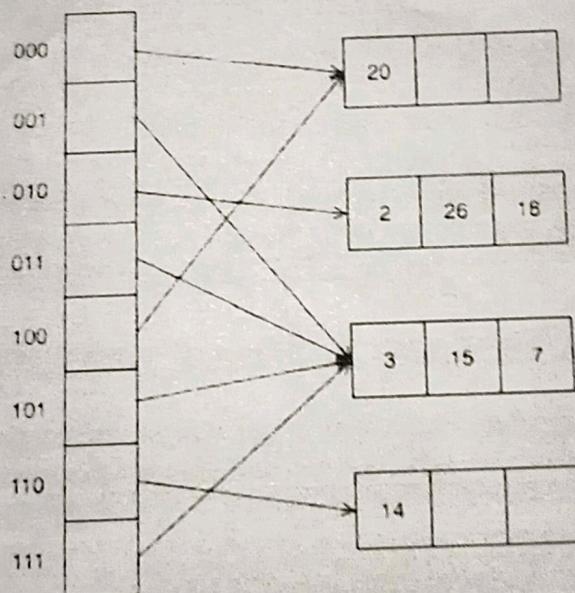
(4)

5. (a). What is the representation shown in the file below and it is for what type of records? Show the structure of the file of the following figure after each of the following steps ("↑i" is used to denote a pointer to record "i"). (5)

- (i). Insert (Mianus, A-101, 2800).
- (ii). Insert (Brighton, A-323, 1600).
- (iii). Delete (Perryridge, A-102, 400).

0	↑s	Perryridge	A-102	400
1		Round Hill	A-305	350
2		Mianus	A-215	700
3	↑s	Downtown	A-101	500
4		Redwood	A-222	700
5	↑s		A-201	900
6		Brighton	A-217	750
7			A-110	600
8			A-218	700

(b). Consider the Extendible Hashing index shown in the following figure. Suppose we insert keys 28, 30, 4, 8, 34 in order. (5)



- (i). Show the index after each insertion.
- (ii). Which key will cause the first split?
- (iii). Which key will first cause the directory to double in size?

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI-15

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

V SEMESTER B.TECH, SEMESTER EXAMINATION

CSPC53 COMPUTER NETWORKS

DATE: 04/12/2023

Answer All Questions

MAX. MARKS: 50

1. (a) With a neat diagram, explain the concept of encapsulation and decapsulation in the context of the OSI model. How is data encapsulated/decapsulated as it moves through the layers? (4)

(b) Encode the following bit sequence using AMI, HDB3, RZ and Differential Manchester technique.
1010000100001100001110000111100001010000 (4)

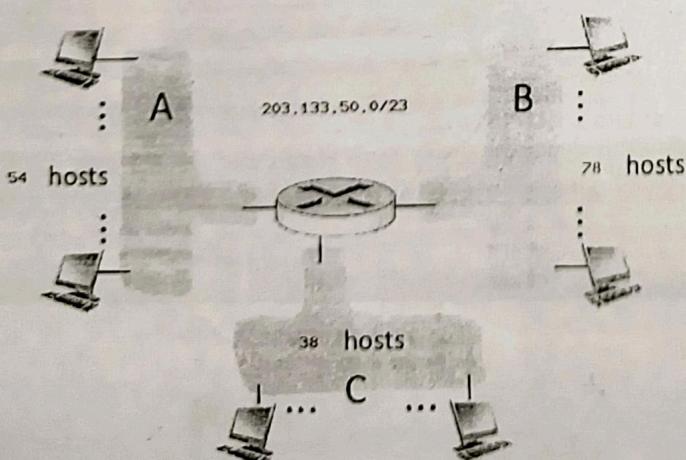
2. (a) Provide a step-by-step procedure for detecting and correcting the burst errors using Hamming codes. To illustrate this process, provide a numerical example of your own. (4)

(b) Two hosts, A and B, are separated by **20,000 kilometers** and are connected by a direct link with **2 Mbps**. The propagation speed over the link is **2.5×10^8 meters/sec**. A file containing **800,000 bits** is sent from Host A to Host B in **20** equally sized packets. Each packet, when received, is acknowledged by Host B, and the transmission time of an acknowledgement packet is negligible. Assume that Host A cannot send another packet until the preceding one is acknowledged. How long does it take to send the file? (4)

(c) Suppose two nodes, A and B, are attached to opposite ends of an **1200m** cable, and that they each have one frame of **1,500 bits** (including all headers and preambles) to send to each other. Both nodes attempt to transmit at time **t=0**. Suppose there are four repeaters between A and B, each inserting a **40 bit** delay. Assume the transmission rate is **100 Mbps**, and CSMA/CD with backoff intervals of multiples of **512 bits** times is used. After the collision, A draws **K=0** and B draws **K=1** in the exponential backoff protocol. Ignore the jam signal in this case. Assume the signal propagation speed is **2×10^8 m/sec**. At what time (in seconds) is A's packet completely delivered at B? (4)

3. (a) Consider a network in which all nodes are connected to 3 other nodes. In a single time step, a node can receive all transmitted broadcast packets from its neighbors, duplicate the packets, and send them to all of its neighbors (except to the node that sent a given packet). At the next time step, neighboring nodes can receive, duplicate, and forward these packets, and so on. Suppose that uncontrolled flooding is used to provide broadcast in such a network. At time step t, how many copies of the broadcast packet will be transmitted, assuming that at time step 1, a single broadcast packet is transmitted by the source node to its 3 neighbors? (3)

(b) Consider the router and the three attached subnets below (A, B, and C). The number of hosts is also shown below. The subnets share the 23 high-order bits of the address space: **203.133.50.0/23**.



Assign subnet addresses to each of the subnets (A, B, and C) so that the amount of address space assigned is minimal, and at the same time leaving the largest possible contiguous address space available for assignment if a new subnet were to be added. Then answer the questions below:

- i. How many hosts can there be in this address space?
- ii. What is the subnet address of subnet A, B and C?
- iii. What is the broadcast address of subnet A, B and C?

(3)

(c) Using the example network below (Fig. 1. 3(c)), give the virtual circuit table for all the switches after each of the following connections is established. Assume that the sequence of connections is cumulative; that is, the first connection is still up when the second connection is established, and so on. Also, assume that the VCI assignment always picks the lowest unused VCI on each link, starting with 0, and that VCI is consumed for both directions of a virtual circuit. (4)

- (i) Host A connects to host B (ii) Host C connects to host G (iii) Host E connects to host I
- (iv) Host D connects to host B (v) Host F connects to host J (vi) Host H connects to host A

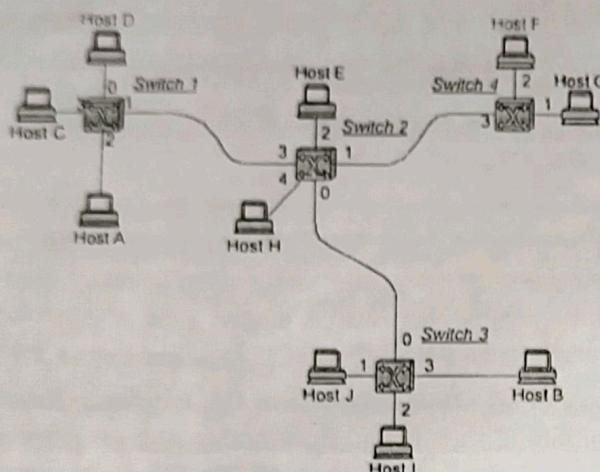


Fig 1: 3(c)

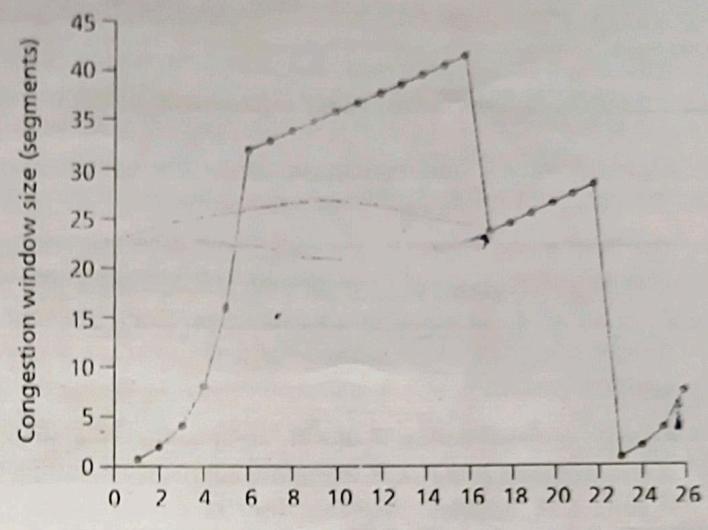


Fig2: 4(b)

4. (a) What are the various guidelines that the recipient must adhere to while sending out an acknowledgement? It is necessary to discuss each rule with appropriate examples. (4)

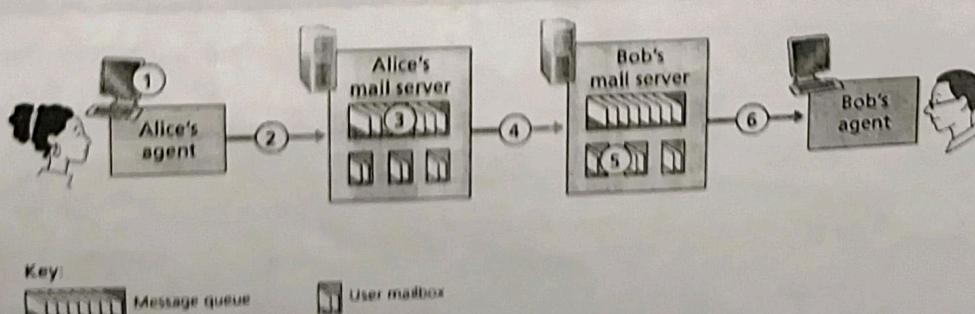
(b) Assume that TCP Reno is the protocol experiencing the behavior shown in the above figure (Fig2: 4(b)). Answer the following questions with a short discussion justifying your answer.

- (i) After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
- (ii) After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
- (iii) During what transmission round is the 70th segment sent?
- (iv) Assuming a packet loss is detected after the 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of ssthresh? (4)

(c) Draw the state transition diagram for TCP. Can the state transition diagrams for TCP and UDP be contrasted and compared? Justify your answer. (4)

5. (a) Describe the S-DES key generation and decryption procedure using the neat flow diagrams. (4)

(b) Look at the scenario below, where Alice sends an email to Bob. Assume both Bob's and Alice's user agents use the IMAP protocol. What protocol is being used at point 2,4 and 6 in the diagram? Explain their roles in this email system. (4)





**Department of Computer Science & Engineering
National Institute of Technology**

**CSPE51 – Augmented & Virtual Reality
End Semester Examination**

Date : 06.12.2022

Time : 10.00 am – 01.00 pm

Max. mark : 40

1. a) i) What is inferred from the given figure w.r.t. to VR terminology? (1)



- ii) Why 6 DOF is required in VR? (1)

- iii) What is Google cardboard? How does it fit into VR world? (2)

- b) How is reality compared with the virtual reality? (2)

- c) How can a participant interact with the things in the virtual world? Explain in detail. (2)

- d) Explain the Field of View and Field of Regard. When can we have FoV = FoR? (2)

2. a) i) Which transformation is helping to achieve a zooming effect on the screen? (1)

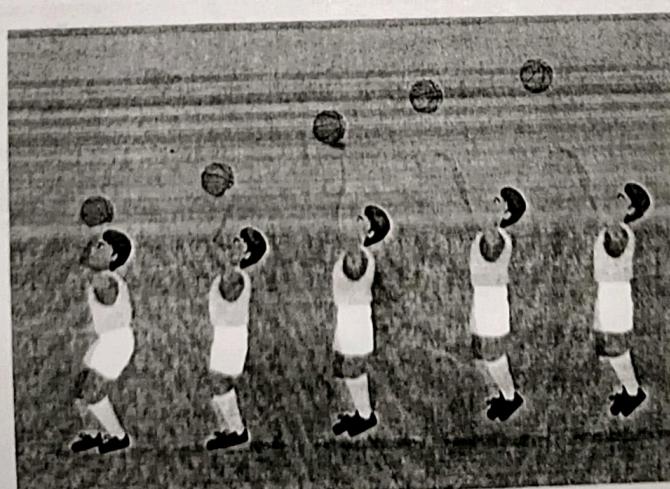
- ii) Explain the 3D viewing pipeline. (2)

- b) i) A cube has its vertices located at A(0,0,10), B(10,0,10), C(10,10,10), D(0,10,10), E(0,0,0), F(10,0,0), G(10,10,0), H(0,20,0). Note that the y-axis is vertical and positive z-axis is oriented towards the viewer. The cube is being viewed from the point (0,10,50). Draw the perspective view of the cube on the xy plane. (2)

- ii) A rectangular parallelopiped having a length on x-axis, y-axis and z-axis as 2, 3, 1 respectively. What is the effect of scaling when scaling factor $s_x = 1/2$; $s_y = 1/3$ and $s_z = 1$? (1)

- c) Find the reflected view of a triangle with vertices (3,4), (5,5) and (4,7) about the mirror which is vertically placed such that it passes through (10,0) and (0,10). (2)

- d) What kind of transformations are used in the given animation sequence? Explain in detail. (2)



3. a) i) What is temperature feedback? How is it realized? (1)
ii) What is the importance of a hybrid tracker? (1)
iii) Is the 3Ball / 3D mouse provide interaction with the virtual world? Justify your answer. (1)
iv) Why navigation is required in VR? (1)
- b) Explain about Tactile feedback interface with an example. (2)
- c) What are the parameters that affect the performance of the trackers? Explain how are they used in the trackers (all kinds of trackers). (4)
4. a) In what aspect are the Metaverse and Virtual reality technologies interlinked? Explain it in detail. (2)
b) What are Fiducial markers? How are they used in Augmented reality? (2)
c) Write down the steps involved in the development of AR app. (2)
d) What is projection based AR? Explain different types of Projection based AR. (2)
e) Explain the basic points of view of participants in augmented reality applications. (2)

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI – 620015
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B.Tech (CSE) – End Semester Examination – July - December 2023

CSPC54– Introduction to Artificial Intelligence and Machine learning

Semester: V, Section: B

Max Marks: 80

Curriculum: NITTUGCSE21

Time: 3 hours

Date of Exam: 7th December 2023

1. a. For a puzzle, given the following initial and goal states, show all the states in a Breadth first search and Depth first search methods and compare their performance for time / space complexity. (CO1) (6)

Initial State			Goal State		
8	3	2	1	4	7
7	6	4	2	5	8
	1	5	3	6	

- b. You are designing an agent for evaluation of the answer scripts. The answer scripts contain the following types of answers.

Question Type	Answer pattern
MCQ	Just the choice as answer (Eg. A, B, 1, 2...)
Fill in the blanks	Just the answer (Eg. Pot, Water, ...)
Decision Statements	True / False
Short answers	5 to 7 sentences in bullet points
Problems	Math problem kinds of solution

Give a complete problem formulation for each of the above question type and the corresponding answer type so that it is precise enough to be implemented as an evaluation agent. What type of agent will you design? Draw the architecture of the same. (CO2) (6)

- c. Discuss the Expect minimax algorithm. Apply the algorithm to a two player game and explain the calculation of the root node. (CO1) (4)

2. a. Define Horn clause and definite clause. Explain with an example. (CO3) (4)

- b. Justify the following sentences for their validity, satisfiability or not using propositional logic rules and inferencing (CO3) (4)

- (i) $((\text{Smoke} \wedge \text{Heat}) \Rightarrow \text{Fire}) \Leftrightarrow ((\text{Smoke} \Rightarrow \text{Fire}) \vee (\text{Heat} \Rightarrow \text{Fire}))$
(ii) Big V Dumb V (Big \Rightarrow Dumb)

- c. Write FOL statements for the following and convert them into CNF. (CO3) (8)

(i) Anyone who rides any Harley is a rough character.

(ii) No coyote catches any smart roadrunner

(iii) Anytime it is foggy, anyone can travel if he has some source of light.

(iv) Any student who does not study does not pass.

3. a. Discuss Unification with examples. Explain Generalized modus ponens and explain it with an example incorporating Unification. (CO3) (8)
- b. Define an ontology in first-order logic for Tic-Tac-Toe. The ontology should contain actions, situations, squares, players, marks (X, O, or blank) and the notion of winning / losing / drawing a game. Write rules and axioms for the domain. (CO3) (8)
4. a. The sales of a company (in million dollars) for each year are shown in the table below. Estimate the linear regression equation to predict the sales of the company in the year 2015 and 2020 (CO4) (6)

X year	2005	2006	2007	2008	2009	2010
Y Sales	12	19	29	37	45	48

b. What are the issues in Decision trees? How do you handle the issues? (CO4) (4)

c. Construct a Naïve Bayes classifier model for the following data and predict the risk class of a car driver based on the following attributes: Time 1- 2 year, Female, Urban. (CO4) (6)

Time years	in	Gender	Area	Risk
1-2	M	Urban	-	LOW
2-7	M	Rural	-	HIGH
>7	F	Rural	-	LOW
1-2	F	Rural	-	HIGH
>7	M	Rural	-	HIGH
1-2	M	Rural	-	HIGH
2-7	F	Urban	-	LOW
2-7	M	Urban	-	LOW

5. a. Cluster the following points using complete link clustering and show the clusters. Show the no. of epochs as well. Draw the dendrogram. A1= (2,10,1), A2=(2,5,2), A3=(8,4,1), A4=(5,8,2), A5=(7,5,1), A6=(6,4,2), A7=(1,2,1), A8=(4,9,2). (CO5) (8)

b. For the same dataset use K = 2 and cluster the points using K-means clustering with initial seed clusters at A2, A6. Compare the performances with K-medoids clustering. (CO5) (8)

--- BEST WISHES ---



National Institute of Technology Tiruchirappalli

CSPE56-Cloud Computing July 2023

Date: 08-12-2023

Department of CSE
End Semester Exam

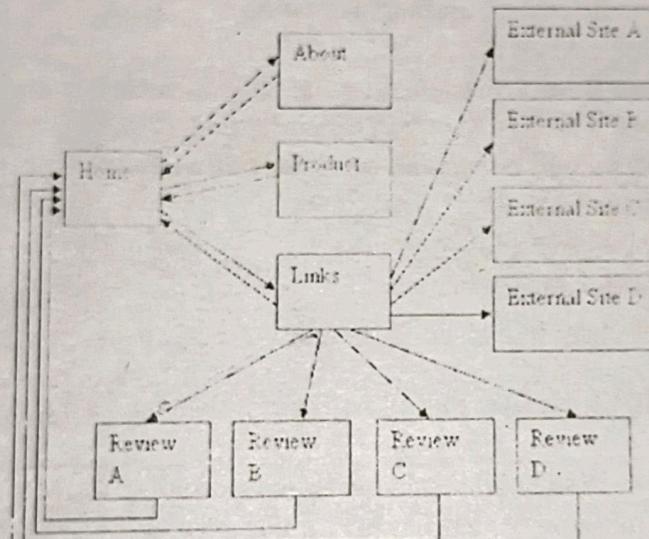
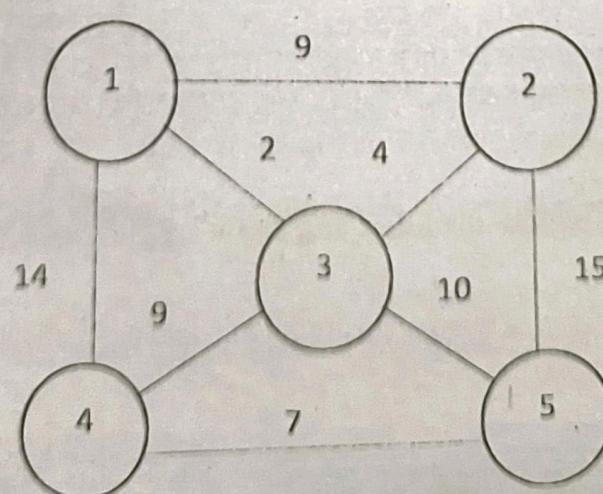
Marks:80

Answer all questions

Question No.	Questions	COs involved	Marks
1.(a)	Draw Edge computing architecture diagram and mention the functions of each tier?	CO5	1
(b)	Compare and contrast Grid and Cloud?	CO2	1
(c)	What is hype cycle of cloud computing?	CO4	1
(d)	Differentiate multitenancy and virtualization?	CO2	1
(e)	Differentiate hypervisor and VIM?	CO3	1
(f)	In a MapReduce framework consider the HDFS block size is 64MB. We have 3 files of size 64Kb, 65Mb, and 127Mb. How many blocks will be created by Hadoop framework?	CO5	1
(g)	Give 4 real-life examples of Cloud Stack?	CO4	1
(h)	Mention 4 use cases of Fog computing?	CO5	1
(i)	What is hashing security mechanism?	CO3	1
(j)	Name the OpenStack deployment models?	CO4	1
2.(a)	Explain Mobile Cloud Computing key components with their workflow?	CO5	2
(b)	Differentiate OS-based and hardware-based virtualization?	CO2	2
(c)	What is RDD and how is it different from Triplet, explain with example?	CO5	2
(d)	Differentiate Open Nebula and Eucalyptus (consider their architecture and application)?	CO4	2
(e)	Differentiate cloud service orchestration and cloud service management?	CO1	2
(f)	Explain cloud usage monitor with its agents?	CO3	2
(g)	Differentiate AWS, GCP, and Azure?	CO4	2
(h)	Differentiate SLA management and billing management system?	CO3	2
(i)	Find the dimension and rank of the following tensor? 	CO5	2
(j)	Define REST and its working procedures?	CO2	2
3. (a)	Differentiate IaaS, PaaS, SaaS, and XaaS with suitable examples? What is CloudFormation Template, explain with example?	CO1, CO4	5
(b)	What is service technology? Define its 4 types of services with suitable diagrams and examples?	CO2	5



National Institute of Technology Tiruchirappalli

(c)	Explain resource cluster with diagram and all its types?	CO3	5	
(d)	What is parallel computing? Explain the parallel database architecture with diagrams? Give one application of parallel computing architecture?	CO5	5	
(e)	Compute total and average salary of organization XYZ and group by gender (male or female) using MapReduce. Write the pseudo code for the same. The input is as follows: <Name, gender, Salary>	CO5	5	
(f)	Show all steps with diagram in MapReduce operation to count the number of words present in the following input: "How many cookies could a good cook cook if a good cook could cook cookies"?	CO5	5	
4. (a)	Consider the below graph and find the page rank of each page? Also, mention which page is the popular page and why?	CO5	10	
				
(b)	Consider the following graph and using GraphX (write the code in Scala programming) find the shortest path from vertex 4 to all other vertices?	CO5	10	
				



National Institute of Technology, Tiruchirappalli
Department of Computer Science and Engineering

END SEMESTER EXAMINATION
CSPC51 – Computer Architecture

Branch/Semester/ Section : CSE/ V/ B Time : 10:00AM to 1:00 PM
Date : 11.12.2023 Max Marks : 50

Answer All Questions

- 1.a. The average memory access time for a microprocessor with 1 level of cache is 2.4 clock cycles
- If data is present and valid in the cache, it can be found in 1 clock cycle. (5)
 - If data is not found in the cache, 80 clock cycles are needed to get it from off-chip memory

Designers are trying to improve the average memory access time to obtain a 65% improvement in average memory access time, and are considering adding a 2nd level of cache on-chip.

- This second level of cache could be accessed in 6 clock cycles
- The addition of this cache does not affect the first level cache's access patterns or hit times
- Off-chip accesses would still require 80 additional CCs.

To obtain the desired speedup, how often must data be found in the 2nd level cache?

- b. Assume that the base CPI for a pipelined datapath on a single core system is 1. (5)
- Note that this does NOT include the overhead associated with cache misses!!!

Profiles of a benchmark suite that was run on this single core chip with an L1 cache suggest that for every 10,000,000 accesses to the cache, there are 308,752 L1 cache misses.

- If data is found in the cache, it can be accessed in 1 clock cycle, and there are no pipe stalls
- If data is not found in the cache, it can be accessed in 10 clock cycles

Now, consider a multi-core chip system where each core has an equivalent L1 cache:

- All cores reference a common, centralized, shared memory
- Potential conflicts to shared data are resolved by snooping and an MSI coherency protocol

Benchmark profiling obtained by running the same benchmark suite on the multi-core system suggests that, on average, there are now 452,977 misses per 10,000,000 accesses.

- If data is found in a cache, it can still be accessed in 1 clock cycle
- On average, 14 cycles are now required to satisfy an L1 cache miss

What must the CPI of the multi-core system be for it to be worthwhile to abandon the single core approach?

2. For the code sequence below, state whether it must stall, can avoid stalls using only forwarding, or can execute without stalling or forwarding. (3)

- | | |
|--|---|
| i. lw \$t0,0(\$t0)
add \$t1,\$t0,\$t0 | iii. addi \$t1,\$t0,1
addi \$t2,\$t0,2
addi \$t3,\$t0,2
addi \$t3,\$t0,4
addi \$t5,\$t0,5 |
| ii. add \$t1,\$t0,\$t0
addi \$t2,\$t0,5
addi \$t4,\$t1,5 | |



a 1F 1D ex MEM WB
 100 180 90 130P 60
 b 180 100 120 220 60
 reg-10

b. Problem given below assumes that instructions executed by a pipelined processor are broken down as follows: (7)

	ADD	BEQ	LW	SW
a.	50%	25%	15%	10%
b.	30%	15%	35%	20%

- i. Assuming there are no stalls and that 60% of all conditional branches are taken, in what percentage of clock cycles does the branch adder in the EX stage generate a value that is actually used?
 - ii. Assuming there are no stalls, how often (percentage of all cycles) do we use the data memory?
 - iii. Each pipeline stage has some latency. Additionally, pipelining introduces registers between stages, and each of these adds an additional latency. Assume the following latencies for logic within each pipeline stage and for each register between two stages. **10 pts**
 - iv. Assuming there are no stalls, what is the speed-up achieved by pipelining a single-cycle datapath?

3. Implement the following code using Tomasulo's Algorithm. Assume Multiply takes 4 clocks and Loads may have cache misses. Use the format given below: (10)

Instruction status				Execution Write			
Instruction	j	k	iteration	Issue	complete Result	Busy	Address
LD F0	0	R1	1			Load1	No
MULTF4	F0	F2	1			Load2	No
SD F4	0	R1	1			Load3	No
LD F0	0	R1	2			Store1	No
MULTF4	F0	F2	2			Store2	No
SD F4	0	R1	2			Store3	No

Reservation Stations				S1	S2	RS for j	RS for k	
Time	Name	Busy	Op	Vj	Vk	Qj	Qk	Code:
0	Add1	No						LD F0 0 R1
0	Add2	No						MULTF4 F0 F2
0	Add3	No						SD F4 0 R1
0	Mult1	No						SUBI R1 R1 #8
0	Mult2	No						BNEZ R1 Loop

Register result status			
Clock	R1	F0	F2 F4 F6 F8 F10 F12... F30
0	80	Qi	

4. a. Describe the parameters used to calculate the performance of Vector Architecture. Also, for the problem given below, calculate the no. of convoys, chimes, FP operations, and no. of CC for 10 vector elements.

LV V1,Rx	;load vector X	(5)
MULVS.D V2,V1,F0	;vector-scalar multiply	
LV V3,Ry	;load vector Y	
ADDV.D V4,V2,V3	; add SV Ry,V4 ;store the result	

b. Calculate the execution time and fill as per the format given (Startup time - Time latency from pipelining of vector operation).

(5)

Convoy	Starting time	First result time	Last result time

Assume the following:

- i. vector length of n
- ii. Startup Overhead(Cycles) for Load and store unit, Multiply Unit, and Add Unit are 12, 7, and 6 respectively.

5. a. In a computer with cache, we have the average number of clock periods per instruction equal to 4, if there are no misses in the cache.

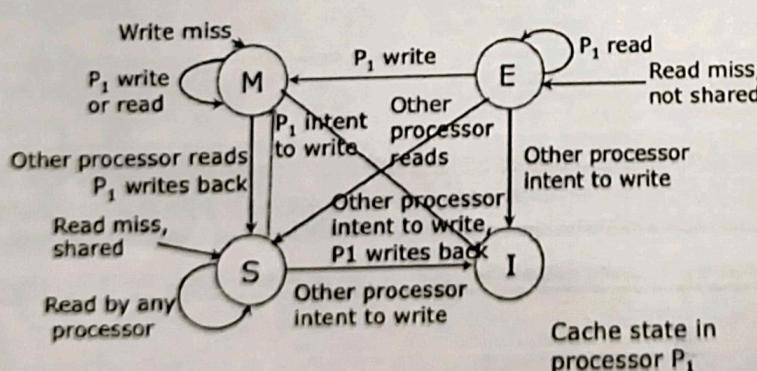
(3)

i) What is the real number of clock periods per instruction, if the probability of miss in the cache is 10%? For the replacement of the block (line) in the cache, we need 5 clock periods for read and 10 for write accesses. Assume that each instruction requires an average of 2 memory accesses and that 20% of all are write accesses.

ii) What is the real CPI, if we increase the probability of hit to 95%?

b. Consider the following code running in two cores. For this question use the original MESI protocol as shown below:

(7)



- (1) LW x1, 0(x5)
- (2) LW x2, 0(x6)
- (3) SW x3, 0(x6)
- (4) SW x2, 0(x5)
- (5) LW x1, 0(x6)

Do not optimize or re-order the code. Assume the processor guarantees sequential consistency.
Also, the addresses in x5 and x6 map to different cache lines.

Assume the following execution sequence:

A.1, A.2, B.1, B.2, A.3, B.3, B.4, A.4, A.5, B.5 (A and B are the two cores)

Fill in the table below with the states of the cache lines at every step. Also, count the number of communication events. A communication event is a message sent from the cache as part of the transition, and is part of certain transitions. For example, shared to owned causes communication to broadcast the new value.

Assume invalid to exclusive does not cause communication (i.e., we assume the cache knows there is no other sharer), but invalid to shared does only if another cache has the line as exclusive. The initial state of both cache lines in both caches is invalid.

Core: Instruction	State x5 cache line in core A	State x6 cache line in core A	State x5 cache line in core B	State x6 cache line in core B
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