



In-Semester Exam-I (Autumn'2017)
IT 214 Database Management Systems

Time: 90 minutes

Max Points: 90

IMPORTANT NOTE:

1. Write answers neat and clean. Answers that are difficult to read may simply be discarded.
2. Answer all queries in order. If you want to defer answering a query, may move to next by leaving sufficient blank space. You may follow a strategy of not answering more than two queries on a page.
3. In all questions marks awarding strategy will be discrete (i.e., 0, half, and full marks).
4. You may have to pay penalty for lengthier solutions.

Consider following relation schema **Company**. Note that it is slightly modified over the one that we have been discussing in Lectures/Labs.

DEP(dno, dname, head_eno)

-- attribute **head_eno** is emp no of the head of the department and refers into EMP relation

EMP(eno, name, gender, category, salary, supervisor_eno, dno)

-- attribute **supervisor_eno** is emp no of the employee's supervisor and refers to **eno** of EMP itself.

-- attribute **cat** is employee category and has domain of {worker, manager, engineer, staff}

PROJ(pno, pname, dno)

-- attribute **dno** is FK referring into DEP relation

WORK_HOURS(eno, pno, hours_per_month)

-- Attributes **eno** and **pno** are FKs referring into EMP and PROJ respectively.

1. Suppose, we want to have a constraint on Database that an employee can be head of department of only one department. Provide SQL code fragment for accomplishing this.

head per student be unique. [5]

Write expressions in Relational Algebra to answer following queries [Questions 2 to 7]
(No marks will be awarded if answered in SQL)

[6x10]

2. List (ENO, Name, DNO, SALARY) of all workers (that is employees that belong to worker category)
3. List (ENO, Name, Salary) of all Female supervisors.
4. List departments (dname, ~~manager_name~~) where head of department is not a Manager (i.e. not belonging to manager category).
5. Compute Average salary for each category of employees.
6. List employee (ENO) who work on all projects on which employee with ENO=123 works.
7. Suppose a person gets Rs. 100 extra on top of salary for each hour he works on a project.
Compute Total Salary for ~~all~~ employees.
every.



Continued on Page No 2.....

8. Study and understand following database requirement. You task is to draw ER Diagram for proposed database. Specify key attributes also along with attributes for all identified entities. Also specify Cardinality and Participation constraints.

While marking this question, the question will be split into few components, and there will be discrete (0, half, and full) marking for each component.

[25]

IBM organizes an annual event called The Great Mind Challenge (TGMC). A number of Teams from various institutes around the country participate in the event. There can be more than one team from an institute.

Every participating team has to register online at TGMC site www.tgmc.in. While registering teams are required to furnish following details- Team Name, Login ID, Password, and details of team members - email id, name, email, and contact number. Each Team has a faculty mentor from same institute. Mentor Details- Name, Designation, email, and contact number are also furnished on the time of registration. A faculty can be mentor for more than one team.

At the end of event Winner, Runner teams are declared. In addition appreciation to other top-10 teams is also given.

The objective of building this database is that the organizer is able to maintain records of all teams registered for the event and for there after math. Motivated with various statistical summaries, city and state of institute is also recorded.

Team : Team Name, Login ID, Password, Score, 2nd Score
 Member : Name, Email, Contact
 Mentor : Name, Designation, Email, Contact
 Institute : Name, City, State

10]

DK

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Time: 80 minutes

Max Points: 80

IMPORTANT NOTE:

1. Write answers neat and clean. Answers that are difficult to read may simply be discarded.
2. Answer all queries in order. If you want to defer answering a query, may move to next by leaving sufficient blank space. You may follow a strategy of not answering more than two queries on a page.
3. In all questions marks awarding strategy will be discrete (i.e., 0, half, and full marks).
4. You may have to pay penalty for lengthier solutions.

Consider relational schema given below, and write relational algebra expressions for following queries (NO SQL)-

Student(StudetID, StdName, ProgID, Batch, CPI)

Course(CourseNo, CourseName, Credit)

Faculty(FacultyID, FacultyName)

Offers(AcadYear, Semester, CourseNo, FacultyID)

Registers(StudetID, AcadYear, Semester, CourseNo, grade)

HoR_Room(rno, wing, floor)

Allot(sid, rno)

SBG(sid, Committee, Role)

-- sid is student id of sbg member, and role can be like convener, or member,
committee is name of committee like "CMC", or Cultural, or so

[6x10]

1. List CourseNo, Number_of_Registrations, Faculty_Name for course offering (in term Autumn'2017) where number of registrations are less than 10.
2. List of ID and Name of students from B.Tech. (progid='01') and 2015 batch who do not reside in HOR.
3. List Room Nos' along with ID and Name of resident that are singly occupied.
4. List ID, Name, and Role of all members of "Cultural" committee who are residing in J and K wings.
5. Report (StudentID, Student-Name, Grade) of students who are residing in C wing, progid='01' and took course IT633 (in Autumn'16) and passed with grade ≥ 7.0 .
6. Report (StudentID, Student-Name, CPI) that have scored more than 7.0 grade in all of the courses given here {IT110, IT214, IT205, SC215, IT314, IT301}.
7. Consider maintaining database of books (let us say by an on-line book-store) with details of ISBN, Title, Price (consists of Currency, and Amount), Author-Name, Publisher-Name, Publisher-Address. A book has one (at least) or more authors, and published by exactly one publisher. ISBN is a universally unique number each book has. Some of books are reprinted by different publisher in some other country or region. In that case reprint of the book is given different ISBN, and will have different price in some other currency. Let us also maintain relationship of reprint with original publication.

Draw ER Diagram for the said database requirement. Do not add any additional attribute from your own, unless you have proper justification.

[20]

72 1/2 + 10 Q-2 Q-3
28.5

(51)



Time: 90 minutes

Max Points: 70

Your ID: 201501099

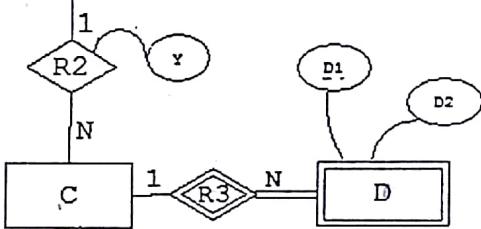
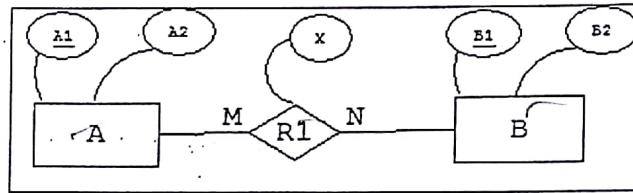
Name: AKRAM SHAH

IMPORTANT NOTE:

- There are 4 pages in question paper, ensure that you have got all.
- Answer questions in the space provide against the question itself. Overwriting is not allowed.
- Write answers neat and clean. Answers that are difficult to read may simply be discarded.
- In all questions marks awarding strategy will be discrete (i.e., 0, half, and full marks).

- Consider ER Diagram given here, and do following [14]

- Derive Relational schema from this ER diagram using ER to Relational mapping rules. Also indicate all keys and foreign keys.
- Find out minimal FD set from semantics of attributes in given ER Diagram.
- Indicate normal form of each derived relation in (a)



Relation

~~→ A (A₁, A₂) → A₁ → A₂ ✓ |~~

~~→ B (B₁, B₂) → B₁ → B₂ ✓ |~~

~~→ R₁ (A₁, B₁, X) → A₁, B₁ → X ✓ |~~

~~FK: A₁, B₁~~

1
N.F.S

N.F.

BCNF

B(NF)

BCNF

2

→ D (C₁, D₁, D₂) → C₁, D₁ → D₂ ✓ |

C₁ is FK refer to C

BCNF

→ C (C₁, C₂, A₁, B₁, Y) → C₁ → C₂ ✓ | | 1/2
C₁ → Y ✓ | 1/2 INF

FK: A₁, B₁ refer to R₁

5 1/2

2

5

Q1/2

- A
2. Again consider scenario of book database for an on-line store. Details of books are ISBN, Title, Price (consists of Currency, and Amount), Author-Name, Publisher-Name, Publisher-Address. You can assume publisher-name to be unique, and we record only one address of a publisher. A book has one (at least) or more authors, and published by exactly one publisher. ISBN is a universally unique number each book has. Some of books are reprinted by different publisher in some other country or region. In that case reprint of the book is given different ISBN, and will have different price in some other currency. However Title and author of book remain same as original print. Let us also maintain relationship of reprint with original publication.

, Amount

[10+10]

Suppose all attributes here has been placed in a single universal relation

$R(\text{ORG-ISBN}, \text{Title}, \text{Currency}, \text{Price}, \text{Author-Name}, \text{Publisher-Name}, \text{Publisher-Address}, \text{Reprint-ISBN}, \text{Reprint-Currency}, \text{Reprint-Price}, \text{Reprint-Publisher-Name})$

For compact representation, let us rename attribute of R as following

$R(O\text{ISBN}, \text{TITLE}, C, P, \text{AUTH}, \text{PUB}, \text{PUBADD}, R\text{ISBN}, RC, RP, RPUB)$

Task #1. Use your understanding of attributes in R here, and give minimum set of functional dependencies.

$O\text{ISBN} \rightarrow \{\text{TITLE}, \text{PUB}, \}$

$\text{PUB} \rightarrow \{\text{PUBADD}\}$

$R\text{ISBN} \rightarrow \{\text{TITLE}, RPUB, O\text{ISBN}\}$

$\{O\text{ISBN}, C\} \rightarrow \{P\}$

$\{R\text{ISBN}, RC\} \rightarrow \{RP\}$

$O\text{ISBN} \rightarrow P$

(?)

ASSUMPTION:- There can be same title for different book.

Task #2. Using BCNF decomposition algorithm, derive normalized relations for the said database requirement. In the derivation, give only final and intermediate results, and do not give any textual descriptions.

KEY:- $\{O\text{ISBN}, R\text{ISBN}, C, RC, \text{AUTH}\}$

$R_1 = \{O\text{ISBN}, \text{TITLE}, \text{PUB}, \text{PUBADD}\}$

$F_1 = \{O\text{ISBN} \rightarrow \{\text{TITLE}, \text{PUB}\}$
 $\text{PUB} \rightarrow \{\text{PUBADD}\}\}$

$R_2 = \{O\text{ISBN}, C, P, \text{AUTH}, R\text{ISBN}, RC, RP, RPUB\}$

$F_2 = \{R\text{ISBN} \rightarrow \{O\text{ISBN}, RPUB\}$
 $\{O\text{ISBN}, C\} \rightarrow \{P\}$
 $\{R\text{ISBN}, RC\} \rightarrow \{RP\}\}$

$\text{BCNF} \rightarrow R_{11} = \{ \underline{\text{PUB}}, \text{PUB ADD} \}$ ✓
 $F_{11} = \text{PUB} \rightarrow \text{PUB ADD}$

$\text{BCNF} \rightarrow R_{12} = \{ \underline{\text{O2ISBN}}, \text{TITLE}, \text{PUB} \}$
 $\text{O2ISBN} \rightarrow \{ \text{TITLE}, \text{PUB} \}$

$\text{BCNF} \rightarrow R_{21} = \{ \underline{\text{R2ISBN}}, \text{O1ISBN}, \text{RPUB} \}$ ✓
 $F_{21} = \text{R2ISBN} \rightarrow \{ \text{O2ISBN}, \text{RPUB} \}$

$R_{22} = \{ \underline{\text{R1ISBN}}, \underline{\text{CP}}, \text{RC}, \text{RP}, \text{AUTH} \}$

$\text{BCNF} \rightarrow R_{221} = \{ \underline{\text{R2ISBN}}, \text{RC}, \text{RP} \}$ ✓
 $\{ \text{R2ISBN}, \text{RC} \} \rightarrow \text{RP}$

$\text{BCNF} \rightarrow R_{222} = \{ \underline{\text{R2ISBN}}, \text{AUTH} \}$ ✓
 No FDs

$\text{BCNF} \rightarrow R_{223} = \{ \underline{\text{R2ISBN}}, \text{CP} \}$ ✓
 $\{ \text{R2ISBN}, \text{C} \} \rightarrow \text{P}$

Assumption: R1ISBN can determine O1ISBN .

3. In next question you are given a number of relations and FDs over them. You need to do following for each relation -
 - a. Compute key(s)
 - b. Determine highest normal form of the relation (consider only up-to BCNF, let further higher normal forms be out of scope here)
 - c. Name FD that "violates the requirement" of the relation being in higher further higher normal form. If a relation is already in BCNF you have answer "NONE" here.
 - d. Give BCNF Normalized relations. Make sure that decomposition is lossless and FD preserving. If you cannot decompose due to any loss, mention the same. Also underline key attributes of each normalized relation.

28.5

A

$R(ABCD)$ $AB \rightarrow CD$ $B \rightarrow C$ $C \rightarrow D$	Key: AB ✓	Normal Form: 2NF ✓	Culprit FD: $B \rightarrow C, C \rightarrow D$ ✓
	Normalized Relations $R_1(\underline{CD}) \cup F_1 = \{C \rightarrow D\}$		
	$R_2(\underline{BC}) \cup F_2 = \{B \rightarrow C\}$		Now further FD can't preserve $R(AB)$
$R(ABCD)$ $A \rightarrow BC$ $B \rightarrow C$ $A \rightarrow B$ $AB \rightarrow C$	Key: AD ✓	Normal Form: 1NF ✓	Culprit FD: $A \rightarrow BC, B \rightarrow C$, $A \rightarrow B, AB \rightarrow C$ ✓
	Normalized Relations $R_1(\underline{BC}) \cup F_1 = B \rightarrow C$		Now for further decomposition FD can't preserve.
$R(ABCD)$ $AB \rightarrow C$ $C \rightarrow D$	Key: AB ✓	Normal Form: 2NF ✓	Culprit FD: $C \rightarrow D$ ✓
	Normalized Relations $R_1(\underline{ABC}) \cup F_1 = AB \rightarrow C$		
	$R_2(\underline{CD}) \cup F_2 = C \rightarrow D$ ✓		
$R(ABCDE)$ $A \rightarrow BCD$ $B \rightarrow C$ $C \rightarrow E$	Key: A ✓	Normal Form: 2NF ✓	Culprit FD: $B \rightarrow C$, $C \rightarrow E$ ✓
	Normalized Relations $R_1(\underline{CE}) \cup F_1 = C \rightarrow E$		$R_3(\underline{ABD})$
	$R_2(\underline{BC}) \cup F_2 = B \rightarrow C$		2nd
$R(ABCDE)$ $A \rightarrow CD$ $B \rightarrow DE$ $C \rightarrow D$	Key: AB ✓	Normal Form: 1NF ✓	Culprit FD: $A \rightarrow CD$, $B \rightarrow DE, C \rightarrow D$ ✓
	Normalized Relations $R_1(\underline{CD}) \cup F_1 = C \rightarrow D$		
	Now further decomposition can't preserve FD.		
$R(ABCDE)$ $A \rightarrow BC$ $B \rightarrow DE$ $D \rightarrow A$	Key: A, D, B	Normal Form: BCNF ✓	Culprit FD: NONE
	Normalized Relations $R(\underline{ABCDE})$		FDs: $A \rightarrow BC$, $B \rightarrow DE$, $D \rightarrow A$
	3 Candidate Keys: - A, B, D		



In-Semester Exam-IV (Autumn'2017)
IT 214 Database Management Systems

Time: 75 minutes

Max Points: 75

IMPORTANT NOTE:

1. Write answers neat and clean. Answers that are difficult to read may simply be discarded.
2. In all questions marks awarding strategy will be discrete (i.e., 0, half, and full marks).

1. Consider Company Schema. Write a stored function (in pseudo code) that computes standard deviation of salary from EMPLOYEE relation and returns.

Formula for standard deviation is given here for your reference.

[20]

$$SD = \sqrt{\frac{\sum(x-\bar{x})^2}{n}}$$

2. What are the parameters to getConnection message in JDBC?

[5]

3. Consider Indian Railways scenario from one of a Lab. It has been copied here in the box below for your reference. A short name for every attribute is given in parenthesis.

[20]

③ D D Train_Number(TN) – every train has unique number. For same pair of stations a train has different numbers for to and return.

④ Train_Run_Day (DAY) – like Monday, Tuesday or so; it is day of run from source station [note that train may not run on all days of a week]

⑤ Source_Station_Code (SRC_SCODE) – like ADI for Ahmedabad and is unique.

⑥ Destination_Station_Code (DST_SCODE)

⑦ Station_Code (SCODE) – any other station on train route

⑧ Date_of_Run (DATE) – a particular date of run

⑨ Scheduled_Arrival_Time (SAT) – on a station; assume that train arrives at a on same time on all days.

⑩ Scheduled_Departure_Time (SDT) – from a station

⑪ Expected_Arrival_Time (EAT) – on the run date on a station

- a. List down minimal FD set on all attributes given here.

- b. Beginning from a single schema R, given below, derives BCNF relations using BCNF decomposition algorithm. Make sure that no FD is lost.

R(TN, DAY, SRC_SCODE, DST_SCODE, SCODE, DATE, SAT, SDT, EAT)

4. Are following FD sets F and G are equivalent (Yes or NO, Give proofs) - [10]

$$F = \{A \rightarrow B, AB \rightarrow C, D \rightarrow E\} \text{ and } G = \{A \rightarrow BC, D \rightarrow AE\}$$

5. Give a relation R(ABCDEF), and following FD set F [10]

$$A \rightarrow B; A \rightarrow C; CD \rightarrow E; CD \rightarrow F; B \rightarrow E$$

Do following FDs are inferred from F? Yes/No, Give Proof.

$$\begin{aligned} A &\rightarrow E \\ CD &\rightarrow EF \\ AD &\rightarrow F \\ B &\rightarrow CD \end{aligned}$$

6. Given a relation R(ABCDEF), and following FDs [10]

$$\begin{aligned} ABC &\rightarrow E \\ ABCD &\rightarrow F \end{aligned}$$

What is the key? What normal form it is in? Name FD that violates requirement of next immediate higher normal form.

Can you loss-lessly decompose R into BCNF? If yes, give decomposed relations.



Dhirubhai Ambani Institute of Information & Communication Technology
Mid Semester Test-1, 1st Semester 2017-18

Course Title IT304 Computer Networks
Date 1 September 2017

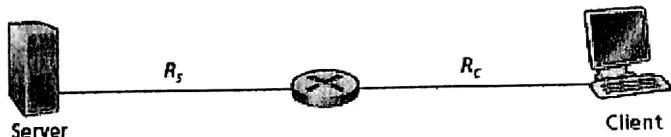
CLOSED BOOK

Max Marks 15
Time 1 Hour

In protocol design problems,

- Assume that all the nodes run the required application components.
- Give a brief description of how your protocol functions.
- Provide the details of message structure, message sequence, timer functions (if needed), and other actions performed by the nodes.
- Give brief justification for each component of your design.

1. Assume that the resolving name-server is running on DAIICT network and there is an iterative DNS server at each domain level. Draw the relevant DNS hierarchy and list the DNS messages sent and received and records processed in obtaining the IP address corresponding to "mail.cse.mit.edu". [4]



2. Assume that we know the bottleneck link along the path from the server to the client is the first link with rate R_s bits/sec. Suppose we send a pair of packets back to back from the server to the client, and there is no other traffic on this path. Assume each packet of size L bits, and both links have the same propagation delay d_{prop} .
- a. What is the packet inter-arrival time at the destination? That is, how much time elapses from when the last bit of the first packet arrives until the last bit of the second packet arrives? [2]
 - b. Now assume that the second link is the bottleneck link (i.e., $R_c < R_s$). Is it possible that the second packet queues at the input queue of the second link? Explain. Now suppose that the server sends the second packet T seconds after sending the first packet. How large must T be to ensure no queuing before the second link? Explain. [4]
3. On a LAN server, a ToD (time of day) application runs that periodically (at interval D) broadcasts the time to all the nodes connected on the LAN. A node, on booting, however, can ask for the ToD server to send the time immediately. ToD server responds with a single message, even if multiple requests come within time interval d . Design the protocol specifying the functionalities, message structure, actions, and syntax. [7]

d
reqd

TCP / UDP



Dhirubhai Ambani Institute of Information & Communication Technology
Mid Semester Test-2, 1st Semester 2017-18

Course Title	IT304 Computer Networks	Max Marks	25
Date	12 October 2017	Time	90 min

1. In the context of a reliable link-layer protocol
 - a. Define the efficiency of the protocol.
 - b. Compute the efficiency of GBN and SR for a noisy link with constant RTT.
 - c. What is the optimal window size and maximum sequence number for each of these protocols? [1+4+1]

2. A transport layer congestion control protocol like TCP relies only on the information contained in ACK feedback received from the receiver along with estimating packet timeout timer.
 - a. Describe the TCP timeout timer estimation for each packet.
 - b. Describe how the packet timeout may be used to manage congestion.
 - c. Describe how the RTT values of the ACK may be used to manage congestion.
 - d. Under appropriate assumptions, show that the dependency of expected throughput on RTT and packet loss probability p. [2+2+2+3]

3. A node can use an echo packet to find the round-trip-delay to its direct neighbors. Let's define the weight of a link between neighbor nodes A and B as $W_{AB} = W_{BA} = (RTT_{AB} + RTT_{BA})/2$.
 - a. Design this echo protocol to compute W_{AB} .
 - b. Design a protocol that uses repeated communication between direct neighbors to find the shortest path between any pair of nodes in the network. [2+3]

4. A UDP socket application typically needs to build flow-control logic within the application itself. This requires, among other things, implementing sliding window operations (buffer management, packet sequencing), and retransmissions.
 Using a combination of socket library functions and system calls, provide a pseudocode skeleton for implementing these. Detailed code is not required but familiarity with the function and system calls signature and their usage is expected. [5]



Course Title IT304 Computer Networks
Date 30 November 2017

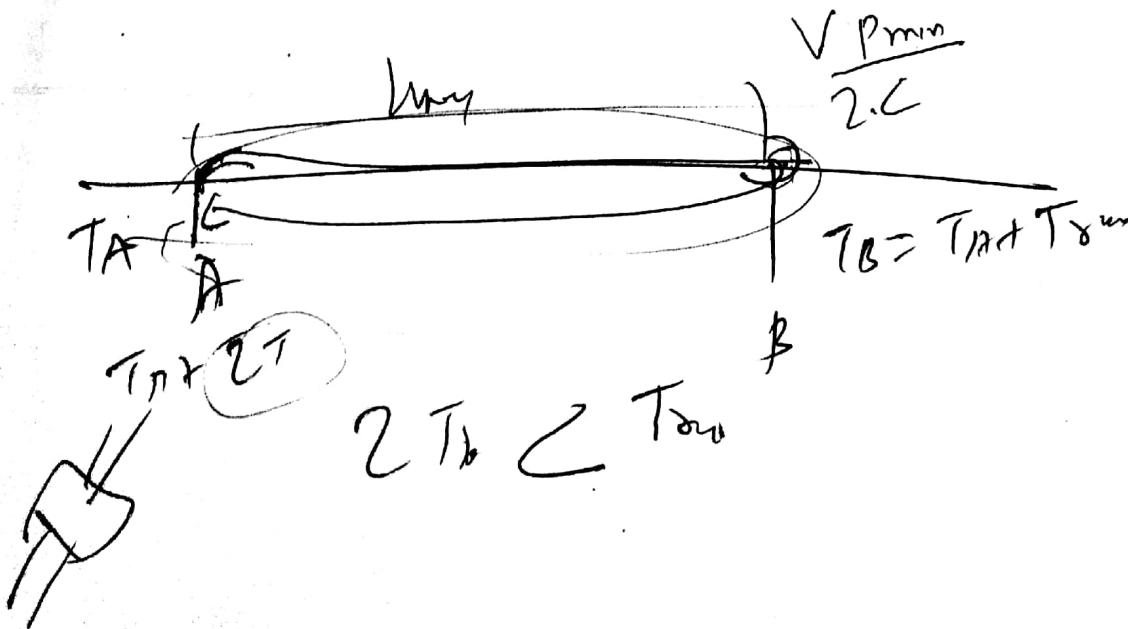
PART-B
CLOSED BOOK

Max Marks 30%
Time 2 Hours

All questions carry 5 marks each.

1. A TCP sender is transmitting data to a receiver. The initial congestion window size is 2KB and the threshold is 16KB. Maximum segment size is 64KB. The first 4 RTT value measured by the sender are (in milliseconds) [400, 300, 900, 100].
 - a. What is the congestion window size after the 4 successive ACKs are received?
 - b. Assuming the smoothing parameter (weight given to old value) $\alpha = 0.9$, what is the estimated RTT for the next packet sent?
 - c. What is the value of the Timeout Timer? $\beta = 0.2$
2. An organization has some 500 nodes in its network divided into 3 segments. This can be done by subnetting one class B address block. Using specific addresses explain the subnetting mechanism. How does routing between subnets take place?
3. Using clear examples, briefly explain how DHCP, NAT, and CIDR help in more efficient use of the Internet address space.
4. Explain how tunneling is used to allow incremental deployment of IPv6 and co-existence of IPv4 and IPv6?
5. What are switching element and switching fabric? Draw the schematic of an 8x8 Banyan switch. Using an example, show that Banyan design leads to internal blocking?

6. In the context of IEEE 802.3 (Ethernet) LAN protocol, answer the following:
 - a. Derive an expression for the maximum length L_{max} of a LAN as a function of relevant LAN parameters (e.g. link capacity C, min packet size P_{min} , max packet size P_{max} , propagation speed V etc.)
 - b. Explain the need of exponential back-off mechanism in 1-persistent CSMA/CD.



Autumn Semester

Computational and Numerical Methods (SC374)

End-Semester Examination

Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar

Time: 3 Hours Total Marks: 30

All questions are compulsory. Answer all the sub-parts of a question together. Marks for each question are indicated next to it. All terms and symbols carry their standard textbook meaning.

- ✓ 1. Convert the second-order equation $Y'' + 4Y' + 13Y = 40 \cos(x)$, $Y(0) = 3$, $Y'(0) = 4$, to a system of first-order equations. [1]

- ✓ 2. Clearly stating all necessary conditions, show how the fourth-order Runge-Kutta method can give Simpson's rule (or Simpson's method) for numerical integration. [2]

- ✓ 3. Solve the following system by using an augmented matrix: [3]

$$\begin{array}{l} \text{f} \\ \text{t} \\ \text{r} \\ \text{c} \\ \text{m} \end{array} \quad \left[\begin{array}{ccc|c} 4x_1 + 2x_2 - x_3 & = 5 \\ x_1 + 4x_2 + x_3 & = 12 \\ 2x_1 - x_2 + 4x_3 & = 12 \end{array} \right] \rightarrow \left[\begin{array}{ccc|c} 1 & 2 & -1 & 12 \\ 0 & 4 & 1 & 12 \\ 0 & -1 & 4 & 12 \end{array} \right] \rightarrow \left[\begin{array}{ccc|c} 1 & 2 & -1 & 12 \\ 0 & 4 & 1 & 12 \\ 0 & 0 & 1 & 12 \end{array} \right]$$

- ✓ 4. Obtain the integral solution of the differential equation $Y'(x) = -Y(x) + \sin(x) + \cos(x)$ for the initial value $Y(0) = 1$. $\sin x + e$ [3]

- ✓ 5. Show how the numerical derivative of the second order can be obtained by the method of undetermined coefficients. Also find the order of the error. [3]

- ✓ 6. Consider the following system of nonlinear equations:

$$x^2 + y^2 - 4 = 0, \quad x^2 - y^2 - 1 = 0$$

- (a) Plot both the equations together on the $x-y$ plane.

- (b) Obtain all the roots (where the equations intersect) by the Newton method. [1+3=4]

- ✓ 7. Evaluate the following by Gaussian quadrature using the approximation with two nodes.

$$\int_0^5 (3x^2 + 2) dx$$

$$135, 134.9999$$

Also estimate the percentage error with respect to the exact integral. [4]

- ✓ 8. Find the inverse of

$$\begin{bmatrix} 1 & 2 & 4 \\ 1 & 3 & 9 \\ 1 & 4 & 16 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 2 & 4 \\ 1 & 3 & 9 \\ 1 & 4 & 16 \end{bmatrix}^{-1} = \begin{bmatrix} 6 & -8 & 3 \\ -3.5 & 6 & 2.5 \\ 0.5 & 1 & 0.5 \end{bmatrix}$$

by performing Gaussian elimination on an augmented matrix. [5]

- ✓ 9. Consider the initial-value problem $Y'(x) = Y(1 + e^{2x})$, $Y(0) = 1$.

- (a) Integrate by Euler's method up to $n = 3$, with a step-size of $h = 0.1$.

- (b) Integrate by the second-order Taylor method up to $n = 2$, with $h = 0.1$. [2+3=5]

$$\begin{array}{cccc} 1.23 & 1.34 & 1.46 & 1.58 \\ 1.23 & 1.34 & 1.46 & 1.58 \\ 1.23 & 1.34 & 1.46 & 1.58 \end{array}$$

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6.069

Roll No. 201501099
Academic Year 2017-18

Autumn Semester

Computational and Numerical Methods (SC374)

First In-Semester Examination

Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar

Total Marks: 15

Time: 1 Hour 30 Minutes

All questions are compulsory. Answer all the sub-parts of a question together. Marks for each question are indicated next to it. All terms and symbols carry their standard textbook meaning.

1. Plot the two following functions $y = f(x)$, fully discussing the quadrants in which they lie, their turning points (if any), the type of turning points and the asymptotic behaviour of $f(x)$.
A. $y = (\ln x)/x$ B. $y = x - 1 + e^{-x}$ (Plot only for $x \geq 0$). [2.5+2.5=5]
2. Produce the second-degree Taylor polynomial for $f(x) = \cos x$ using $a = \pi$ as the point of approximation. Plot the Taylor polynomial along with $f(x)$ within $0 \leq x \leq 2\pi$. [2.5]
3. Prove that if $f(x) = 0$ is a polynomial equation with real coefficients, then its complex roots occur only in conjugate pairs. [2]
4. Find the root of $f(x) = x + \ln x = 0$ by the bisection method. Apply an error tolerance of $\epsilon = 0.0010$ and provide your final answer correct up to 4 places of decimal. Present your numerical steps clearly in a table with full details. [3]
5. Find the root of $f(x) = x^5 + x - 1 = 0$ by the Newton-Raphson method. Present your numerical steps clearly in a table, and provide your final answer correct up to 4 places of decimal. [2.5]

Roll No. 201501099
Academic Year 2017-18

Autumn Semester

Computational and Numerical Methods (SC374)

Second In-Semester Examination

Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar

Time: 2 Hours

Total Marks: 25

All questions are compulsory. Answer all the sub-parts of a question together. Marks for each question are indicated next to it. All terms and symbols carry their standard textbook meaning.

1. Prove that three data points can be interpolated only by a unique quadratic polynomial. [2]
2. Show that the approximation $f[x_0, x_1] \simeq f'((x_0 + x_1)/2)$ is valid when x_0 and x_1 are very close to each other. [2]
3. Given $f(x) = \sqrt{x}$,
 - (a) First calculate the exact integral of $f(x)$ over the interval $0 \leq x \leq 1$.
 - (b) Now estimate $T_n(f)$ over the same interval for $n = 2$ and find the percentage error. [1+1=2]
4. Given $f(x) = e^x \sqrt{x}$, find $S_n(f)$ for $n = 2$ and $n = 4$ over the interval $0 \leq x \leq 1$. [2]
5. Show that the error due to the central difference formula is proportional to h^2 . [2]
6. Find the root of $f(x) = 2 - x - e^x = 0$ by the secant method. Present your numerical steps clearly in a table, and provide your final answer correct up to 5 places of decimal. [2.5]
7. For three data points $(-2, -15)$, $(-1, -8)$ and $(0, -3)$,
 - (a) Perform a linear Lagrange interpolation for $f(x)$ at $x = -0.5$.
 - (b) A quadratic Lagrange interpolation for $f(x)$ at the same point. [1+1.5=2.5]
8. For three data points $(0, 1)$, $(1, 1)$ and $(2, 5)$,
 - (a) Produce Newton's divided-difference interpolation polynomial of the quadratic order.
 - (b) Find the natural cubic spline functions to interpolate the data. [2+3=5]
9. Find the roots of $x^4 - 3x^2 - 6x - 2 = 0$ by either the Descartes or the Ferrari method. [5]

$$\sqrt{e} e^{x^2} + \frac{2}{3} e^{x^2} x^3 e$$

$$e + \frac{2}{3} e$$

$$\begin{array}{r} \cancel{1.925736} \\ \cancel{1.925736} \\ \times 0.859 \\ \hline 1.64610801 \\ 7.26754 \\ \hline 1.64610801 \end{array}$$