BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2018-2019

Sub: **CSE 207** (Data Structures and Algorithms II)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

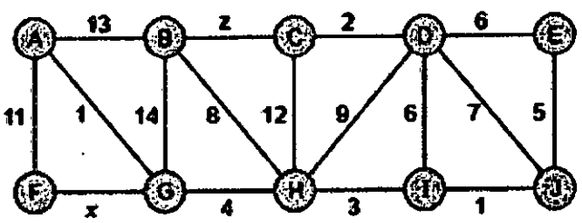
There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Dijkstra's algorithm for the shortest path problem is shown below. What would be the time-complexity of the algorithm (show line by line analysis) for an input graph *G* if *adjacency list* is used for graph representation and *an ordinary array* is used for storing d[] values. **(15)**

```
Dijkstra(G)
1     Q = V[G];
2     for each u ∈ Q
3         d[v] = ∞;
4     d[s] = 0; S = Ø;
5     while (Q ≠ Ø)
6         u = ExtractMin(Q);
7         S = S U {u};
8         for each v ∈ u->Adj[]
9             if(v ∈ Q and d[v] > d[u]+w(u,v))
10                d[v] = d[u]+w(u,v);
```

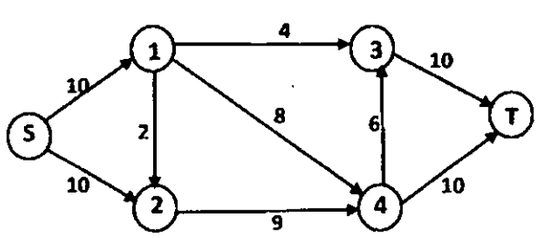
(b) i) Prove that an optimal minimum spanning tree is composed of optimal minimum spanning subtrees. **(15)**

ii) Draw a minimum spanning tree of the graph *G* shown below such that the minimum spanning tree contains the edges with weights *x* and *z*.



2. (a) Johnson's Algorithm makes clever use of Bellman-Ford and Dijkstra's Algorithms to do `All-Pairs-Shortest-Paths` efficiently on sparse graphs. Explain the basic clever idea of Johnson's Algorithm. **(15)**

(b) For the flow network shown in the following figure, find the value of the maximum flow by drawing residual networks in each step. Finally, draw the maximum flow network. Also, identify the min-cut of the maximum flow network. **(15)**



3. (a) i) What ate the rotations that are required to balance an AVL tree? **(15)**

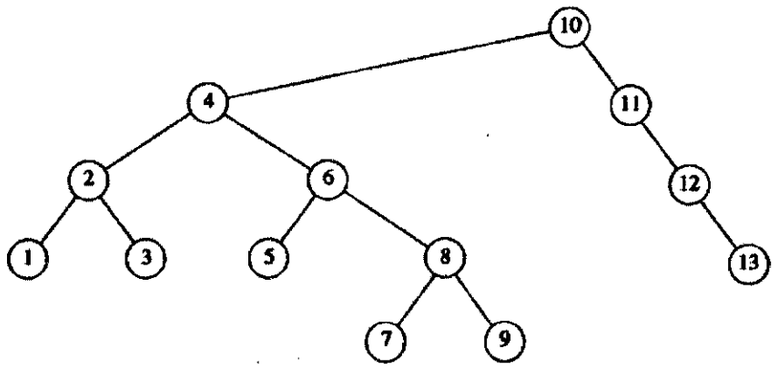
ii) How does a rotation balance an AVL tree?

iii) What is the maximum height of an AVL tree having 10 nodes?

(b) For the splay tree of the following figure, **(15)**

i) show the resulting tree after successively accessing the keys 3 and 9 in the splay tree,

ii) show the resulting tree after deleting key 6 after doing operations in (i) (i.e., accessing the keys 3 and 9).



4. (a) i) When we insert a node into a red-black tree, we initially set the color of the new node to red. Why don't we choose to set the color to black? **(15)**

ii) Would inserting a new node to a red-black tree and then immediately deleting it change the tree? Explain with an example.

iii) What is the ratio between the lengths of the longest path and the shortest path in a red-black tree?

(b) In a skip list with n entries, prove that **(15)**

i) the expected space used is $O(n)$, and

ii) the expected search and insertion time is $O(\log n)$.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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Sub: **CSE 207** (Data Structures and Algorithms II)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5 (a) Assuming simple uniform hashing, prove that an unsuccessful search in separate chaining takes expected $O(1+\alpha)$ work, where α is the load factor. **(12)**

(b) Quadratic probing does not necessarily probe all locations in hash tables. Do you agree with this statement? Justify your answer. **(6)**

(c) Consider successively inserting the keys 14, 3, 29, 3, 19, 16, 35, and 2 into a hash table of size m = 11 with hash function h(k) = k mod m. Illustrate the resulting hash table after inserting these keys using quadratic probing. You do not need to show the intermediate steps, just show the hash table after inserting all the elements. **(12)**

6 (a) Prove that there are ${}^{k}C_{i}$ nodes at depth i in a binomial heap B_k of order k. **(10)**

(b) Show the Fibonacci heap that results when the minimum node (3) is deleted from the Fibonacci heap shown in Figure for Q2. Show the intermediate steps. **(15)**

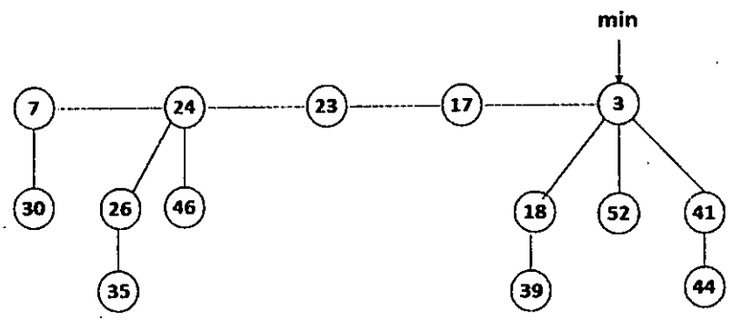


Figure for Q2.

(c) Mention the running times of the following operations for binomial heap and Fibonacci heap. **(5)**

i) Union, ii) Find min, iii) Extract min, and iv) Decrease key.

CSE 207

7 (a) Prove that P = NP => NP = co-NP. **(12)**

(b) The TAUTOLOGY problem asks if a given Boolean formula is true for all possible assignments to the Boolean variables. Prove or disprove that TAUTOLOGY is in co-NP. **(6)**

(c) For a graph $G = (V,E)$, a set S of vertices in G is a vertex cover if every edge e in G has at least one end in S. A set of vertices I in G is an independent set if for every two vertices in I, there is no edge between them. **(12)**

Given a graph G and a number K, the vertex cover problem asks if G contains a vertex cover of size at most K. Given a graph G and a number K, the independent set problem asks if G contains an independent set of size at least K.

Prove that the vertex cover problem is at least as hard as the independent set problem.

8 (a) Give an approximation algorithm for the vertex cover problem. Analyze the approximation ratio of your algorithm. **(10)**

(b) Analyze the running time of the randomized quick sort algorithm. **(10)**

(c) Consider the following Boolean formula: **(10)**

(x' v y') ^ (x v y') ^ (x' v y) ^ (x v y v z') ^ (x v y v z)

Use backtracking algorithm to decide whether this is satisfiable or not. You must show the backtracking tree.

L-2/T-2/CSE **Date: 9/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations (January 2020 Term)

Sub: **CSE 209** (Digital Electronics and Pulse Techniques)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. Consider the DTL NAND gate shown in Fig. 1. Assume that voltage drop across a conducting diode is 0.70v and V_γ(diode) = 0.60v. For the transistor, assume that V_{BE}(sat) = 0.85v, V_{CE}(sat) =0.20v, V_γ = 0.5v, and h_{FE} = 50. Assume reasonable values for other parameters if necessary.

   Now, calculate the following.

   a) Find I_{R_b} and V_o when all inputs are at logic level 0 (0.20v). 10

   b) Find I_B and V_o when all inputs are at logic level 1 (5.0v). 10

   c) Using the I_B calculated in 1(b), find the fan-out of the gate. 10

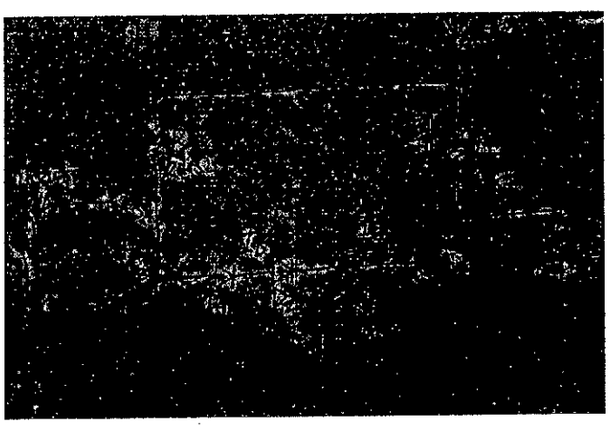


Fig. 1

2. (a) Why is the propagation delay of a TTL NAND gate much less than the same of a DTL NAND gate? What are the benefits of the totem-pole output stage in a TTL circuit? 5+5 = 10

   (b) Explain the operation of an n-bit $R-2R$ ladder type D/A converter with circuit diagram. Derive its output equation. 14

   (c) Write down two differences between BJT and MOSFET. 6

3. (a) Draw circuit diagrams of PMOS inverters for the following two cases: (i) the load transistor works in triode region and (ii) the load transistor works in saturation region. In both cases, the driver is an enhancement device. 10

   (b) Explain the transfer characteristics of a CMOS inverter. 10

   (c) Draw a CMOS positive logic NAND gate. Using this circuit, draw a CMOS positive logic AND gate. 10

4. (a) Consider the ECL gate shown in Fig. 4. Assume the base-emitter voltage drop across all transistors is 0.75v when in active-region or saturation. Assume reasonable values for other parameters if necessary.

Now, calculate the following.

I. Show that $V_{o2} = -0.76v$ at logic level 1 and $V_{o2} = -1.58v$ at logic level 0. 10

II. Calculate noise margins $NM(0)$ and $NM(1)$ for the given gate. 8

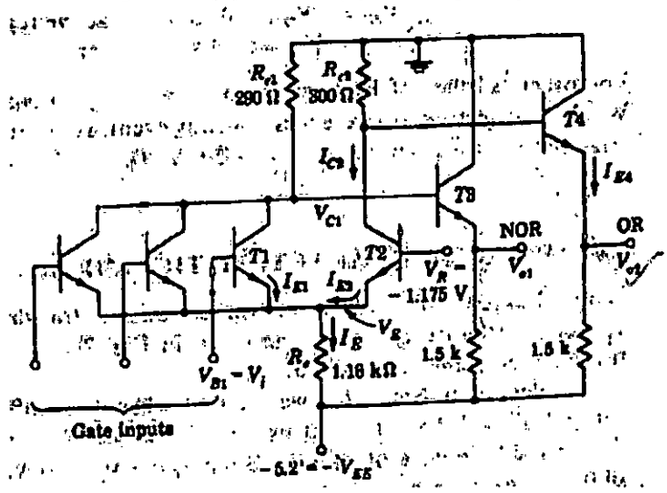


Fig. 4

(b) Briefly explain the following terms which describe the quality of performance of a D/A converter: (i) Resolution, (ii) Linearity, and (iii) Settling time 12

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2018-2019

Sub: **CSE 209** (Digital Electronics and Pulse Techniques)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) In Figure 5(a), a pulse signal with amplitude V is fed to a Low Pass RC Circuit for t_p seconds. On the right, the input wave v_i (in dashed curve) and output wave v_o (in solid curve) are also shown. Prove that the total area under the output curve is $V \times t_p$. **(20)**

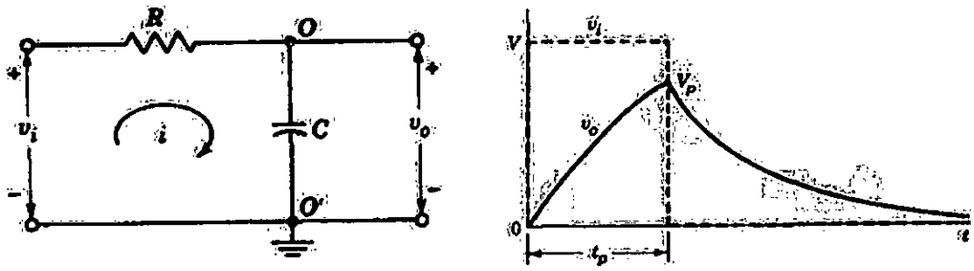


Figure 5(a): Low Pass RC circuit, Input Output wave shape

(b) A ramp input $v_i = 5t$ is fed to a High Pass RC Circuit, where $RC \ll 1$. Using the fact $RC \ll 1$, find out the equation of the output v_0. **(10)**

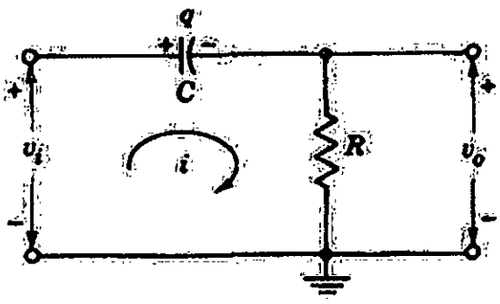


Figure 5(b): High Pass RC Circuit

6. (a) For the given input and circuit in Figure 6(a) **(15)**

- Find out the transfer function (relation of v_o and v_i in various states)
- Draw the output wave shape

Please use piecewise linear model for diode ($V_\gamma = 0.7V$ and diode forward resistance $R_f = 100\Omega$).

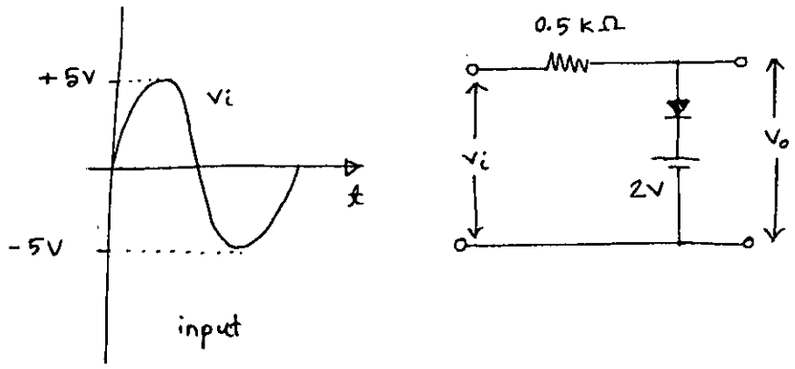


Figure 6(a): Input and Circuit

(b) For the given input and circuit in Figure 6(b), draw the output wave shape. Please use constant voltage drop model for both diodes ($V_\gamma = 0.7V$). **(15)**

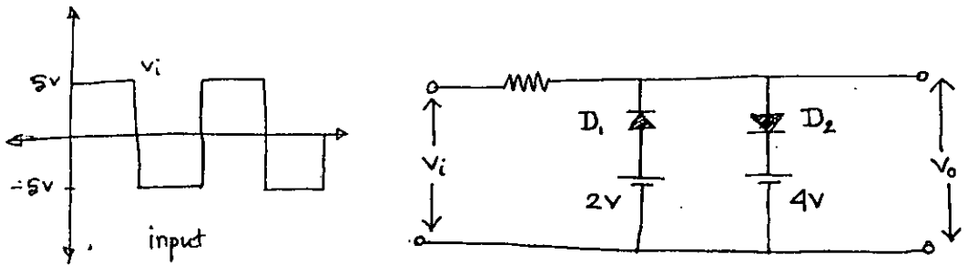


Figure 6(b): Input and Circuit

7 (a) Design a circuit that will take the sine wave given in Figure 7(a)-i as the input and produce the output given in Figure 7(a)-ii. Please use constant voltage drop model for the diodes you will use in your circuit ($V_\gamma = 0.7V$). **(15)**

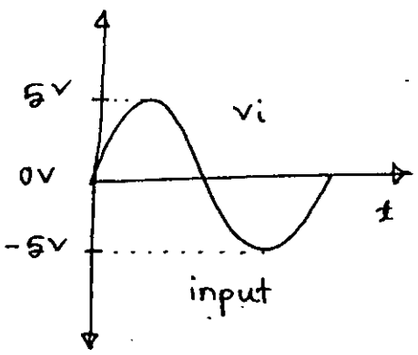


Figure 7(a)-i

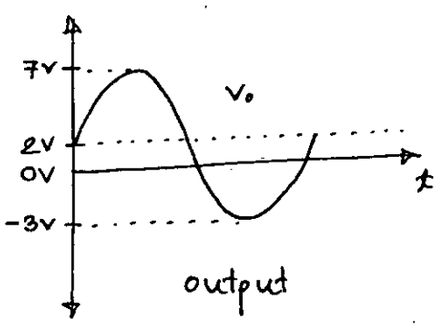


Figure 7(a)-ii

(b) Draw the diagram of a 4-bit weighted resistor Digital to Analog Converter (DAC). **(10)**

(c) Write down the disadvantages of using weighted resistor DAC. **(5)**

8 (a) Write the differences between monostable multivibrator and astable multivibrator. **(10)**

(b) Explain how the data of a "Single-MOSFET dynamic memory cell" will be destroyed during read operation. **(10)**

(c) Draw the basic circuit of a two input RTL NOR gate. **(10)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations (January 2020 Term)

Sub: **CSE 211** (Theory of Computation)

Full Marks: 180, Section Marks: 90, Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Given an instance of the Dominating Set problem, desctibe how the certificate can determine whether the Dominating Set problem is in NP. (6)

   (b) After learning the pumping lemma (difficult to understand, easy to go astray when applying it), Surcharged Skye got very excited and came up with his very personal opinions regarding a number of languages as follows: (12)

   i. For $\Sigma = \{0, 1\}$, $L_1 = \{ww \mid w \in \{0,1\}^*\}$, we choose the string 0^p0^p, take $x = \epsilon$, $y = (00)^k$, $k \leq \frac{p}{2}$. Now, since $\forall i \geq 0$, $xy^iz \in L_1$, L_1 is regular.

   ii. For $\Sigma = \{0, 1\}$, $L_2 = \{w \in \Sigma^* \mid n_0(w) = 3n_1(w)\}$ ($n_a(w)$ denotes the number of a's in w), we choose the string $0^{3p}1^p$, take $y = 0001$. Since $\forall i \geq 0$, $xy^iz \in L_2$, we have failed to demonstrate that L_2 contradicts pumping lemma.

   Explain clearly whether you find anything wrong in each of the opinions expressed by Skye.

   (c) Consider the NFA given below: (12)

	a	b	c	ϵ
$\rightarrow p$	$\{p\}$	$\{q\}$	$\{r\}$	$\emptyset$
q	$\{q\}$	$\{r\}$	$\emptyset$	$\{p\}$
$*r$	$\{r\}$	$\emptyset$	$\{p\}$	$\{q\}$

   Give, with necessary explanations, general forms of all the strings of length three or less accepted by the automaton.

2. (a) State informally, the language accepted by the DFA shown in the figure. (7)

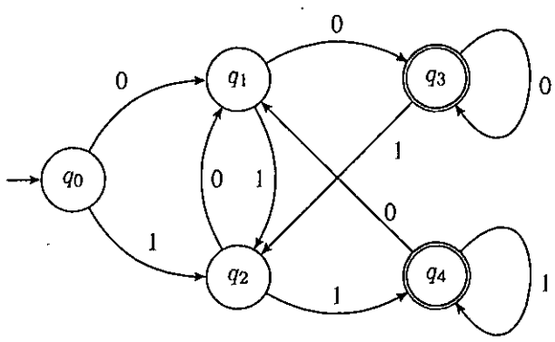


Figure for Question 2(a).

   (b) For the DFA in Question 2(a), draw the equivalent NFA for the corresponding language. (13)

   (c) For the DFA in Question 2(a), write down the regular expression for the strings that *do not* belong to the corresponding language. (10)

CSE 211

3. (a) Evaluate the following regular expressions. Show the detailed computations. (10)

   i. $\emptyset^*\emptyset^*\emptyset^*\emptyset^*$

   ii. $\emptyset^* \cup \{\epsilon\}$

   iii. $(\emptyset^* \cup 1)\{0,1\}$

   iv. $(11)^*\emptyset(00)^*$

   v. $(\emptyset^* \cup 0)\{0,1,11\}$

   (b) We have got an NFA $N_1 = (Q_1, \Sigma, \delta_1, q_1, F_1)$ which recognizes the language L_1. (20)
   We want to construct $N = (Q, \Sigma, \delta, q_0, F)$ to recognize L_1^*.
   In this process, we define δ for N such that for any $q \in Q$ and any $a \in \Sigma_\epsilon$,

$$\delta(q,a) = \begin{cases} \delta_1(q,a) & q \in Q_1 \text{ and } q \notin F_1 \\ \delta_1(q,a) & q \in F_1 \text{ and } a \neq \epsilon \\ \delta_1(q,a) \cup \{q_1\} & q \in F_1 \text{ and } a = \epsilon \\ \{q_1\} & q = q_0 \text{ and } a = \epsilon \\ \emptyset & q = q_0 \text{ and } a \neq \epsilon \end{cases}$$

   Explain clearly in plain English (stressing on the purpose) each of the conditions (at right) in the above transition function.

4. (a) Give a description in English of the language of the regular expression: (10)
   $(1 + \epsilon)(00^*1)^*0^*$.

   (b) Convert the NFA shown in the figure to an equivalent DFA. Show the computations. (20)

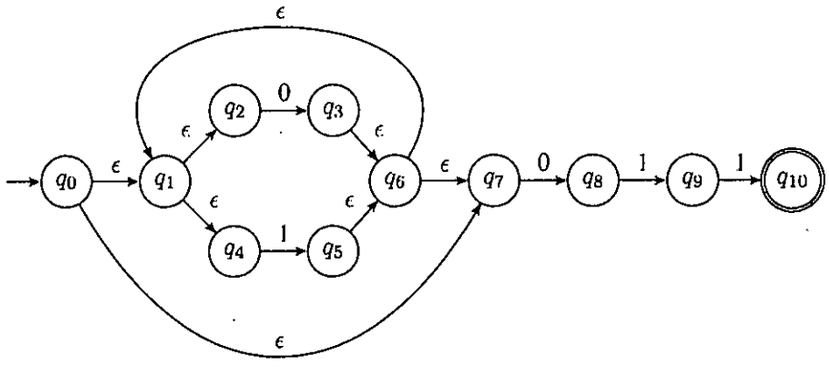


Figure for Question 4(b).

— THE END —

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations (January 2020 Term)

Sub: **CSE 211** (Theory of Computation)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – B

There are **EIGHT** questions in this section. Answer any **SIX**.

5. Give context-free grammars that generate the following languages for an alphabet, $\Sigma = \{0,1\}$: 7+8

   a) $\{w \mid w$ contains at least one 0 and at least one 1$\}$,

   b) The set of all strings with equal number of 0s and 1s.

6. Design a context-free grammar for an alphabet, $\Sigma = \{a,b,c,d\}$ that generates the language, 10+5

   $$L=\{a^n b^n c^m d^m \mid n \geq 1,\ m \geq 1\} \cup \{a^n b^m c^m d^n \mid n \geq 1,\ m \geq 1\}$$

   Show that the grammar you designed is ambiguous by giving two different parse trees for some string in the language.

7. The following are the productions of a grammar G in Chomsky Normal Form (S is the start symbol). 15

   $S \rightarrow BZ \mid CY \mid ZZ \mid YY$

   $B \rightarrow ZA$

   $C \rightarrow YA$

   $A \rightarrow ZA \mid YA \mid 0 \mid 1$

   $Z \rightarrow 0$

   $Y \rightarrow 1$.

   Determine whether 10011 is in $L(G)$ using the CYK algorithm (you need to show the table).

8. Design a pushdown automaton (PDA) that recognizes the language $\{a^i b^j c^k \mid i, j, k \geq 0$ and $(i=j$ or $i=k)\}$. Show its transition diagram. Recall that, PDAs are non-deterministic. 15

9. Design a Turing machine (TM) that takes as input two numbers, w_1 and w_2 in binary of equal lengths and computes the logical XOR of the two numbers. The tape initially contains $w_1 c w_2 c$ where 'c' is a tape symbol that is used as the separator. Your TM should terminate with the XOR of the two numbers in binary after the second c. (You can use multiple tracks and storage in the state if you wish). 15

10. Briefly explain whether the following statements are true or false: 7+8

    i) A one-tape Turing machine with multiple tracks and storage in the state can simulate a multi-tape Turing machine.

    ii) A deterministic Turing machine can simulate n steps of a conventional computer in $P(n)$ steps, where $P(n)$ is some polynomial in n.

11. a) Define recursively enumerable (RE) languages and recursive languages. 7+8

b) Give one example of the following (with definitions):

i) A language that is not recursively enumerable (not RE),

ii) A language that is RE but not recursive.

12. a) State Cook's theorem. Explain why finding a polynomial time algorithm for an NP-complete problem implies P=NP. 7+8

b) Draw the Venn diagram showing the widely believed relationships (whether they are equal or which one is a subset of the other) among the classes of problems P, NP, PSPACE, NPSPACE and EXPTIME. Briefly justify your answer.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations (January 2020 Term)

Sub: **CSE 215** (Database)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Q1.

a. Explain the ACID properties of a transaction with an example. Why are these properties essential for the concurrent execution of transactions? 10+5

b. Two transactions are given as follows:

i. Transaction T1 transfers the sum of 20% of balances of accounts A and B to account C 8+7

ii. Transaction T2 transfers Tk. 2000 from account D to account C

Prepare a concurrent schedule for the above two transactions and prove that the schedule is conflict serializable.

Q2.

a. The size of an unsorted relation r-unsorted is 36 blocks (B1, B2, B3, ..., B36) and the memory size to external sort merge the relation is 4 blocks. Show the diagram to sort the relation using the external sort merge algorithm and store it in the database as r-sorted. Using the diagram, explain the total number of blocks transfer needed to sort the relation and store it into the database. 10+5

b. The Employee Management System of an organization has the following relational schema: 8+7
employee (e-id, name, date-of-birth, salary, street, thana, district, NID)
Total employees are 40000 and the size of the employee relation is 4000 blocks. The primary index is e-id and secondary indices are name, district and NID. The heights of the indices e-id, name, district and NID are 4, 3, 2 and 4 respectively. The time to transfer 1 block is 0.5ms and the average seek time in the disk is 8ms. The number of tuples with salary = 50000 is 100 and district = 'Comilla' is 2000. Consider each tuple is in different block and non-overlapping.

(i) Find the query costs using the indices for the

SQL: SELECT * FROM employee WHERE salary = 50000 OR district = 'Comilla'

(ii) Explain the algorithm you have used to process the SQL of Q2 (b).

Q. 3

a. Explain how the following queries will be executed using the sparse index shown in Figure 1. 15

(i) SELECT * FROM instructor WHERE id = 22222

(ii) SELECT * FROM instructor WHERE id = 99999

b. Explain the deletion of records from 10101 to 22222 from instructor relation given in Figure 1 as per deletion algorithm of relation with sparse index. 15

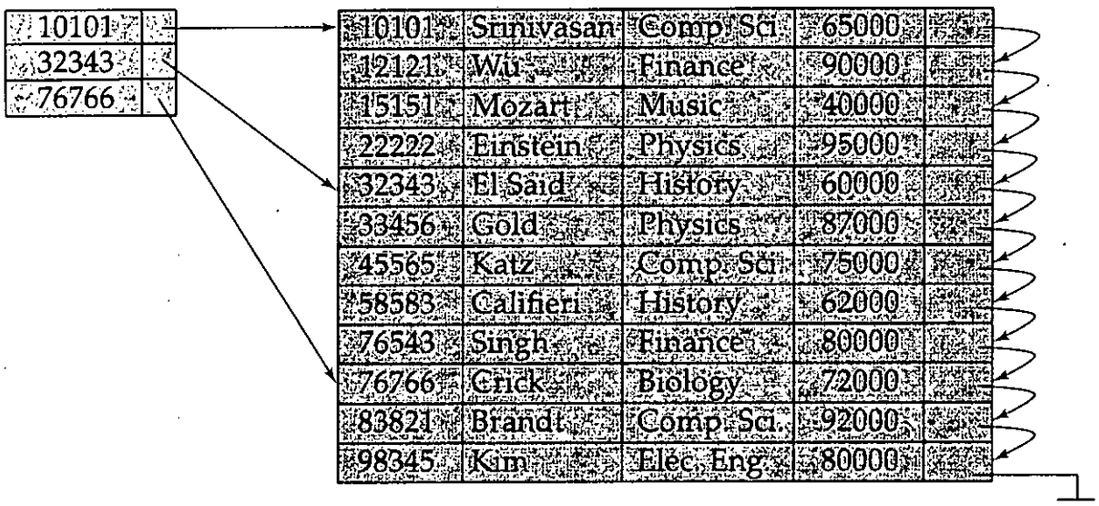


Figure 1: Sparse index and instructor relation for question 3(a) and 3(b)

Q.4

a. Describe the storage mechanism, data read and update of data block for RAID level 5 storage with a set of 4 disks: D0, D1, D2 and D3; and a relation with 8 blocks: B0, B1, B2 ..... B7. Describe the full recovery mechanism of all blocks of D1, if disk D1 fails. 10+5

b. Given the relational schema as follows: 15

Student (id, name, DOB, cgpa, tot-cred, house-no, street, city, remarks, NID)
Takes (id, course-no, semester, year, grade)
Course (course-no, title, credit, pre-req)

The tuple size for Student, Takes and Course are 400, 100 and 80 bytes respectively. The block size is 8 KB (8000 Byte). Show the organization of slotted page structure after insertion of

i. two tuples of Student,
ii. two tuples of Takes, and
iii. one tuple of Course.

L-2/T-2/CSE **Date: 19/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2018-2019

Sub: **MATH 247** (Linear Algebra, Laplace Transform & Fourier Analysis)

Full Marks: 240 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

SECTION-A

There are **FOUR** questions in this section. Answer any **THREE**.

1. **(a)** Solve the following system of equations by reducing the augmented matrix to its canonical form: **(20)**

$$\begin{aligned} x - 2y - 3z &= -4 \\ 2x + 3y + 4z &= 8 \\ 4x - 2y - 2z &= 2 \end{aligned}$$

(b) Find all eigenvalues and the corresponding eigenvectors of the matrix **(20)**

$$A = \begin{pmatrix} 3 & 2 & 4 \\ 2 & 0 & 2 \\ 4 & 2 & 3 \end{pmatrix}.$$

2. **(a)** Find rank and nullity of the matrix $A = \begin{bmatrix} 1 & -1 & 3 \\ 5 & -4 & -4 \\ 7 & -6 & 2 \end{bmatrix}$. Hence verify the dimension theorem. **(20)**

(b) Find the inverse of the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & -1 & 4 \\ 3 & 1 & 1 \end{bmatrix}$ by Cayley-Hamilton theorem. **(20)**

3. **(a)** Consider the basis $S = \{v_1, v_2, v_3\}$ for R^3, where $v_1 = (1, 2, 1)$, $v_2 = (2, 9, 0)$, and $v_3 = (3, 3, 4)$. Let $T: R^3 \to R^2$ be the linear transformation such that $T(v_1) = (1, 0)$, $T(v_2) = (-1, 1)$ and $T(v_3) = (0, 1)$. Find a formula for $T(x, y, z)$ and use that formula to find $T(7, -3, 5)$. **(20)**

(b) Describe the Kernel and Range of the orthogonal projection on the plane defined by $y = x$. **(20)**

4. **(a)** Find the Laplace transforms (i) $L\{\sin at\}$ and (ii) $L\left\{\frac{\sin t}{t}\right\}$ and then find **(20)**

$$L\left\{\int_0^t \frac{\sin u}{u}\, du\right\}.$$

(b) If F(t) is a periodic function of period T > 0 then prove that (20)

$$L\{F(t)\} = \frac{\int_0^T e^{-st} F(t)dt}{1-e^{-sT}}.$$

SECTION-B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Evaluate $L^{-1}\left\{\tan^{-1}\left(\frac{1}{s}\right)+\cot^{-1}(s+k)\right\}$. (20)

(b) Evaluate $L^{-1}\left\{\frac{4s}{(s-1)(s^2+1)^2}\right\}$ by Convolution theorem. (20)

6. (a) Use Laplace transform to solve $\frac{d^2y}{dx^2}+2\frac{dy}{dx}+5y=e^{-x}\sin x$, given that (20)
$y(0)=0$, $y'(0)=1$.

(b) Using the Laplace transform, find charge Q(t) in the R-C series circuit assuming the electromotive force $E=10k\cos t$, resistor R =10 Ω, capacitor C= 0.1 farads, and zero initial charge on the capacitor. (20)

7. (a) Find the Fourier series of $f(x)$ defined by (25)

$$f(x)=\begin{cases}-\pi, & -\pi \le x < 0\\ x, & 0 < x \le \pi\end{cases}$$

(b) Find Fourier cosine integral formula of $e^{-x}\cos x$ for $x \ge 0$. (15)

8. (a) Find the sine Fourier transform of $f(x)=\begin{cases}x, & 0<x<1\\ k+1-x, & 0<x<k+1\\ 0, & x>k+1\end{cases}$ (20)

(b) Use finite Fourier cosine transform to solve the boundary value problem given by (20)

$$\frac{\partial u}{\partial t}=3\frac{\partial^2 u}{\partial x^2},\ 0<x<6,\ t>0;$$

given that $u(0,t)=0$, $u(6,t)=0$ and $u(x,0)=2x$.

L-2/T-2/CSE **Date: 09/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-II B.Sc. Engineering Examination 2018-19

Sub: **EEE 269** (Electrical Drives and Instrumentation)

Full Marks: 180 Time: 2 Hours

The Figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 4 page(s) in this question paper.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**

All the symbols have their usual meanings

Assume reasonable values for missing data.

1. The following test data are obtained from open-circuit and short-circuit tests of a 20kVA, 8000-240, 50 Hz step-down transformer: (30)

Open circuit Test (High Side)	**Short circuit Test (High Side)**
V_{oc} = 8000 V	V_{sc} = 489 V
I_{oc} = 0.214 A	I_{sc} = 2.5 A
P_{oc} = 400 W	P_{sc} = 240 W

Determine

a) All the transformer model parameters (R_{eq}, X_{eq}, R_{fe} and X_M) referred to the low side and draw the equivalent circuit.
b) Voltage Regulation if the transformer operates at rated load and 80% power factor lagging.
c) Efficiency if it operates at one-half of rated load and 85% power factor leading.

2. (a) Describe the effect of changing rotor resistance in the torque speed characteristic of three phase induction motor. (5)

(b) A 3 phase, Δ-connected, 25hp, 600V, 4 pole induction motor has the torque-speed characteristic shown in Fig 2(b). The graph is plotted for a rotor resistance of 2.52 Ω(referred to the stator side). The magnetizing reactance X_M and core loss resistance R_C are negligible. Using graph in Fig 2(b), determine the following: (2+1 +12 +10)

i. Synchronous speed
ii. Breakdown torque.
iii. Stator resistance.
iv. If the rated induced torque is 69.6% of the breakdown torque, then what will be the air gap power and rotor copper loss?

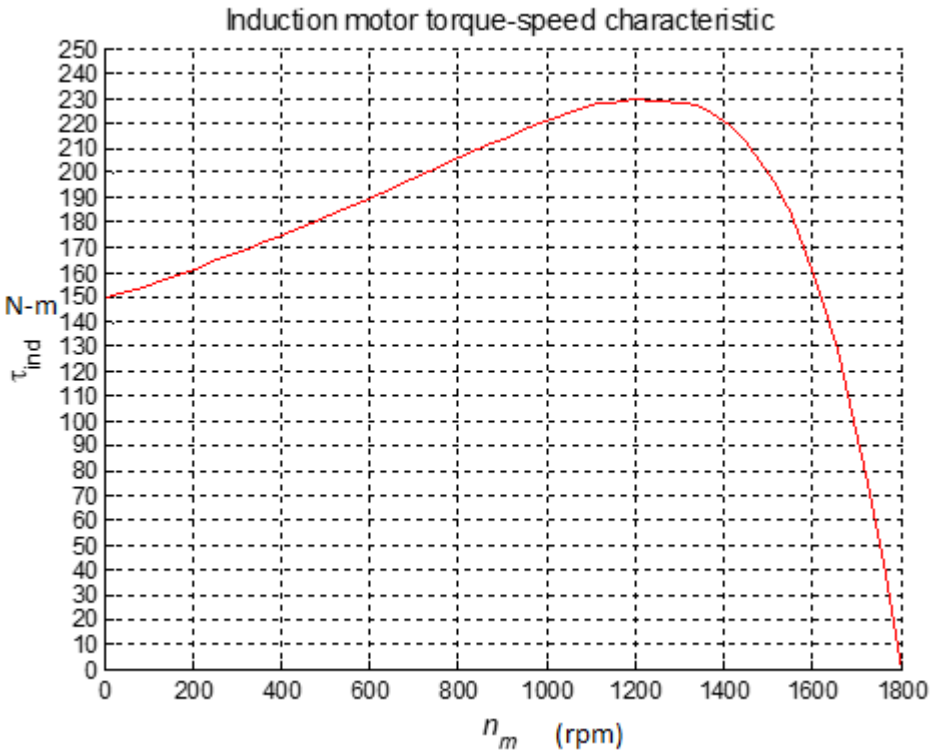


Fig 2(b)

3. A 480-V, 500-kVA, 0.8-PF-lagging, Y-connected synchronous generator has a synchronous reactance of 0.4Ω and a negligible armature resistance. This generator is supplying power to a 480-V, 80-kW, 0.8-PF-leading, Y-connected synchronous motor with a synchronous reactance of 2.0Ω and a negligible armature resistance. The synchronous generator is adjusted to have a terminal voltage of 480 V when the motor is drawing the rated power at unity power factor. (30)

a) Prove that, the power supplied to the synchronous motor in this system is given by $P=\frac{3\,E_{A,g}\;E_{A,m}}{X_{s,g}\;+X_{s,m}}\sin(\delta_g+\delta_m)$,

Where symbols have their usual meaning and $E_{A,g}$ is used as reference.

b) Calculate the magnitudes and angles of $\boldsymbol{E_A}$ for both machines.

c) If the flux of the motor is increased by 10 percent, what will be the value of the terminal voltage of the power system?

4 (a) Describe briefly three starting techniques of single-phase induction motor. (15)

(b)Describe the operation of stepper motor drive circuit. (15)

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**

All the symbols have their usual meanings

Assume reasonable values for missing data

5. (a) A DC shunt motor has armature and field components of Ra = 0.5 Ω and Rf = 220 Ω. Initially when the motor runs at 1000 rpm, it draws 20 A from a 220 V power supply. If the field resistance is increased by 5%, calculate the new steady state armature current and speed of the motor. Assume the load torque delivered by the motor remains constant. (18)

(b) Discuss the advantages and limitations of different forms of compound DC motors. (12)

6. (a) The resistance of the shunt field and armature of a dc shunt generator are 50 Ω and 0.03 Ω, respectively. Calculate the generated e.m.f. of the machine if it is connected to a load assembly and is able to deliver 450A at 230 V. (12)

(b) Discuss how brush shifting could aggravate the flux-weakening effect of the armature reaction. Comment on the differences between separately excited and shunt dc generators. (18)

7. (a) Explain how neural plane shift is related with distortion of magnetic flux in dc machines. Also, discuss how voltage in the wire undergoing commutation can be made zero in such machines. (15)

(b) Explain the role of comparator circuits and sequential elements in the functioning of digital frequency meters. (15)

8 (a) With examples, explain how transducers could play a role in the measurement of temperature. Also, discuss the principle which could help a transducer to be employed as a pressure sensor. (15)

.

(b) What are the benefits of using an instrumentation amplifier over a basic differential amplifier for instrumentation purposes? Explain how it could be used in measuring the intensity of light. (15)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations (January 2020 Term)

Sub: **CSE 215** (Database)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Q1.

a. Explain the ACID properties of a transaction with an example. Why are these properties essential for the concurrent execution of transactions? 10+5

b. Two transactions are given as follows:

i. Transaction T1 transfers the sum of 20% of balances of accounts A and B to account C 8+7

ii. Transaction T2 transfers Tk. 2000 from account D to account C

Prepare a concurrent schedule for the above two transactions and prove that the schedule is conflict serializable.

Q2.

a. The size of an unsorted relation r-unsorted is 36 blocks (B1, B2, B3, ….., B36) and the memory size to external sort merge the relation is 4 blocks. Show the diagram to sort the relation using the external sort merge algorithm and store it in the database as r-sorted. Using the diagram, explain the total number of blocks transfer needed to sort the relation and store it into the database. 10+5

b. The Employee Management System of an organization has the following relational schema:
employee (e-id, name, date-of-birth, salary, street, thana, district, NID)
Total employees are 40000 and the size of the employee relation is 4000 blocks. The primary index is e-id and secondary indices are name, district and NID. The heights of the indices e-id, name, district and NID are 4, 3, 2 and 4 respectively. The time to transfer 1 block is 0.5ms and the average seek time in the disk is 8ms. The number of tuples with salary = 50000 is 100 and district = ‘Comilla’ is 2000. Consider each tuple is in different block and non-overlapping. 8+7

(i) Find the query costs using the indices for the

SQL: SELECT * FROM employee WHERE salary = 50000 OR district = ‘Comilla’
(ii) Explain the algorithm you have used to process the SQL of Q2 (b).

Q. 3

a. Explain how the following queries will be executed using the sparse index shown in Figure 1. 15
(i) SELECT * FROM instructor WHERE id = 22222
(ii) SELECT * FROM instructor WHERE id = 99999

b. Explain the deletion of records from 10101 to 22222 from instructor relation given in Figure 1 as per deletion algorithm of relation with sparse index. 15

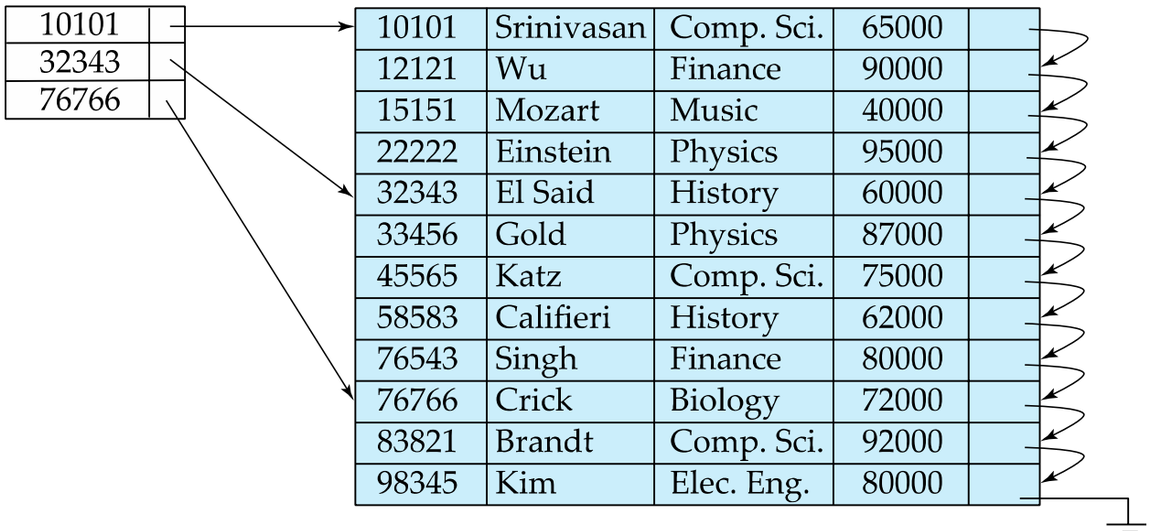


Figure 1: Sparse index and instructor relation for question 3(a) and 3(b)

Q.4

a. Describe the storage mechanism, data read and update of data block for RAID level 5 storage with a set of 4 disks: D0, D1, D2 and D3; and a relation with 8 blocks: B0, B1, B2 ….. B7. Describe the full recovery mechanism of all blocks of D1, if disk D1 fails. 10+5

b. Given the relational schema as follows: 15

Student (<u>id,</u> name, DOB, cgpa, tot-cred, house-no, street, city, remarks, NID)
Takes (id, course-no, semester, year, grade)
Course (course-no, title, credit, pre-req)

The tuple size for Student, Takes and Course are 400, 100 and 80 bytes respectively. The block size is 8 KB (8000 Byte). Show the organization of slotted page structure after insertion of

i. two tuples of Student,
ii. two tuples of Takes, and
iii. one tuple of Course.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2018-19

Sub: **CSE 215** (Database)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – B

There are **TWELVE** questions in this section. Answer any **NINE**.

Figure 1 represents the Relational Schema of the Human Resource (HR) department of an organization. Use this schema for answering the Questions 5-7.

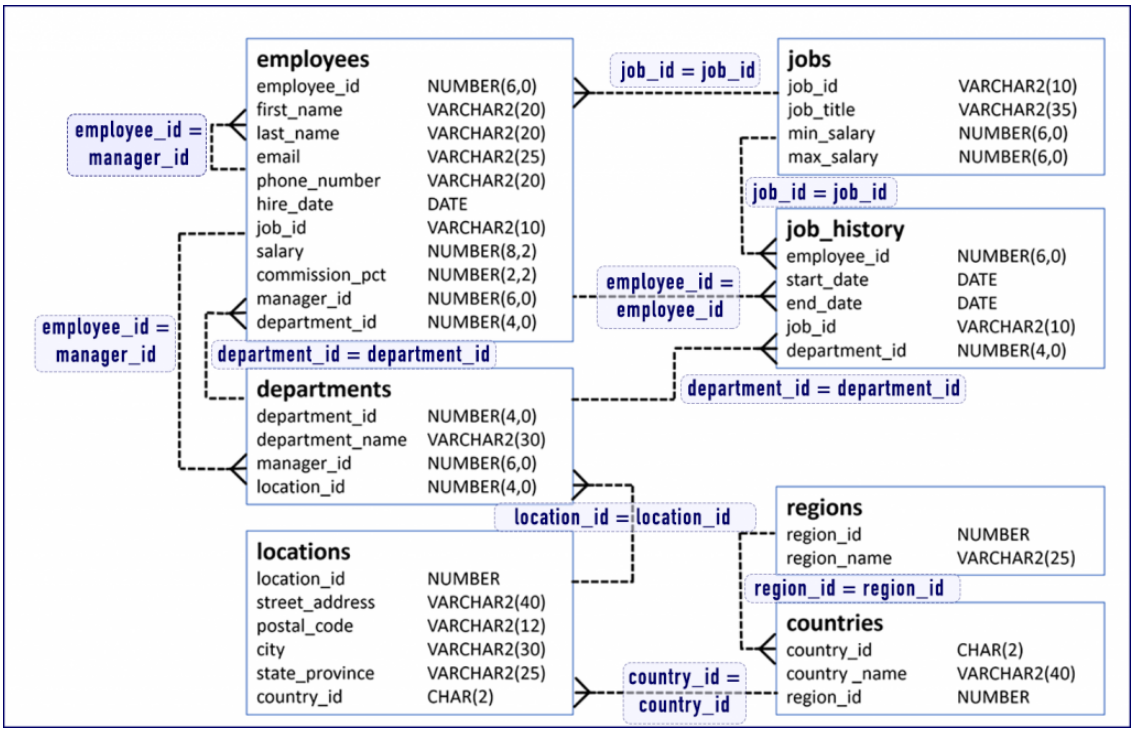


Figure 1: Relational Schema for Q. 5-7

5. Suppose you are intended to show the name (last name only) of each manager along with the number of employees he is managing. You have written the following query which is not giving the correct result. Find out the fault in the query and rewrite it so that it gives your desired result. (10)

```
SELECT E1.LAST_NAME, COUNT(*) AS "TOTAL MANAGED EMPLOYEES"
FROM EMPLOYEE E1 JOIN E2
ON (E1.MANAGER_ID = E2.EMPLOYEE_ID)
GROUP BY E1.MANAGER_ID
ORDER BY "TOTAL MANAGED EMPLOYEES" ASC;
```

6. Write an SQL Query to show the department id, job id, first hiring date, last hiring date and average salary of the employees for each combination of department id and job id, where the average salary is more than 3000. Make sure that any sort of null value is not printed and order the result by department id. (10)

7. Write a procedure named `IncreaseOrDecrease` which takes an employee id as input. If the salary of the employee is greater than the average salaries of all the departments except for his/her own, but less than the average salary of his/her own department, then the procedure will increase his/her salary by 10%. Otherwise, it will decrease his/her salary by 5%. During the execution, as output, it will print "Increasing Salary", or "Decreasing Salary", accordingly. (10)

8. Suppose we are generating a `StaffPropertyInspection` table to include property inspection by staff members. When the staffs are required to undertake the inspections, they are allocated a company car for use on the day of the inspections. However, a car may be allocated to several staff members on the same day at different time slots. A member of staff may inspect several properties on a given date, but a property is only inspected once by a single staff member on a given date. Now normalize the Table `StaffPropertyInspection` of Figure 2 upto 2NF.

   Hint: you have to perform and only show the results of the following steps: (2x5=10)

   i) Find all the candidate keys.
   ii) Determine the primary key.
   iii) Find all the functional dependencies.
   iv) Get the first normal form.
   v) Get the second normal form.

StaffPropertyInspection

propertyNo	iDate	iTime	pAddress	comments	staffNo	sName	carReg
PG4	18-Oct-00	10.00	6 Lawrence St, Glasgow	Need to replace crockery	SG37	Ann Beech	M231 JGR
PG4	22-Apr-01	09.00	6 Lawrence St, Glasgow	In good order	SG14	David Ford	M533 HDR
PG4	1-Oct-01	12.00	6 Lawrence St, Glasgow	Damp rot in bathroom	SG14	David Ford	N721 HFR
PG16	22-Apr-01	13.00	5 Novar Dr, Glasgow	Replace living room carpet	SG14	David Ford	M533 HDR
PG16	24-Oct-01	14.00	5 Novar Dr, Glasgow	Good condition	SG37	Ann Beech	N721 HFR

Figure 2: Table for Q. 8

9. What are the requirements of an ideal DBMS? Define *entity* and *attribute* in the context of database with suitable example(s). (4+6=10)

10. How *redundancy* and *incompleteness* can lead to a bad database design? Explain with appropriate example(s). (10)

11. Differentiate between *strong entity* and *weak entity* by showing appropriate examples. How do you design them in a relational schema? (5+5=10)

12. Production tracking is important in many manufacturing environments (e.g., the pharmaceuticals industry, children's toys, etc.). The ER diagram of Figure 3 captures important information of production tracking. Specifically, the ER diagram captures the relationships among production lots (or batches), individual production units, and raw materials.

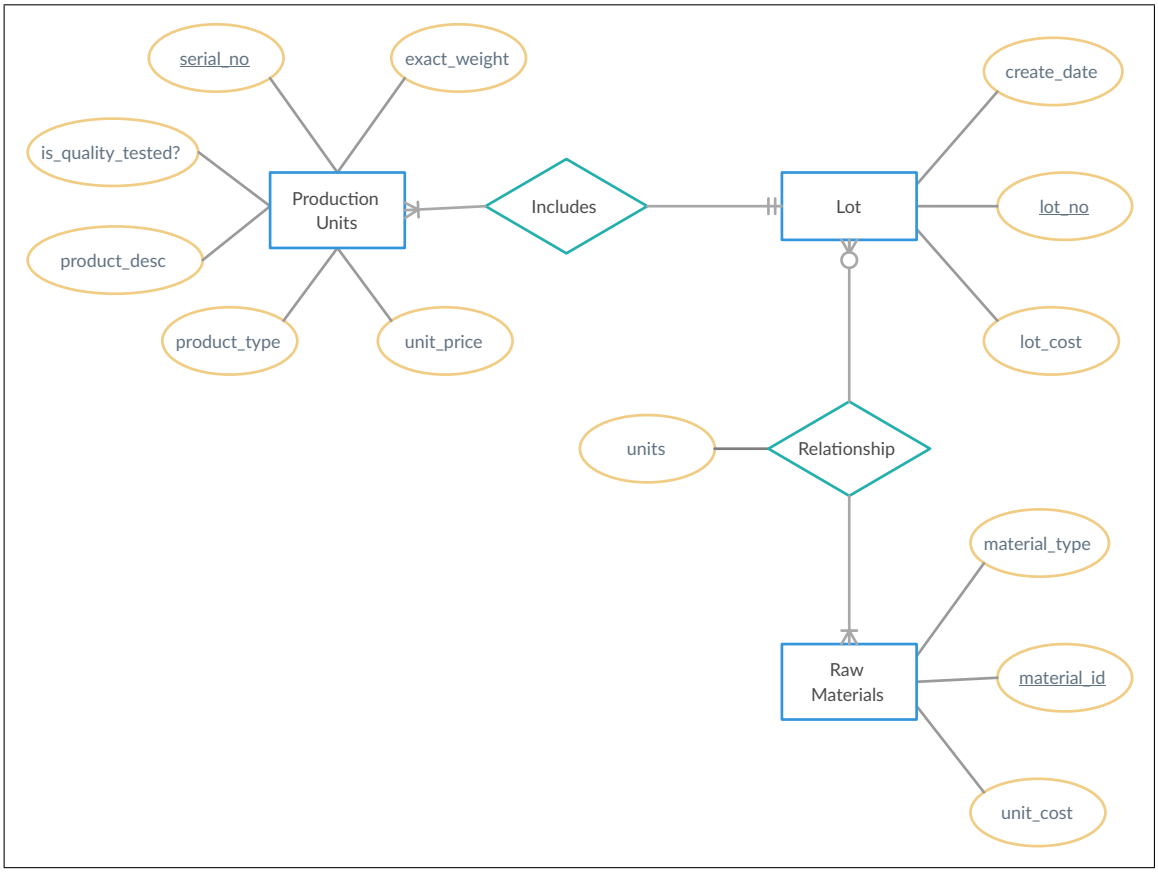


Figure 3: ERD for Q. 12

Now your task is to convert the Entity Relationship Diagram given in Figure 3 into a Relationship Schema. Be certain to indicate primary keys and referential integrity constraints. (10)

13. Suppose you are the manager of the website development department of your organization. Each website developed by your organization can be uniquely identified by a *url*. It also has a public *host-ip* address and a *date* of going live. Each website is developed by a team of developers. Each developer can be uniquely identified by an *employee id*. The relevant information for a developer is his/her *name*, *address*, highest educational *qualification*, *salary* and *hire date*. Each website is developed by a web-based framework which is associated with a particular programming language. Each framework and its associated programming language have a specific *name* and the *development year*. The other information relevant to a web framework is its *author name*.

    Now design a Entity Relationship Diagram for your website development department so that you can manage it conveniently. (10)

14. "A table in `3NF` may fail to meet the criteria of `BCNF`" – do you agree? Show an appropriate example to validate your claim. (10)

15. Consider the following schema of Sonali Bank Limited.

customer (customer_id, customer_name, customer_address)
account (account_id, account_type, account_branch, account_balance)
branch (branch_routing_number, branch_name)
transaction (account_id, transaction_amount, transaction_date)
loan (loan_id, customer_id, loan_amount)

Notice that the attribute *account_branch* of table *account* is a foreign key referencing the primary key *branch_routing_number* from table *branch*. On the other hand, the attribute *account_id* of table *account* is a foreign key referencing the primary key *customer_id* from table *customer*.

Now, write a relational algebra expression using Cartesian product to find out the customers' name and their corresponding loan amounts who have a "savings" type account at the branch named "BUET Br.". (10)

16. Write the equivalent relational algebra expression for the following SQL statement (consider the schema from Q. 15): (10)

```
select c.customer_name, a.account_id, t.transaction_amount
from customer c, account a, transaction t
where c.customer_id = a.account_id and a.account_id = t.account_id
and t.transaction_date = "01-JAN-2020" and t.transaction_amount > 5000
```

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2018-2019

Sub: **CSE 207** (Data Structures and Algorithms II)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

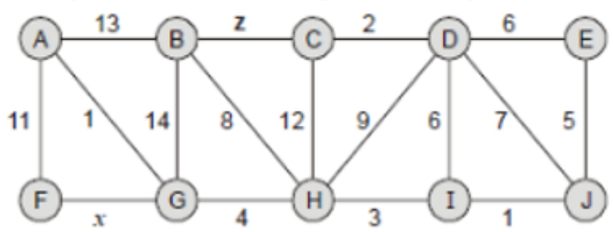
There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Dijkstra's algorithm for the shortest path problem is shown below. What would be the time-complexity of the algorithm (show line by line analysis) for an input graph *G* if *adjacency list* is used for graph representation and *an ordinary array* is used for storing `d[]` values. **(15)**

```
Dijkstra(G)
1     Q = V[G];
2     for each u ∈ Q
3         d[v] = ∞;
4     d[s] = 0; S = ∅;
5     while (Q ≠ ∅)
6         u = ExtractMin(Q);
7         S = S U {u};
8         for each v ∈ u->Adj[]
9             if(v ∈ Q and d[v] > d[u]+w(u,v))
10                d[v] = d[u]+w(u,v);
```

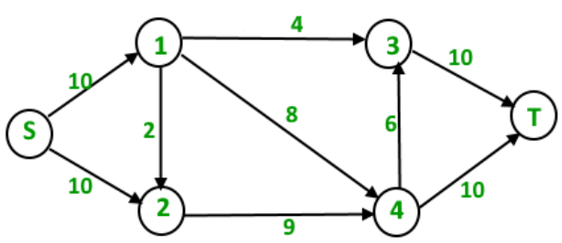
(b) i) Prove that an optimal minimum spanning tree is composed of optimal minimum spanning subtrees. **(15)**

ii) Draw a minimum spanning tree of the graph *G* shown below such that the minimum spanning tree contains the edges with weights *x* and *z*.



2. (a) Johnson's Algorithm makes clever use of Bellman-Ford and Dijkstra's Algorithms to do `All-Pairs-Shortest-Paths` efficiently on sparse graphs. Explain the basic clever idea of Johnson's Algorithm. **(15)**

(b) For the flow network shown in the following figure, find the value of the maximum flow by drawing residual networks in each step. Finally, draw the maximum flow network. Also, identify the min-cut of the maximum flow network. **(15)**



3. (a) i) What ate the rotations that are required to balance an AVL tree? **(15)**

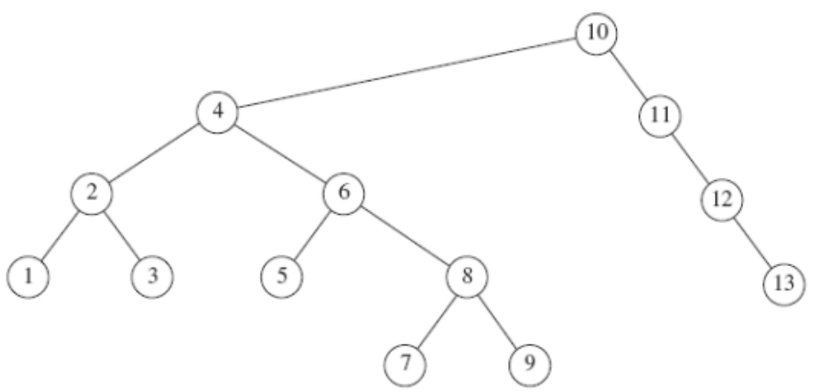
ii) How does a rotation balance an AVL tree?

iii) What is the maximum height of an AVL tree having 10 nodes?

(b) For the splay tree of the following figure, **(15)**

i) show the resulting tree after successively accessing the keys 3 and 9 in the splay tree,

ii) show the resulting tree after deleting key 6 after doing operations in (i) (i.e., accessing the keys 3 and 9).



4. (a) i) When we insert a node into a red-black tree, we initially set the color of the new node to red. Why don't we choose to set the color to black? **(15)**

ii) Would inserting a new node to a red-black tree and then immediately deleting it change the tree? Explain with an example.

iii) What is the ratio between the lengths of the longest path and the shortest path in a red-black tree?

(b) In a skip list with n entries, prove that **(15)**

i) the expected space used is $O(n)$, and

ii) the expected search and insertion time is $O(\log n)$.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2018-2019

Sub: **CSE 207** (Data Structures and Algorithms II)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5 (a) Assuming simple uniform hashing, prove that an unsuccessful search in separate chaining takes expected $O(1+\alpha)$ work, where α is the load factor. **(12)**

(b) Quadratic probing does not necessarily probe all locations in hash tables. Do you agree with this statement? Justify your answer. **(6)**

(c) Consider successively inserting the keys 14, 3, 29, 3, 19, 16, 35, and 2 into a hash table of size m = 11 with hash function h(k) = k mod m. Illustrate the resulting hash table after inserting these keys using quadratic probing. You do not need to show the intermediate steps, just show the hash table after inserting all the elements. **(12)**

6 (a) Prove that there are ${}^{k}C_{i}$ nodes at depth *i* in a binomial heap B_k of order *k*. **(10)**

(b) Show the Fibonacci heap that results when the minimum node (3) is deleted from the Fibonacci heap shown in Figure for Q2. Show the intermediate steps. **(15)**

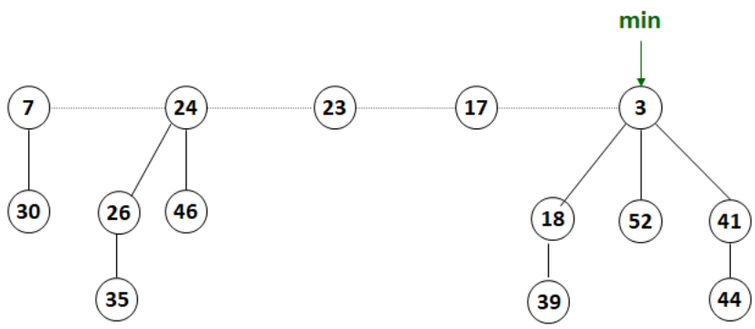


Figure for Q2.

(c) Mention the running times of the following operations for binomial heap and Fibonacci heap. **(5)**

i) Union, ii) Find min, iii) Extract min, and iv) Decrease key.

CSE 207

7 (a) Prove that P = NP => NP = co-NP. **(12)**

(b) The TAUTOLOGY problem asks if a given Boolean formula is true for all possible assignments to the Boolean variables. Prove or disprove that TAUTOLOGY is in co-NP. **(6)**

(c) For a graph $G = (V,E)$, a set S of vertices in G is a vertex cover if every edge e in G has at least one end in S. A set of vertices I in G is an independent set if for every two vertices in I, there is no edge between them. **(12)**

Given a graph G and a number K, the vertex cover problem asks if G contains a vertex cover of size at most K. Given a graph G and a number K, the independent set problem asks if G contains an independent set of size at least K.

Prove that the vertex cover problem is at least as hard as the independent set problem.

8 (a) Give an approximation algorithm for the vertex cover problem. Analyze the approximation ratio of your algorithm. **(10)**

(b) Analyze the running time of the randomized quick sort algorithm. **(10)**

(c) Consider the following Boolean formula: **(10)**

(x′ v y′) ^ (x v y′) ^ (x′ v y) ^ (x v y v z′) ^ (x v y v z)

Use backtracking algorithm to decide whether this is satisfiable or not. You must show the backtracking tree.