

Sub : **MATH 143** (Integral Calculus, Ordinary and Partial Differential Equations and Series solutions)

Full Marks : 280

Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION - AThere are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Compute the following integrals:

$$(i) \int \frac{3x+2}{5x^2+2x+3} dx. \quad (10)$$

$$(ii) \int_0^1 \frac{\ln(1+x)}{1+x^2} dx. \quad (10)$$

$$(b) \text{ Evaluate } \lim_{n \rightarrow \infty} \left[\left(1 + \frac{1}{n^2}\right) \left(1 + \frac{2^2}{n^2}\right) \dots \left(1 + \frac{n^2}{n^2}\right) \right]^{1/n}. \quad (11 \frac{2}{3})$$

$$(c) \text{ Find the value of, } \int_1^2 \frac{dx}{(1+x)\sqrt{(x^2-1)}}. \quad (15)$$

$$2. (a) \text{ Find the area of the loop of the curve } x^3 + y^3 = 3axy. \quad (15)$$

$$(b) \text{ Find the surface area of the solid generated by revolution of } x = a(\theta + \sin\theta), \text{ and } y = a(1 + \cos\theta) \text{ about } x\text{-axis.} \quad (16 \frac{2}{3})$$

$$(c) \text{ Evaluate the triple integral, } \int_0^2 \int_0^{\frac{1}{3\sqrt{4-x^2}}} \int_{x^2+y^2}^{4-8y^2} dz dy dx. \quad (15)$$

3. Solve the following:

$$(a) (x^3 + y^2 \sqrt{x^2 + y^2}) dx = xy \sqrt{x^2 + y^2} dy. \quad (14)$$

$$(b) \frac{dy}{dx} + \frac{y}{x} \ln y = \frac{y}{x^2} (\ln y)^2. \quad (16 \frac{2}{3})$$

$$(c) (12y + 4y^3 + 6x^2) dx + 3(x + xy^2) dy = 0. \quad (16)$$

$$4. (a) \text{ Solve: } (D^3 - 3D^2 + 4D - 2)y = e^x + \cos x. \quad (14)$$

$$(b) \text{ Solve the homogeneous linear differential equation } 2x^2 y'' - xy' + y = 4 \sin(\ln x) \quad (16)$$

$$(c) \text{ Solve the differential equation } (x+1) \frac{d^2 y}{dx^2} + (x-1) \frac{dy}{dx} - 2y = 0 \text{ by the method of factorization of operator.} \quad (16 \frac{2}{3})$$

MATH 143**SECTION – B**

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

5. Solve the following partial differential equations:

$$(a) \ x(x+y)p - y(x+y)q + (x-y)(2x+2y+z) = 0. \quad (15)$$

$$(b) \ (p^2 + q^2)x = pz \quad (15)$$

$$(c) \ \text{Find the integral surface of } px^2 + qy^2 + z^2 = 0 \text{ which passes through the hyperbola} \\ xy = x + y, z = 1 \quad (16\frac{2}{3})$$

6. Solve the following:

$$(a) \ (D_x^2 - D_x D_y - 2D_y^2)z = (y-1)e^x \quad (15)$$

$$(b) \ (D_x^3 - 2D_x^2 D_y - D_x D_y^2 + 2D_y^3)z = e^{x+y} \quad (15)$$

$$(c) \ (x^2 D_x^2 - 2xy D_x D_y + y^2 D_y^2 - x D_x + 3y D_y)z = \frac{8y}{x} \quad (16\frac{2}{3})$$

7. Show the following

$$(a) \ J'_n(x) = \frac{1}{2}[J_{n-1}(x) - J_{n+1}(x)] \quad (15)$$

$$(b) \ \int_0^1 x^3 J_0(ax) dx = \frac{a^2 - 4}{a^3} J_1(a) + \frac{2}{a^2} J_0(a) \quad (16\frac{2}{3})$$

$$(c) \ nP_n(x) = xP'_n(x) - P'_{n-1}(x) \quad (15)$$

$$8. (a) \ \text{Show that } \int_{-1}^1 x^2 P_{n-1}(x) P_{n+1}(x) dx = \frac{2n(n+1)}{(2n+3)(2n-1)(2n+1)} \quad (16\frac{2}{3})$$

$$(b) \ \text{Solve the following differential equation in series by the method of Frobenius:} \quad (30)$$

$$9x(1-x)\frac{d^2y}{dx^2} - 12\frac{dy}{dx} + 4y = 0.$$

SECTION – A

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

1. (a) (i) Construct a truth table for the expression $(p \rightarrow q) \vee (\neg p \rightarrow q)$ (5×4=20)
- (ii) Write the following proposition in the form “p if and only if q” in English.
- (iii) State the converse, contrapositive and inverse of the following conditional statement “When I stay up that it is necessary that I sleep until noon.”
- (iv) What conclusion can you draw from the following statement:
The nth statement in a list of 100 statements is “Exactly n of the statements in this list are false.”
- (v) Translate the following statement into propositional logic using the propositions provided. You can graduate only if you have completed the requirements of your major and you do not owe money to the university and you do not have an overdue library book. Express your answer in terms of the following:
g : “You can graduate.” m : “You owe money to the university,”
r : “You have completed the requirements for your major,”
b : “You have an overdue library book.”
- (b) (i) Let P(x), Q(x) and R(x) be the statements “x is a clear explanation.” “X is satisfactory.” And “X is an excuse.” Respectively. Suppose that the domain for x consists using quantifiers, logical connectives, and P(x), Q(x) and R(x). (5×3=15)
- All clear explanations are satisfactory. Some excuses are unsatisfactory, some excuse are not clear explanations.
- Does the third follow from the first two?
- (ii) Use quantifiers and predicates to express the fact that $\lim_{x \rightarrow a} f(x)$ does not exist. Where f(x) is a real-valued function of a real variable x, and a belongs to the domain of f.
- (iii) Prove that if n is an integer and $5n + 2$ is odd, then n is odd.
2. (a) Prove that there exist irrational numbers x and y that x^y is rational. (7×5=35)
- (b) Prove that there is no positive integer n such that $n^2 + n^3 = 100$.
- (c) Prove that $\sqrt[3]{2}$ is irrational.
- (d) Find the value of $\sum_{j=1}^n j^2$
- (e) Define function, inverse function, 1 to 1 function and onto functions with examples.

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3. (a) Write down the algorithm for modular exponentiation. Find the value of $3^{644} \pmod{645}$. (20)
- (b) Prove that every positive integer can be uniquely factorized. (15)
4. (a) Find the minimum x that satisfies $x \equiv 2 \pmod{3}$, $x \equiv 3 \pmod{5}$, $x \equiv 1 \pmod{7}$ (15)
- (b) The encrypted message is 09810461. What is the decrypted message if it was encrypted using the RSA cipher ($n = 43.59$ and exponent 13)? (20)

SECTION – B

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

5. (a) Let $A = \{ 1, 2, 3, 4, 5 \}$ be a set. Give an example of a relation R on A that is (12)
- (i) reflexive and symmetric but not transitive.
- (ii) reflexive and transitive but not symmetric
- (iii) Symmetric and transitive but not reflexive. (Give the digraph for (i), (ii), (iii) also.
- (b) There are pre requisites for the following courses. How many ways can the courses be taken sequentially? (Draw Hasse Diagram.) (13)

Courses	Pre requisits.
A -	B, C
B-	G
C-	None
D-	A, F
E-	None
F-	B, E
G-	None

- (c) Using Warshall's algorithm find the transitive closure of relation $R = \{(a,a), (a,b), (b,a), (c,b), (c, c), (d,b), (d,c), (d,d)\}$ on $\{a, b, c, d\}$ (show the steps.) (10)
6. (a) Let $R = \{s, t, x, y\}$ and $(R, +, \cdot)$ is defined by the following tables: (12)

+	s	t	x	y
s	y	x	s	t
t	x	y	t	s
x	s	t	x	y
y	t	s	y	x

·	s	t	x	y
s	y	y	x	x
t	y	y	x	x
x	x	x	x	x
y	x	x	x	x

Does $(R, +, \cdot)$ form a ring?

- (b) Find and solve recursive definition for finding the determinant D_n given by – (13)

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Contd ... Q. No. 6(b)

$$\begin{vmatrix} b & b & 0 & 0 & 0 & 0 \\ b & b & b & 0 & 0 & 0 \\ 0 & b & b & b & 0 & 0 \\ 0 & 0 & b & b & b & 0 \\ & & & b & b & b & 0 \\ & & & 0 & b & b & b \\ & & & 0 & 0 & b & b \end{vmatrix}, \text{ (for } n \times n \text{ and } b \in \mathbb{R}^+ \text{)}$$

(c) In a communication channel words of length n are to be transmitted using symbols $\{a; b, c\}$ with the condition that no word will be transmitted in which two 'a' appear consecutively. Find the number of allowed words using recursion. (10)

7. (a) For the first six weeks of the last year of "B.Sc. Engineering" degree programme Rina sends at least on resume each day but no more that 60 resumes in total. Show that there is a period of consecutive days during which she sends exactly 23 resumes. (State the underlying theory of your solution.) (8)

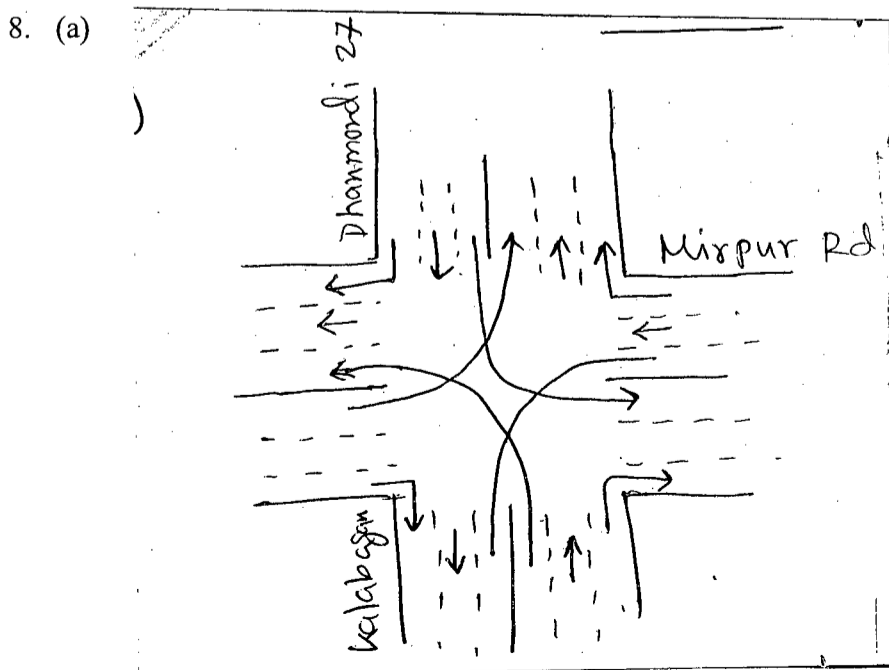
(b) For $1 \leq m \leq t$, the number of elements in S . that satisfy exactly m of the conditions c_1, c_2, \dots, c_t is given by –

$$S_m - \binom{m+1}{1} S_{m+1} + \binom{m+2}{2} S_{m+2} - \dots + (-1)^{t-m} \binom{t}{t-m} S_t,$$

where S_n means the total number of elements satisfying the n conditions (Prove the above statement). (12)

(c) A robotic machine inserts letters into envelopes. What is the probability that in a group of 100 letters, (i) no letter is put into the correct envelope? (ii) exactly 1 letter is put into the correct envelope?

(iii) exactly 98 letters are put into the correct envelope? (Use derangements.) (15)



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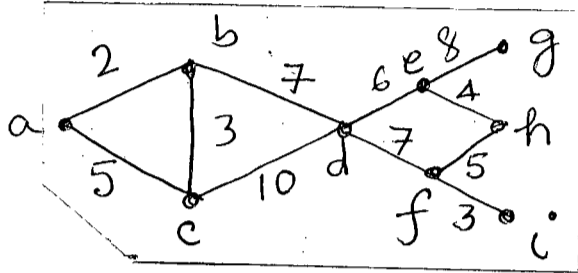
Contd ... Q. No. 8(a)

For the above traffic flows, design a traffic signal pattern in the intersection (Use graph coloring)

(15)

(b) Prove that $r = e - v + 2$ for a connected planar graph G with e edges, v vertices and r regions.

(7)



(c) (i) Find the minimum cost connections if you start from 'a'. (Use "Kruskal's" Algorithm)

(ii) Find the tree for next player's turn for

0	x
	x

Player 1 starts first with 'x'.

(13)



BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2014-2015

Sub : **CSE 105** (Structured Programming Language)

Full Marks : 210

Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – AThere are **FOUR** questions in this Section. Answer any **THREE**.

Please read carefully, some questions might have additional restrictions such as not allowing the use of any library functions except the I/O related ones.

1. (a) State whether the following relational expressions are true or false: (6)
- (i) 'A' - 'Z' == 'a' - 'z'
- (ii) '0' == 0
- (iii) (x > 0) && (x <= 0)
- (v) ~(x (~x)) == 0
- (b) The modulus operator (%) can be used to find remainder when an integer x is divided by another integer y. Show how we can find the remainder without using modulus operator. You can use any other mathematical operators as many times as needed. (6)
- (c) Write a short function **upcase(ch)** which accepts a character parameter *ch*, and returns the same character unless it is a lowercase ASCII character. If it is a lowercase ASCII character, the function returns the equivalent uppercase ASCII character. In the function you can only use *switch-case* statement to solve the problem (i.e., **no if else, no library function**). (8)
- (d) July, 20, 1973 is a FRIDAY. There is a formula to find day of the week for a particular date. Zeller's congruence is an algorithm developed by Christian Zeller to calculate the day of the week. The formula is as follows: (15)

$$h = \left(q + \left\lfloor \frac{26(m+1)}{10} \right\rfloor + y + \left\lfloor \frac{y}{4} \right\rfloor + 6 \times \left\lfloor \frac{y}{100} \right\rfloor + \left\lfloor \frac{y}{400} \right\rfloor \right) \% 7$$

Where, h is the day of week (0: Saturday, 1: Sunday, 2: Monday, 3: Tuesday, 4: Wednesday, 5: Thursday, 6: Friday).

q is the day of the month

m is the month (3: March, 4: April, 12: December). January and February are counted as months 13 and 14 of the previous year.

y is the year.

$\lfloor \rfloor$ is called floor operator. When it is applied to a fractional number x it returns the largest integer not exceeding x. For example, $\lfloor 2.3 \rfloor = 2$, $\lfloor 2.7 \rfloor = 2$ and $\lfloor 2.0 \rfloor = 2$

NOTE: In this algorithm January and February are counted as months 13 and 14 of the previous year. E.g. if it is February 2, 2010, the algorithm counts the date as the second day of the fourteenth month of 2009 (02/14/2009 in DD/MM/YYYY format). Write down a program that takes year, month and day of the month as input and prints the day of the week.

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2. (a) Most of the positive integers can be expressed as a sum of two prime integers. For example, 9 can be expressed as a sum of 2 and 7 both of which are prime numbers. However, there are some numbers which cannot be expressed, for example 11. Write down a C program that will take an integer n as input and check whether n can be expressed as a sum of two prime numbers or not. (11)

(b) Write down a function **void remove (int A[], int N, V)** that searches if V exists in the array A of N integers and removes the first occurrence of V , shifting each following elements to the left and adding a zero at the end of the array. (12)

(c) A degree n -polynomial of the form: (12)

$$p(x) = a_0 + a_1x + a_2x^2 + \dots + a_ix^i + \dots + a_nx^n$$

can be evaluated efficiently using a technique known as Horner's rule. Horner's rule avoids computing the numerous x_i values explicitly, by rewriting and evaluating $p(x)$ in the following form:

$$p(x) = a_0 + x \times (a_1 + x \times (a_2 + x \times (\dots (a_i + x \times (\dots (a_{n-1} + x \times (a_n)) \dots)) \dots)))$$

Complete the definition of the function horner with the following prototype:

```
double horner (double a[], int n, double x);
```

so that it uses Horner's rule to evaluate a polynomial. The first parameter is an array of coefficients of the polynomial, the second is the degree of the polynomial, and the third is the value of x at which the polynomial is to be evaluated. The array a has $n + 1$ elements, corresponding to $a_0, a_1 \dots, a_n$.

3. (a) Create a function **int bitparity(int x)** that takes an integer x as parameter and returns 1 if there is an odd number of 0's in the bit form of x , and 0 otherwise. You must use bitwise operator(s) to solve the problem. (10)

(b) Write down a function **void matchbits(int x, int y)** that takes two integer x and y and prints the position of each bit of x in which a match occurs with the bit of y . You must use bitwise operator(s) to solve the problem. (13)

(c) Create a function **setbit(x,p)** that sets the bit of integer x to 1 at the position p and returns x , leaving other bits unchanged. Similarly, create another function **resetbits(x,p)** that resets that bit of x to 0 at the position p and returns. Using the above functions write two other functions **setbit(x,p,n)** and **resetbits(x,p,n)** that sets/resets n bits of x starting from position p and returns x . (12)

4. (a) The n^{th} Fibonacci number, for any positive integer n , is given as: (10)

$$f(n) = 1, \text{ if } n = 1 \text{ or } n = 2$$

$$f(n) = f(n-1) + f(n-2), \text{ otherwise}$$

So, the first 7 Fibonacci numbers are: 1, 1, 2, 3, 5, 8, 13

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Contd ... Q. No. 4(a)

Write down a function **checkFibonacci(n)** which returns 1 if the parameter n is a Fibonacci number and 0 otherwise.

CheckFibonacci(8) should return 1,

CheckFibonacci(21) should return 1,

CheckFibonacci(7) should return 0,

(b) Consider the following enigma (n) function. What will be the output if we execute enigma (13) from the main function? In one sentence state what the function does? **(4+3)**

```
void enigma (int n) {
    if (n != 0)
        enigma(n/2);
    printf("%d", n%2);
}
```

(c) Calculate the value of f (4) for the following recursive function definition: **(6)**

$$f(0) = 1$$
$$f(n) = n \times f(n - 1) + n$$

(d) Write a recursive C function named count, the prototype of which is given below, that returns the number of occurrences of a character c in a string s. For example, **(12)**

count("Toronto", 't') should return 1,

count("Toronto", 'o') should return 3,

Note: You must make use of recursive functions. No credit will be given for a solution that uses while, for- or do-loops.

Prototype: int count (char s [], char c);

SECTION – B

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

5. (a) A substring of a string S is another string S' that occurs in S. For example, "the best of" is a substring of "It was the best of times". Given, 2 strings s and t, you need to detect whether t is a substring of s. Solve this problem by implementing the function declared below. You don't need to write main() or any scanf/printf statements. Note: You cannot use string.h header for this task **(15)**

```
// return 1 if t is a substring of s
// return 0 otherwise
int isSubstring(char *s, char *t);
```

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Contd ... Q. No. 5

(b) The *longest common substring* problem is to find the longest string that is a substring of two strings. For example, the longest common substring of the strings "ABABC", and "BABCAB" is string "BABC" of length 4. Other common substrings are "A", "AB", "B", "BA", "BAB", "ABC", "BC" and "C". Given 2 strings *s* and *t*, you need to find the length of their longest common substring. Solve this problem by implementing the function declared below. You don't need to write `main()` or any `scanf/printf` statements. Note: You cannot use `string.h` header for this task. You can use the functions you implemented in answering question 5(a).

(10)

```
//  
//return the length of longest common substring of s and t  
//  
int longestCommonSubstringLength(char *s, char *t);
```

(c) Using the `qsort()` library function, you need to sort a list of strings lexicographically. Your input contains several lines. Each line contains a string (may contain spaces) of length no more than 32 characters. Process the input until the end of file is reached. The total number of strings will not exceed 150. After sorting, print out the strings according to the sort order. Recall that the `qsort()` library function has the following prototype:

(10)

```
void qsort(  
    void *Base,  
    unsigned int NumOfElements,  
    unsigned int SizeOf Elements,  
    int (*PtFuncCompare)(const void *, const void *)  
);
```

6. (a) Consider the following code. The function `doubleGlobalX()` updates the value of *x* to $2*x$, and returns the value to the caller. The intention of macro "abs" is to produce the absolute value of its parameter. What will be the output of this program when user inputs -5 and 5 respectively? Explain your answer.

(5)

```
#include <stdio.h>  
#define abs(x) (x < 0 ? - x : x)  
int x;  
int doubleGlobalX()  
{  
    x *=2;  
    return x;  
}  
  
in main()  
{  
    scanf("%d", &x);  
    printf("%d\n", abs(doubleGlobalX()));  
    return 0;  
}
```

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Contd ... Q. No. 6

(b) You need to implement a method to print integer co-ordinates of a point in an n-dimensional space. The prototype of the method should be:

(10)

```
void printPoint(int n, ...)
```

To print the point (5, 3) in the 2D space, we call *printPoint(2, 5, 3)*. For printing the point(10, 7, 8) in the 3D space, we call *printPoint(3, 10, 7, 8)* and so on.

(c) Implement a method called *diagonalsSum* that returns the sum of the elements of the 2 diagonals of an $n \times n$ matrix. Design the parameter list appropriately. Additionally, write necessary main function to take n as input ($1 \leq n \leq 10$), followed by the elements of the matrix row by row. Then call *diagonalsSum* to produce the desired sum and print it out to console. Do not use any global variables.

(15)

(d) You are given an unsigned integer as input. Using its bit pattern to represent a floating point number, can you produce the corresponding floating point value? Write necessary code and explain.

(5)

7. You need to write some code for a banking system. In this system, there is a structure called *AccountBalance* to hold the account id (integer) and balance (double precision floating point). The structure is used to read account balance information from file and store in memory as needed, and vice versa. The total number of accounts is defined in a constant N. The accounts are identified by integers from 1 to N.

Today's opening balance information of all accounts is stored in a binary file called "*dayOpeningBalance.dat*" The file contains the data of the accounts in increasing order of account id. For each account, it stores an *AccountBalance* structure. Another binary file, called "*currentBalance.dat*" has the same format as the former file, but contains the current balance (instead of opening balance) for each account. Additionally, each transaction is logged into a text file called "transactions.log". In this file, each line contains an account id, followed by an amount (double precision floating point) that was added (positive number) to or deducted from (negative number) the account in a transaction. Obviously, there can be multiple transactions for an account in the log file. (5+10+5+15)

(i) Write the definition of *AccountBalance* structure. What would be the size of it in bytes?

(ii) Write a program that reads from console an account id, and outputs the opening and current balance of the corresponding account. For efficiency, you *must* use random access, instead of sequential access of the files. You may assume that the input account id is valid.

(iii) In the above scenario, instead of reading the account id from console, read it as a command line argument and write necessary code to obtain the account id as an integer. (You don't need to rewrite the parts of reading/printing the balances)

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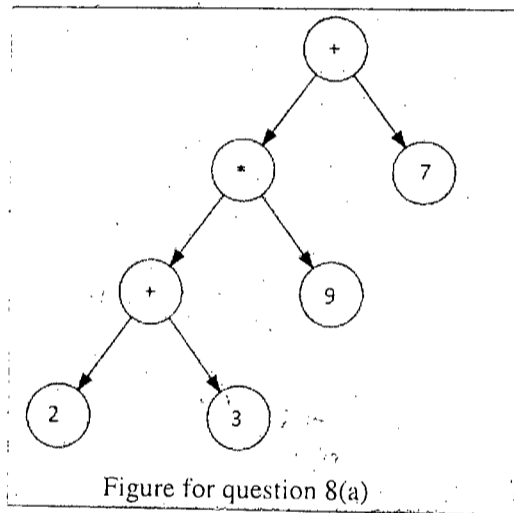
Contd ... Q. No. 7(c)

(iv) Write a program that processes all the recorded transactions to check that the current balance of each account is consistent, For example, if opening balance of account# 1 is 4000 and there are 2 transactions in the log for account# 1 which are “1 2000” and “1 - 1000” then the current balance of the account must be 5000. For each account, your code should print the account id, followed by “Account state is consistent state” or “Account state is inconsistent”.

8. (a) A binary expression tree is a specific kind of a binary tree used to represent expressions. The leaves of the binary expression tree are operands, such as constants or variable names, and the other nodes contain operators. Assume the set of possible operators are {‘+’, ‘-’, ‘*’, ‘/’}. The set of possible operands are [‘0’- ‘9’]. See the figure below, which is the binary expression tree for the expression (in in-fix notations):

$((2+3)*9)+7$

(20)



The input contains several lines to describe an expression tree, until the end of file. Each line describes a node of the tree. Such a line starts with a sequence of ‘L’ and ‘R’'s, that represents the turns (left or right) you have to make to reach the node, starting from the root. The final character represents the content of the node – either an operand or an operator. It is guaranteed that a child node’s description never comes ahead of its parent node. Also, there are no unary operators used in the expression. For the given figure, the input would be:

- +
- L*
- R7
- LL+
- LR9
- LLL2
- LLR3

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Contd ... Q. No. 8(a)

Given description of a particular binary expression tree, you need to construct it using self referential data structure (i.e. a structure definition which includes at least one member that is a pointer to the structure of its own kind). Store the root of the tree in a local variable called root.

Do not use global variables.

(b) Postfix notation is a mathematical notation in which every operator follows all of its operands. An expression in postfix notation is parenthesis-free. For example, for the infix expression $((2+3)*9)+7$, the expression in postfix notation is: $2\ 3\ +\ 9\ *\ 7\ +$. Using the expression tree, constructed in 8(a) and represented by the variable root, write necessary code to produce the expression in postfix notation. There should be a space printed after printing each operator/operand.

(10)

(c) Define a bit field called Flags which consists of the following fields:

(5)

- flag_1, consisting of 4 bits.
- flag_2, consisting of 2 bits.
- flag_3, consisting of 2 bits.

Then, write code to read the values for those flags from console.

SECTION – AThere are **FOUR** questions in this Section. Answer any **THREE**.

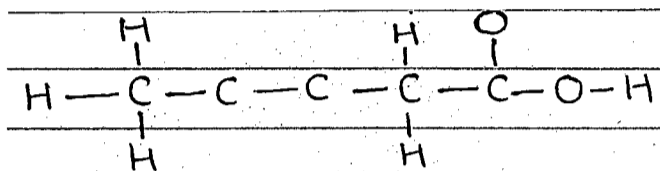
1. (a) Give a brief description of the wave nature of light. What are the two main characteristics of light wave? (4)
 - (b) In your own words, explain the photoelectric effect. (4)
 - (c) Give the equation that relates wave-particle properties of light. Explain the meaning of each symbol in the equation. (4)
 - (d) The binding energy of an electron in a metal surface is 5.86×10^{-19} J. (6)
 - (i) Calculate the minimum frequency of light required to release electrons from the metal. (ii) Calculate the kinetic energy of the ejected electron if light frequency $2.00 \times 10^{15} \text{ s}^{-1}$ is used for irradiating the metal ($h = 6.63 \times 10^{-34} \text{ J.s}$)?
 - (e) The electron in the hydrogen atom makes a transition from an energy state of principal quantum numbers n_i to the $n = 2$ state. If the photon emitted has a wavelength of 434 nm, what is the value of n_i ? ($R_H = 2.18 \times 10^{-18} \text{ J}$) (7)
 - (f) Describe how you build up the detailed electron configuration with the help of all four quantum numbers. (10)
2. (a) What is meant by the term “Effective nuclear charge (Z_{eff})” in an atom? Using the Sodium ($z = 11$) atom as an example, describe the effect of shielding on the 1st ionization energy. (4)
 - (b) An atom of a certain element has 14 electrons, (i) What is the ground-state configuration of the element? (ii) Are the atoms of this element diamagnetic or paramagnetic? (4)
 - (c) Draw a rough sketch of a periodic table (no details are required). Indicate where alkali metals, chalcogens and halogens are located. Write the name and symbol for an element in each of these groups. (0)
 - (d) Explain with figure, how each of these properties of the representative elements generally increases or decreases across the periodic table: (i) atomic size (ii) electron affinity (iii) ionization energy (iv) metallic character (v) acidity of oxides. (12)
 - (e) List all ions and neutral atoms that are isoelectronic with Ne [$z = 10$]. (5)

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3. (a) What is lattice energy and what role does it play in the stability of ionic compound? Explain how the lattice energy of an ionic compound such as KCl can be determined using the Born-Haber cycle. (12)

(b) What is a polar covalent bond? Draw Lewis structure of two compounds that contain one or more polar covalent bonds. (5)

(c) Complete the Lewis structure for the simple organic molecule whose skeletal structure is shown below. Add multiple bonds and lone pairs as needed BUT NO ADDITIONAL ATOMS. Then list the total number of sigma, pi bonds and lone pairs (6)

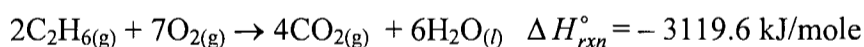
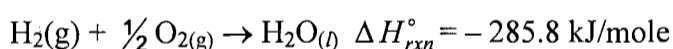
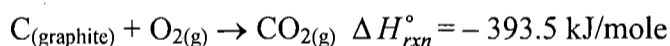


(d) In the trigonal bipyramidal arrangement for a system AB₄E, why does the lone pair occupy an equatorial position rather than an axial position? Sketch the bond moments and resultant dipole moments for the following molecules: H₂O, PCl₃, XeF₄, PCl₅, SF₆ (12)

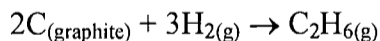
4. (a) (i) Sketch the shapes of the following molecular orbitals σ_{1s} , σ_{1s}^* , π_{2p} and π_{2p}^* .
 (ii) Describe the bonding scheme in the C₂²⁻ ion in terms of molecular orbital theory. Compare the bond order in C₂²⁻ with that in C₂. (12)

(b) Define these terms: Open system, closed system, isolated system, exothermic process, endothermic process. Explain the sign conventions in the equation $\Delta E = q + W$ (10)

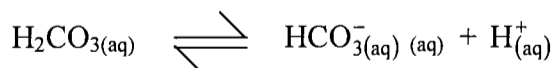
(c) From the following data, (8)



Calculate the enthalpy change for the reaction



(d) The p^H of a bicarbonate-carbonic acid buffer is 8.00. Calculate the ratio of the concentration of carbonic acid (H₂CO₃) to that of the bicarbonate ion (HCO₃⁻). (5)



$$K_{a_1} = 4.2 \times 10^{-7}$$

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SECTION – B

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

Use the attached data sheet to answer questions 5 and 8. Appendixes

5. (a) Define hydration energy and lattice energy. How do they determine the solubility of an ionic solid in water? (6)
- (b) What are colligative properties? What is the meaning of the word “Colligative” in this context? Use a phase diagram to show the difference in freezing point and boiling point between an aqueous urea solution and pure water. (10)
- (c) A 9.66-g sample of a compound with the empirical formula C_5H_4 is dissolved in 284 g of benzene. The freezing point of the solution is $1.37^\circ C$ below that of pure benzene. What are the molar mass and molecular formula of this compound? (8)
- (d) The osmotic pressure of blood is about 7.4 atm. What is the approximate concentration of a saline solution (NaCl) a physician should use for intravenous injection? Use $37^\circ C$ for physiological temperature. (6)
- (e) What is coagulation? Arsenic (iii) sulfide forms a sol with a negative charge. Which of the following ionic substances should be most effective in coagulating the sol? (5)
- (i) KCl (ii) $MgCl_2$ (iii) $Al_2(SO_4)_3$ (iv) Na_3PO_4 Explain your answer.

6. (a) What are the four variables or factors that can affect the rate of reaction? Which of the factor(s) affect the magnitude of the rate constant? Which factor(s) do not affect the magnitude of the rate constant? Why? (8)
- (b) The reaction of thioacetamide with water is shown by the equation below: (8)



The rate of reaction is given by the rate law:

$$\text{Rate} = k[H_3O^+][CH_3CSNH_2]$$

Consider 1L of solution that is 0.20 M in CH_3CSNH_2 and 0.15 M in HCl at $25^\circ C$.

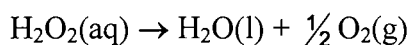
- (i) For each of the changes listed below, state whether the rate of reaction increases, decreases, or remains the same. Why?
- (A) A 4-g sample of NaOH is added to the solution.
- (B) 500 mL of water is added to the solution.
- (ii) For each of the changes listed below, state whether the magnitude of the rate constant k will increase, decrease or remains the same.
- (A) A catalyst is added to the solution.
- (B) The reaction is carried out at $10^\circ C$.
- (c) The following values of the rate constant were obtained for the decomposition of nitrogen dioxide at various temperatures. (10)

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Temperatures (°C)	k(L/mol.s)
320	0.527
330	0.776
340	1.121
350	1.607

Keeping Arrhenius equation in your mind determine the activation energy. Use graph paper where it is necessary.

(d) The decomposition of hydrogen peroxide is a first-order reaction: (3×3=9)

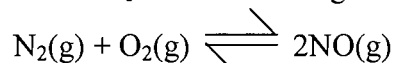


The half life of the reaction is 17.0 minutes.

- (i) What is the rate constant of the reaction?
- (ii) If you had a bottle of H_2O_2 , how long would it take for 86.0% to decompose?
- (iii) If you started the reaction with $[\text{H}_2\text{O}_2] = 0.100 \text{ M}$, what would be the H_2O_2 concentration after 15.0 minutes?

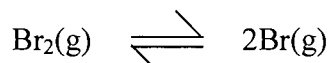
7. (a) Define reaction quotient. How does it differ from equilibrium constant? What are the uses of reaction quotient? (3+2+3=8)

(b) The equilibrium constant K_c of the following reaction equals 4.6×10^{-31} at 25°C . (4+5=9)



- (i) What does the magnitude of K_c tell you about the reaction? Interpret K_c qualitatively.
- (ii) If you assume that the concentrations of N_2 and O_2 are 1.0 M , find the concentration of NO . Comment on the concentration you obtained.

(c) At 128°C the equilibrium constant (K_c) for the reaction



is 1.1×10^{-3} . If the initial concentrations are $[\text{Br}_2] = 6.3 \times 10^{-2} \text{ M}$ and $[\text{Br}] = 1.2 \times 10^{-2} \text{ M}$, calculate the concentrations of these species at equilibrium. (10)

(d) List four factors that can shift the position of an equilibrium. Which one can alter the value of the equilibrium constant? Why? (4+4=8)

8. (a) State Kohlrausch's law and Ostwald's dilution law for strong and weak electrolytes, respectively. How can you use these two equations to determine the limiting values of the molar conductivity of solutions? (4+5=9)

(b) Briefly explain how you can use molar conductivity data to calculate acidity constant of an weak acid. (5+(3×3)=14)

The molar conductivity of $0.0100 \text{ M CH}_3\text{COOH}(\text{aq})$ at 25°C is $\Lambda_m = 1.65 \text{ msm}^2\text{mol}^{-1}$. (i) calculate the limiting molar conductivity of $\text{CH}_3\text{COOH}(\text{aq})$ using the data table B provided in the Appendixes.

CHEM 113**Contd ... Q. No. 8(b)**

- (ii) Calculate the degree of deprotonation, α .
- (iii) Calculate the acidity constant, K_a .
- (c) Draw the phase diagrams of water and carbon dioxide. Why does water's phase diagram have a solid-liquid boundary line with a negative slope? Which one of H_2O and CO_2 will sublime at room temperature and pressure? Why?

(6+3+3=12)**Appendixes - Chem 113****Appendix A. Boiling-Point-Elevation Constants (K_b) and Freezing-Point-Depression Constants (K_f)**

Solvent	Boiling Point (°C)	Freezing Point (°C)	K_b (°C/m)	K_f (°C/m)
Acetic Acid (CH_3COOH)	118.5	16.60	3.08	3.59
Benzene (C_6H_6)	80.2	5.455	2.61	5.065
Camphor ($C_{10}H_{16}O$)	---	179.5	---	40
Carbon disulfide (CS_2)	46.3	---	2.40	---
Cyclohexane (C_6H_{12})	80.74	6.55	2.79	20.0
Ethanol (C_2H_5OH)	78.3	---	1.07	---
Water (H_2O)	100.000	0.000	0.512	1.858

Appendix B. Limiting ionic conductivities in water at 298 K, λ /(mS m² mol⁻¹)

Cations	λ	Anions	λ
Ba^{2+}	12.72	Br^-	7.81
Ca^{2+}	11.90	$CH_3CO_2^-$	4.09
Cs^+	7.72	Cl^-	7.635
Cu^{2+}	10.72	ClO_4^-	6.73
H^+	34.96	CO_3^{2-}	13.86
K^+	7.350	$(CO_3)_2^{2-}$	14.82
Li^+	3.87	F^-	5.54
Mg^{2+}	10.60	$[Fe(CN)_6]^{3-}$	30.27
Na^+	5.010	$[Fe(CN)_6]^{4-}$	44.20
$[N(C_2H_5)_4]^+$	3.26	HCO_3^-	5.46
$[N(CH_3)_4]^+$	4.49	I^-	7.68
NH_4^+	7.35	NO_3^-	7.146
Rb^+	7.78	OH^-	19.91
Sr^{2+}	11.89	SO_4^{2-}	16.00
Zn^{2+}	10.56		

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE** including Q. No. 1 as compulsory.

1. (a) Explain with reference to the context any two of the following: (15)
- (i) I thought I had blood of a man on his hands all these years.
- (ii) “We want to be rescued; and of course we shall be rescued.”
- (iii) I rounded the hut and saw a man’s dead body sprawling in the mud.
- (b) Answer any one of the following: (15)
- (i) Sketch the characters in “Shooting an Elephant”.
- (ii) What is the significance of the title “The Use of Philosophy”? How does the title relate to the text?
- (c) Answer any three of the following: (15)
- (i) Describe the climax scene of the story “An Astrologer’s Day.”
- (ii) Why does Jack want an army?
- (iii) How did the Burmese affect Orwell as a white man in Burma?
- (iv) Narrate the king’s story in “The Use of Philosophy.”
- (v) How is Guru Nayak defeated twice by the Astrologer?
- (vi) How and why do the boys start the fire?
2. (a) Recast and correct any ten of the following sentences: (15)
- (i) The water will reflect your face if the sun is shining dim.
- (ii) Somewheres, there must be an answer.
- (iii) These lines are more nearly parallel than those.
- (iv) This is Mr. Kamal, who serves as my assistant, and who handles all matters of publicity.
- (v) Roby is a professional automobile mechanic.
- (vi) I suspect that Mariam is quite capable of filling the role.
- (vii) A fatality is where someone has been killed.
- (viii) We suppose buy that house.
- (ix) We are certain that he will get over from his illness.
- (x) I do not like to hear a fire whistle blow because they really upsets me.
- (xi) Minar could of had five more helpers.
- (xii) Diana’s snging is vital to the success of the show.

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Contd ... Q. No. 2

(b) Give the meaning of and make a sentence with any ten of the following words: (15)

Acrid, Blithe, Conjecture, Denigrate, Entice, Flicker, Gust, Incisive, Malign, Obstinate, Steadfast, Prevalent.

3. Amplify the idea in any one of the following: (30)

- (i) Action speaks louder than words.
- (ii) Guilty conscious needs no accuser.

4. Write a précis of the following: (30)

The spirit of our liberation war has been found difficult to define. Much has been said about it, not without creating confusion. In substance it is a combination of an expectation of a social revolution embodying secularism and a hope for moving towards socialism through democracy. The Constitution of 1972 has in it the pledge of translating that spirit into reality. The basic state principles enunciated in it, we recall, were secularism, democracy and socialism along with nationalism. During our onward collective journey the ruling classes have found it necessary to introduce corrections in the principles of secularism and socialism, have raised controversies over the definition of nationalism, and failed to practice democracy worthy of its name. This has happened not because the people have changed. They remain where they were with their old hopes and miseries, but the ruling class that was at the official leadership of the liberation war has taken up an anti-people role. The people wanted a democratic transformation of the society but the rulers desired to get rich as quickly as possible. The rulers were in a hurry. There was in them the feeling that much time has been lost and no further delay should be permitted. The rulers and the ruled began to work at cross purposes and as the former continued to rise the latter remained where they were. In economic terms, the new rulers belonged to the petit bourgeois striving to acquire bourgeois status in material wealth if not in intellectual culture. The independence of Bangladesh has opened for the petit bourgeois avenues to rise, and that class is making full use of all opportunities – legal as well as illegal – of getting rich to the detriment of the well-being of the common man, without whose active participation, full commitment and untold sacrifice it would have been impossible to drive away the Pakistani hordes. The pro-liberation intellectuals should have stood against the destructive process; but they have failed. Some of those who could have been active in the field were killed by the Al-badars; some have turned indifferent. Quite a few – both the potential and the active – have left the country. Others are working as collaborators of the rulers, contributing to the safe continuation of the social and political system.

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SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE** including Q. No. 5 as compulsory.

5. Read the passage carefully and answer the questions that follow:

(45)

Is it possible to persuade mankind to live without war? War is an ancient institution which has existed for at least six hundred years. It was always wicked and usually foolish, but in the past the human race managed to live with it. Modern ingenuity has changed this. Either Man will abolish war, or war will abolish Man. For the present, it is nuclear weapons that cause the gravest danger, but bacteriological or chemical weapons may, before long, offer an even greater threat. If we succeed in abolishing nuclear weapons, our work will not be done. It will never be done until we have succeeded in abolishing war. To do this, we need to persuade mankind to look upon international questions in a new way, not as contests of force, in which the victory goes to the side which is most skilful in massacre, but by arbitration in accordance with agreed principles of law. It is not easy to change age-old mental habits, but this is what must be attempted.

There are those who say that the adoption of this or that ideology would prevent war. I believe this to be a profound error. All ideologies are based upon dogmatic assertions which are, at best, doubtful, and at worst, totally false. Their adherents believe in them so fanatically that they are willing to go to war in support of them.

The movement of world opinion during the past two years has been largely such as we can welcome. It has become a commonplace that nuclear war must be avoided. Of course, very difficult problems remain in the international sphere, but the spirit in which they are being approached is a better one than it was some years ago. It has begun to be thought, even by the powerful men who decide whether we shall live or die, that negotiations should reach agreement even if both sides do not find these agreements wholly satisfactory. It has begun to be understood that the important conflict nowadays is not between East and West, but between Man and the H-bomb.

- (i) What is the writer's view on modern war?
 - (ii) What are the writer's suggestions for abolishing war?
 - (iii) What does the writer say about ideologies?
 - (iv) How does the writer organise his ideas?
 - (v) Write a brief summary of the passage.
6. (a) What is a letter of complaint? What are the main points you to focus while writing a letter of complaint?
- (b) Suppose, you are the Managing Director of a company. Now, write a letter of recommendation for an ex-employee who is seeking employment.

(5)

(15)

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Contd ... Q. No. 6

- (c) Write phonetic transcriptions of the following words (any five): (10)
Court, anger, poster, teacher, beautiful, student.
7. (a) Write down the differences between quotation and tender. (5)
(b) Write a dialogue between two friends about how to fight against corruption in Bangladesh. (10)
(c) Write a short essay on any one of the following topics: (15)
(i) Technical Education in Bangladesh
(ii) Facebook : its uses and abuses
(iii) Freedom of Press
8. (a) Transform the following sentences as directed (any five): (10)
(i) At last, they let us go. (make it passive)
(ii) I could picture him at five. (make it complex)
(iii) The car which was repaired by a mechanic was made in Japan. (Make it simple)
(iv) It is shameful that he does not look after his parents. (make it exclamatory)
(v) Besides punishing him, he was fined. (make it compound)
(v) As soon as I completed my exam, the bell rang. (make it negative)
- (b) Write down the front matters of a report mentioning the components of the title page. (5)
(c) Write short notes on any three of the following topics: (15)
(i) Don'ts in a dialogue (ii) Index (iii) Goodwill letter (iv) Inventory report.
-