

Sub : **MATH 147** (Ordinary Differential Equations (ODE), Partial Differential Equations (PDE) and Vector Calculus)

Full Marks : 280

Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

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

1. (a) Find the differential equation corresponding to the family of curves $y = c(x-c)^2$, whose c is an arbitrary constant. (15)
- (b) Solve $\left(x \tan \frac{y}{x} + y\right) dx - x dy = 0$ (15)
- (c) Solve the following initial value problem $x \frac{dy}{dx} - 2y = 2x^4$, $y(2) = 8$. (16 $\frac{2}{3}$)
2. (a) Find the general solution of $\frac{d^2 y}{dx^2} - 2 \frac{dy}{dx} - 3y = 2e^x - 10 \sin x$. (15)
- (b) Solve $x^2 \frac{d^2 y}{dx^2} - 2x \frac{dy}{dx} + 2y = x^3$. (15)
- (c) A capacitor of $\frac{2}{1010}$ Farad, a resistance of 1 Ohm and an inductance of (1/20) Henry are connected in series. At $t = 0$, $i = 0$, charge of the capacitor is 1 Coulomb. Find the charge and current in time $t = .01$ Sec. (16 $\frac{2}{3}$)
3. Solve the following differential equations:
- (a) $(xp + y)^2 = xy$, where $p = \frac{dy}{dx}$. (15)
- (b) $\frac{d^4 y}{dx^4} - \cot x \frac{d^3 y}{dx^3} = 0$. (15)
- (c) $y \frac{d^2 y}{dx^2} - \left(\frac{dy}{dx}\right)^2 = y^3 \log y$. (16 $\frac{2}{3}$)
4. (a) Solve $(x^2 - y^2 - yz)p + (x^2 - y^2 - zx)q = z(x - y)$, where $p = \frac{\partial z}{\partial x}$, $q = \frac{\partial z}{\partial y}$. (15)
- (b) Find the complete and singular integral (if it exists) of $z = px + qy + c\sqrt{1 + p^2 + q^2}$. (15)
- (c) Find the integral surface of the partial differential equation $(x - y)p + (y - z - x)q = z$ through the circle $z = 1$, $x^2 + y^2 = 1$ (16 $\frac{2}{3}$)

Contd P/2

MATH 147(CSE)

SECTION – B

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

5. (a) Solve the following:

$$(i) r + s - 2t = (2x + y)^{1/2} + e^{y+2x} \quad (11\frac{2}{3})$$

$$(ii) x^2 \frac{\partial^2 z}{\partial x^2} - y^2 \frac{\partial^2 z}{\partial y^2} + x \frac{\partial z}{\partial x} - y \frac{\partial z}{\partial y} = \log x \quad (15)$$

(b) Solve the following boundary value problem by the method of separation of variables (20)

$$\frac{\partial u}{\partial t} = 4 \frac{\partial^2 u}{\partial x^2}$$

$$u(0, t) = u(\pi, t) = 0, t > 0$$

$$u(x, 0) = 2 \sin 3x - 4 \sin 5x, 0 < x < \pi.$$

6. (a) Show that any vector \mathbf{r} can be represented as a linear combination of three non coplanar vectors \mathbf{a} , \mathbf{b} , \mathbf{c} . Hence find a linear relation among the vectors $(2, -3, 4)$, $(1, -1, 1)$, $(-1, 1, 1)$ and $(1, 1, 1)$. (20 $\frac{2}{3}$)

(b) Prove that $[\mathbf{a} \times \mathbf{p}, \mathbf{b} \times \mathbf{q}, \mathbf{c} \times \mathbf{r}] + [\mathbf{a} \times \mathbf{q}, \mathbf{b} \times \mathbf{r}, \mathbf{c} \times \mathbf{p}] + [\mathbf{a} \times \mathbf{r}, \mathbf{b} \times \mathbf{p}, \mathbf{c} \times \mathbf{q}] = 0$. (13)

(c) If $\mathbf{r} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$ and $r = |\mathbf{r}|$, prove that $\operatorname{div} \left\{ \frac{f(r)\mathbf{r}}{r} \right\} = \frac{1}{r^2} \frac{d}{dr} \{ r^2 f(r) \}$. (13)

7. (a) Find the equation of the binormal at any point 't' of the curve $x = 3 \cos t$, $y = 3 \sin t$, $z = 4t$. (15)

(b) Define normal and directional derivative. Find the values of the constants a , b , c so that the directional derivative of $\phi = axy^2 + byz + cz^2x^3$ at $(1, 2, -1)$ has a maximum magnitude 64 in the direction parallel to z-axis. (15)

(c) If $\mathbf{F} = (y^2 \cos x + z^3)\mathbf{i} + (2y \sin x - 4)\mathbf{j} + (3xz^2 + 2)\mathbf{k}$, show that $\int_C \mathbf{F} \cdot d\mathbf{r}$ is independent of path. Find the work done in moving an object in the force field \mathbf{F} from $(0, 1, -1)$ to $(\frac{\pi}{2}, -1, 2)$. (16 $\frac{2}{3}$)

8. (a) State Divergence theorem and verify it for $\mathbf{F} = (x + y^2)\mathbf{i} - 2xz\mathbf{j} + 2yz\mathbf{k}$ for the tetrahedron bounded by the coordinate planes and the plane $2x + y + 2z = 6$. (26 $\frac{2}{3}$)

(b) Evaluate $\iint_S (\nabla \times \mathbf{A}) \cdot \mathbf{n} dS$ where $\mathbf{A} = (x^2 + y - 4)\mathbf{i} + 3xy\mathbf{j} + (2xz + z^2)\mathbf{k}$ and S is the surface of the hemisphere $x^2 + y^2 + z^2 = 16$ above the xy plane. (20)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : CSE 107 (Object Oriented Programming Language)

Full Marks : 210

Time : 3 Hours

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**.

All the questions in this section are related to C++ programming language.

1. (a) A class “Date” contains three private variable “day”, “month” and “year”. The users enter the date in Bangladeshi form, e.g., “23/12/2016” but the output of the program display data in Chinese form, e.g., “2016/12/23”. (7×3=21)
 - (i) Define the class along with the constructor;
 - (ii) Write down an extractor function that has the following prompt: Enter a date in Bangladeshi form:
 - (iii) Write down an inserter function generating the following output: Date (Chinese form) is 2016/12/23.

- (b) Create a manipulator named “mystyle” that will print a number in right justified form within a field width of 10, using a precision of five decimal places. An integer is displayed in hexadecimal format and displays a + sign when positive values are displayed.
 Create a program that prints 2 to 100 and the corresponding natural log in a table using the manipulator. (7×2=14)

2. Consider the following class declaration:


```
class Coord{
    int x , y;
    char *pointname;
public:
    -----
    -----
}
```

 - (a) Create necessary constructors to support the following two declarations in the main function: (3×2=6)

```
Coord ob1, ob2, ob3;
Coord ob4(0, 0, “origin”);
```
 - (b) Why does copy constructor work for initialization, but not for assignment? Explain. Create a copy constructor required for the above class declaration. (3+5=8)

CSE 107

Contd ... Q. No. 2

(c) Create necessary methods for supporting following statements in the main function: **(6×3=18)**

```
ob1 = ob2 + ob3 + ob4;
ob1 = 100 + ob2; // increase the values of both x and y by 100
int value = 100 + ob4; // value = 100 +  $\sqrt{(ob4.x)^2 + (ob4.y)^2}$ 
// hints: use conversion function
```

(d) How can you code ++ob1 and ob1++ differently? **(3)**

3. (a) Here is the prototype for a specific version of find() function. Convert it to a generic function. The function searches an array for an object. It returns either the index of the matching object (if one is found) or - 1 if no match is found. **(10)**

```
int find(int object, int *list, int size){
//-----
}
```

(b) Explain different types of casting used in C++ with examples. **(10)**

(c) Why is RTTI a necessary feature of C++? **(5)**

(d) What are the differences between virtual function and pure virtual function? If a class declaration contains a pure virtual function, what is that class called and what restrictions apply to its usage? **(10)**

4. (a) Write an interactive C++ program to maintain an employee database. It has to maintain information such as employee ID, name, qualification, designation, and salary using the standard template called map. The user must be able to access all details about a person by entering employee ID. Note that request for information may come randomly. It has to support an option for creating, updating and deleting an entry of database (in addition to query). **(20)**

(b) Explain why namespace is added to C++. **(5)**

(c) Explain the use of try and catch in C++ with appropriate examples. **(10)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE** questions. All the assumptions in this section are related to Java programming language. Read the constraints/notes mentioned in each question carefully. You *must* adhere to the constraints in answering the respective question. Violation of constraint(s) will result in deduction of full marks.

CSE 107

5. (a) What is a static code block? When is it executed? Can there be multiple static code blocks in a class? In what sequence will the blocks be executed? Show with example. (10)
- (b) What are type wrappers? Why are they used? Explain Autoboxing and Auto-unboxing with examples. (10)
- (c) What is a functional interface? Using lambda expression, implement the functional interface shown in Figure 3 to compute factorial of an input integer. (10)
- (d) When we say “a class is final” or “a method is final” what does that mean? Show example codes to make a class and a method final. (5)
6. (a) You are writing a networked 2 person shooter game. Here, a bullet is modeled by the class shown in Figure 1. When one person shoots, the bullet gets out of his weapon and follows certain calculation model to traverse through the scene. You do not need to worry about the calculation model. During animation, the model continually updates the position of the bullet and sends the updated coordinates to the other person’s machine over the network. This is done by calling *updateBullet()* method of *TwoPersonShooterGame* class. See partial implementation of the class in Figure 2. On the other player’s machine the bullet is rendered accordingly. (3+3+3+11)
- (i) Why does *Bullet* implement *Serializable*?
- (ii) Write a constructor for *TwoPersonShooterGame*. It should have a *Socket* as a parameter and hook up the *_ois* and *_oos* variables to the socket’s input and output streams respectively. The signature of the constructor should not have a throws clause.
- (iii) Add a method in *TwoPersonShooterGame* class to read a bullet object from the network. The method should have the following signature:
- public Bullet receiveBulletFromNetwork()*
- (iv) Once you have completed the tasks of (i) and (ii), the project is complete. However, you observe that in the first person’s machine the bullet is moving through the screen, yet it remains stationary on the second person’s machine. Why is this happening? Show three different solutions for the problem (with code and explanation).
- (b) Write a java program to establish a connection to www.google.com using *HttpURLConnection*. Your program should output the following: (10)
- (i) The request method.
- (ii) The response code.
- (iii) The response message.
- (iv) The keys and values in the response header.
- (c) Why does *Socket* implement *AutoCloseable*? Explain with sample code snippet. (5)

CSE 107

7. (a) You are using a 3rd party package called *Sophisticated* that defines the following classes: (15)

SophisticatedProblemsSolver

SophisticatedProblem

SimpleResult

SophisticatedProblemsSolver has a public method with the following signature.

public SimpleResult Solve(SophisticatedProblem problem)

Your scenario is multi-threaded but you are not sure if *Solve()* is thread-safe or not. The following classes written by you need to use this method:

CompetativeProgrammingProblemsSolver

SoftwareDevelopmentProblemSolver

PassInTheExamsProblemSolver

Each of the above classes needs to interact with the same instance of *SophisticatedProblemsSolver*. The constructors of these classes are passed in a reference of *SophisticatedProblemsSolver* type. Demonstrate a solution to guarantee that your program will be thread-safe. Write necessary code and provide explanations where appropriate (Do not use static variables in your solution. Note: You do not have source code for the package *Sophisticated*)

- (b) Why are *suspend()*, *resume()* and *stop()* methods of *Thread* class deprecated? (5+10)

Demonstrate how you can achieve suspend, resume and stop behaviors in a thread that you have implemented, without using the deprecated methods. Write necessary code and provide explanations where appropriate. Do not use unnecessary/redundant *sleep*, *wait* or *notify* method calls.

- (c) “Oracle recommends that calls to *wait()* should take place within a loop that checks the conditions on which the thread is waiting” –Why? (5)

8. (a) You are given a text file called *MyAnalysisOfStudentsPerformance.txt*. Write necessary code to read each line from the file and print out to the console. However, in your output each line should be prefixed with the line number. Your I/O operations should be efficient. Once you have run your code, you observe (to your surprise) that the first line in the console output is: (10+5)

1. আমার ভয় হচ্ছে তোমরা হয়তো পাস করতে পারবে না!

Here, The “1.” is the line number you added from your code, and the remaining part was the line read from the file. How were you able to read the Bangla text? (Hint: By opening the text file in Notepad program, you have noticed that the encoding of the file is *UTF-8*).

CSE 107

(b) Now, instead of writing each line to the console, you need to write to another file.

There is no need to prefix the lines with line number. Modify your code written in 8(a) so that it reads the destination file name from command line and copies the content of *MyAnalysisOfStudentsPerformance.txt* line by line. Keep in mind that the input file uses UTF-8 encoding. Identify what additional code you had to write to account for UTF-8 encoding and why? If you did not write any additional code, then explain why. (10)

(c) Show the hierarchical relation among the classes *Throwable*, *Exception*, *RuntimeException* and *Error*.

In a user authentication scenario, you would like to generate a custom exception called *AuthFailureException* when authentication fails. Write this custom exception class. You have an *Authenticator* class where the following method is already implemented:

```
private boolean isAuthenticUser(String username, String password)
```

The above method returns true for successful login, false otherwise. Write a public method called *Authenticate* that takes username, password as parameters. In case of successful authentication the method returns nothing. In case of failure, it throws *AuthFailureException*. (10)

```
class Bullet implements Serializable, Cloneable {
    int _posX;
    int _posY;

    public Bullet(int initialX, int initialY) {
        _posX = initialX;
        _posY = initialY;
    }

    public String toString() {
        return "<" + _posX + ", " + _posY + ">";
    }

    public Object Clone()
    {
        return new Bullet(_posX, _posY);
    }
}
```

Figure 1: Bullet class used in Question 6(a)

```
public class TwoPersonShooterGame {
    ObjectOutputStream _oos;
    ObjectInputStream _ois;

    public void updateBullet(Bullet bullet, int x, int y) throws IOException {
        bullet._posX = x;
        bullet._posY = y;

        _oos.writeObject(bullet);
    }
}
```

Figure 2: TwoPersonShooterGame class (partial) used in Question 6(a)

```
interface SomeFunc<T> {
    T func(T t);
}
```

Figure 3: Functional interface for Question 5(c)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **HUM 183** (English)

Full Marks : 210

Time : 3 Hours

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** including Q. No. 1 as compulsory.

1. Read the following passage carefully and answer the questions that follow:**(45)**

A study of art history might be a good way to learn more about a culture than is possible to learn in general history classes. In history books, objective information about the political life of a country is presented; that is, facts about politics are given, but opinions are not expressed. Art, on the other hand, is subjective, it reflects emotions and opinions. The great Spanish painter Francisco Goya was perhaps the first truly “political artist”. In his well-known painting *The Third of May, 1808*, he depicted soldiers shooting a group of people. This depiction of faceless soldiers and their victims has become a symbol of the enormous power, and the misuse of this power over people. Over a hundred years later, symbolic images were used in Pablo Picasso’s painting *Guernica* to express the horror of war. So, a personal and emotional view of history can be presented through art. In the same way art can reflect a culture’s religious belief. For example, one of the main characteristics of art in the Middle East is the absence of human and animal images. This reflects the Islamic belief that statues are unholy. So, Islamic artists have created unique decoration of great beauty with images of flowers and geometric forms on mosques, palaces and other buildings. On the contrary, in Europe, churches and other religious buildings are filled with paintings that depict people and stories from the Bible. Interestingly, in Africa and the Pacific Islands, religion is the *purpose* for art and is, therefore, absolutely essential to it. In traditional tribal cultures, art objects—mask, headdresses, statues etc, are not created simply for beauty. They are essential to both religion and daily life. It is impossible to separate art and religion from their everyday activities: hunting, war, farming, childbirth and so on. In the Solomon Island of Melanesia, the artistic characteristics of common everyday objects are considered to attribute power to these items for their successful use. For example, a small figure on a hunter’s spear is believed to help the spear to reach its target. To sum up, art in many cultures is believed to serve essential and practical functions.

Questions:

- (i) Why is art considered as “subjective”?
- (ii) What does the phrase “political artist” mean?
- (iii) What are the major differences between the Middle Eastern and European art?

Contd P/2

HUM 183(CSE)

Contd ... Q. No. 1

- (iv) How does religion serve as the purpose of art in different tribal societies?
(v) Write down a suitable title for this passage and justify it.
(vi) Write down the meaning of the following words as used in the passage:
Enormous, depiction, unholy, headdress, attribute
2. (a) Briefly discuss the elements that constitute the structure of a business letter. (10)
(b) Draft a claim letter as a manager of a company to replace 10 printers which are identified with malfunction after purchase. (10)
(c) Write the phonetic transcriptions of the following words (any five): (10)
Mother, Cottage, Measure, Able, Vision, Game.
3. (a) What are the three major parts of a formal report? Discuss the "Front Matter" of a report. (10)
(b) Write a short essay on any one of the following topics: (10)
(i) Refugee Crisis: Humanity Blindfolded
(ii) Social Media: Lost in Virtual World
(iii) Your favourite Book
(c) Write a dialogue between two friends sharing their experience of working as volunteers at department's alumni programme. (10)
4. (a) Transform the following sentences as directed (any five) (10)
(i) He was the last man to go there. (Complex)
(ii) Sheila kept the promise she had made. (Simple)
(iii) If Habib does not return the goods, he must pay the bill. (Compound)
(iv) Speak the truth and I shall pardon you. (Simple)
(v) The enemy fled as soon as they saw us. (Compound)
(vi) Newtown never permitted his mind to rest until he had discovered all the laws by which the plants are guided through the sky. (Simple)
(b) What are the features of a cover letter? (5)
(c) Write Short notes on any three of the following: (15)
(i) Bibliography and Glossary
(ii) Monophthongs
(iii) Primary and Secondary Sources
(iv) Morphology and Syntax.

HUM 183(CSE)

SECTION – B

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

5. (a) Explain with reference to the context any two of the following: (15)
- (i) “The mother had a small income, and the father had a small income, but not nearly enough for the social position which they had to keep up.”
 - (ii) “It will do you good to sit down for a while and chat with me.”
 - (iii) “All the same you need an army for hunting.”
- (b) Answer any one of the following: (15)
- (i) Sketch the character of the astrologer in “An Astrologer’s Day”.
 - (ii) Why does the writer finally decide to shoot the elephant in the story “Shooting an Elephant”?
- (c) Answer any three of the following: (15)
- (i) What is the main problem of the family from Paul’s mother’s point of view?
 - (ii) Why does the writer say the young Buddhist Priests were the worst?
 - (iii) Sketch the symbols of the story “Fire on the Mountain”.
 - (iv) Identify the climax of the story “An astrologer’s Day”.
 - (v) What are the writer’s internal conflicts with Imperialism in “Shooting an Elephant”?
6. (a) Recast and correct any ten of the following sentences: (15)
- (i) The couple spoke to one another earnestly.
 - (ii) Mrs. Chowdhury is planning to do up her house.
 - (iii) The child is unmistakably ill-bred.
 - (iv) Death is more preferable than disgrace.
 - (v) Either he or his sister are guilty.
 - (vi) He is what better today.
 - (vii) The answer looked wrong to Jimmy and he.
 - (viii) Of all the boxes, few is left.
 - (ix) They theirselves were on hand for the show.
 - (x) They juice tastes sourish.
 - (xi) I was disinterested in the story.
 - (xii) The constructor applied the final coat of cement and laid the concrete base on rainy days.
- (b) Give the meanings of and make sentences with any ten of the following words: (15)
- absorbed, baffle, castigate, designate, enhance, flicker, grudge, identical, munch, palatable, retard, surmise
7. (a) Amplify any one of the following ideas: (30)
- (i) When everything is coming your way, you’re in the wrong lane.
 - (ii) People who live in glass houses should not throw stones.

HUM 183(CSE)

8. Write a précis of the following passage:

(30)

Each night at 7 pm, many of China's television channels beam the state broadcaster's flagship news programme into Chinese homes: a remorseless half-hour diet of where Xi Jinping went today, how well the economy is doing and (for a few minutes at the end) a look at all those people in foreign countries killing each other. Despite China's transformation over the past 40 years, the evening news has changed very little. Around a tenth of the population still watch it - a remarkable number given the profusion in recent years of livelier news sources in print and online. News Simulcast, usually known by its Chinese name, Xinwen Lianbo, has chronicled the country's extraordinary metamorphosis with almost unremitting leadenness since it was first aired in 1978. The same opening tune has been used for nearly 30 years (through the orchestra has improved). News is chosen not for its importance or human interest but for its political value in strengthening the Communist Party. It is translated into eight minority languages, just to be sure its message is understood by as many people as possible. The fare has barely changed in decades. A typical programme in the 1980s highlighted the development of a self-opening umbrella and a contest in which happy only children (China had recently introduced a one child-per-couple policy) performed household chores. Today the backdrop is just more high-tech. Scenes of bullet-trains and microchip makers have replaced those of dreary stateowned factories. Now, as then, reports featuring Chinese leaders - no matter how trivial their activities - nearly always take precedence over other news. A popular song accurately describe the format: "The leaders are always busy, the people are perfectly healthy, the world outside Chine is extremely chaotic." Early newscasters - almost always one man and one woman - were chosen for their standard Mandarin pronunciation and dull character; the same few read the news for decades. These have been replaced with younger, more glamorous presenters (though they still need official permission to change their hairstyles). To make broadcasts seem more newsy, TV screens flicker in what appears to be a newsroom behind. But live reports are rare; they create too big a risk of something embarrassing making it to air. A fraction of households had TV sets when Xinwen Lianbo started broadcasting. But as China entered the age of mass consumption a few years later, TV news became the perfect vehicle for the party to try to guide public opinion. Still Xinwen Lianbo has more viewers than any other TV news on Earth. For many, the programme provides useful clues to the party's latest thinking, and a chance to see leaders who rarely appear in public. Propagandists have used the news to try to demystify President Xi, says Chang Jiang of Renmin University in Beijing. The president is shown as a man of the people, drinking tea with villagers or kicking footballs. His voice is often heard, notes Mr. Chang - perhaps because, unlike his predecessors, he speaks standard Mandarin and is therefore widely understood. Ratings apparently rise when his elegant wife, Peng Liyua, appears. But such cosmetic innovations are as far as the party will go in messing with a brand they consider successful.

SECTION – A

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

1. (a) What are photons? What role did Einstein's explanation of the photoelectric effect play in the development of the particle-wave interpretation of the nature of electromagnetic radiation? (9)
- (b) What do you mean by Eigen values and Eigen functions? (6)
- (c) An 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 ? (8)
- (d) What is meant by the term "Shielding of electrons" in an atom? Using the Li atom as an example, describe the effect of shielding on the energy of electrons in an atom. (7)
- (e) Matter and radiation have a "dual nature" – Explain. (5)
2. (a) Use the VSEPR model to predict the geometry of the following ions: (8)
 - (i) N_3^- (ii) BH_4^- (iii) SO_3^{2-} (iv) NO_2^-
- (b) Use molecular orbital theory to describe the bonding in the following. For each one, find the bond order and decide whether it is stable. Is the substance diamagnetic or paramagnetic? (9)
 - (i) Be_2^+ (ii) Ne_2 (iii) B_2^-
- (c) What do you mean by basic sets in computational Chemistry? "The accuracy of a calculation is dependent on both the model and the type of basic set applied to it" – Explain. (6)
- (d) Write down the salient features of Ab/nitio" method? When you choose this method for computation? (7)
- (e) Discuss the advantages and disadvantages of Semi-empirical method of computation. (5)
3. (a) Write down the factors that accelerate the polymer degradation. (9)
- (b) Show schematically how soliton pair on a trans-polyacetylene is formed by doping? (6)
- (c) How conjugated conducting polymer can be doped by chemical method. (6)

CHEM 113 (CSE)

Contd ... Q. No. 3

- (d) Write down the structures of the following polymers (any seven) (7×2=14)
- (i) Poly (glycolic acid) (ii) Poly (B-hydroxybutyrate) (iii) Poly-lycine (iv) Polyaniline emeraldine base (v) Poly thiophere (vi) Polyazulene (vii) Poly (ϵ -caprolactone) (viii) Chitin (ix) Poly (dichloro phosphazene) (x) Starch
4. (a) "Mutarotation occurs by a reversible ring-opening of each anomer to the open-chain aldehyde, followed by reclosure" – Explain with suitable example. (5)
- (b) Why amino acids are amphiprotic? Find out what species are present in a 1.00 M solution of alanine at pH = 9.00. The pK_{a1} and pK_{a2} values of alanine are 2.34 and 9.69, respectively. (10)
- (c) What do you mean by rRNA, tRNA and mRNA? What are the differences between DNA and RNA? (3+6=9)
- (d) What is soap? Show the cleaning mechanism of soaps. (8)
- (e) What sequence of bases on one strand of DNA is complementary to the sequence TATGCAT on another strand? (3)

SECTION – B

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

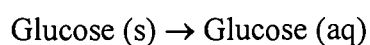
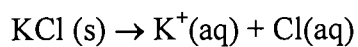
Use the Appendices whenever necessary.

5. (a) One of the first computer, ENIAC, weighing 30 tons and occupying a 15 m × 9 m large room, was built in the 1940s, before nanofabrication techniques were available. In your words, explain how nanochemistry helped the evolution of computer to its current form. (8)
- (b) "Everything when miniaturized to the sub-100-nanometer scale, has new properties, regardless of what it is" says Chad Mirkin, Professor of Chemistry at Northwestern University. (6+4)
- (i) List four examples that support this statement.
- (ii) What are the microscopes that scientists use to see at sub-100-nanometer scale?
- (c) There are two general approaches to the synthesis of nanomaterials. How would you compare these two approaches? Give the pros and cons. (8)
- (d) Eight types of colloidal dispersions were listed in class. Give four types and give one example for each. Explain how Tyndall effect is used to distinguish colloids and solution. (4+5)

CHEM 113 (CSE)

6. (a) What is ion-dipole force? How does this force work in determining the solubility of ionic solid in water? Use the dissolution of KCl in water as an example. (10)

(b) KCl and glucose undergo the following reactions when they are dissolved in water: (3+3+3+7)



Consider that equal molar amounts of these substances are dissolved in equal volume of water.

(i) Which solution would you expect to have higher freezing point? Why?

(ii) Which one would have higher vapor pressure? Why?

(iii) The container of KCl is left out for several days that allows some of the water to evaporate from the solution. How would the boiling point of this solution compare to the boiling point of the original solution?

(iv) If the freezing point of KCl solution is -1.0°C , what would be the freezing point of glucose solution? What would be the boiling point of glucose solution?

(c) Desalination is a process by which salts are removed from sea water. Reverse osmosis is one of the major ways to accomplish desalination by controlling water movement through a semipermeable membrane. (4+5)

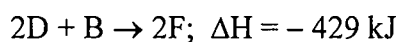
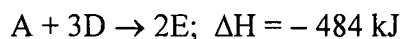
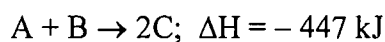
(i) Draw a diagram showing how reverse osmosis can be carried out.

(ii) You are to desalinate sea water that is 0.70 M NaCl solution. What minimum pressure (in atm) must be applied to sea water at 25°C for reverse osmosis to occur?

7. (a) Explain why enthalpy is a state function and why this is an extensive property. (8)

(b) What is pressure-volume work? How is this work related to enthalpy? (8)

(c) Given the following hypothetical thermo-chemical equations: (9)



Calculate ΔH for the equation: $4\text{E} + 5\text{B} \rightarrow 4\text{C} + 6\text{F}$

(d) Why is the Kirchoff's equation so important in thermo chemistry? Calculate the heat of formation of $\text{H}_2\text{O}(\text{l})$ at 60°C if the standard heat of formation of $\text{H}_2\text{O}(\text{l})$ is 68.370 Kcal. Given that the heat capacities (C_p) of $\text{H}_2(\text{g})$, $\text{O}_2(\text{g})$, and $\text{H}_2\text{O}(\text{l})$ are 6.90, 7.05 and $18.0 \text{ Cal mol}^{-1}\text{deg}^{-1}$, respectively. (10)

CHEM 113 (CSE)

8. (a) Sketch a rough phase diagram of SO₂ from the following information: (12)

normal freezing point = - 72.7°C,

normal boiling pint = - 10°C,

triple point = - 75.5°C and 1.65×10^{-3} atm,

Critical point = 157°C and 78 atm

Label each phase region on the diagram. Calculate degrees of freedom at all regions and equilibrium.

(b) Acetylene has a critical point 36°C, 62 atm- What can be inferred about the liquification of acetylene from this data? (6)

(c) What is meant by limiting ionic conductivity? Appendix B contains limiting ionic conductivities of various cations and anions in water. Explain why the limiting ionic conductivity of H⁺ is so high compared to other cations. (7)

(d) The molar conductivity of 0.010 M CH₃CO₂H (aq) at 25°C is $1.65 \text{ ms m}^2\text{mol}^{-1}$. (10)

(i) Calculate the limiting molar conductivity of CH₃CO₂H (aq) using the Appendix B.

(ii) Calculate the degree of deprotonation, α .

(ii) Calculate the acidity constant, K_a of CH₃CO₂H.

Appendices - 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 ₃ COOH)	118.5	16.60	3.08	3.59
Benzene (C ₆ H 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 ₆ H ₁₂)	80.74	6.55	2.79	20.0
Ethanol (C ₂ H ₅ OH)	78.3	---	1.07	---
Water (H ₂ O)	100.000	0.000	0.512	1.858

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

Cations		Anions	
Ba ²⁺	12.72	Br ⁻	7.81
Ca ²⁺	11.90	CH ₃ CO 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 ₂ H ₅) ₄] ⁺	3.26	HCO ₂ ⁻	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 – AThere are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) State the converse, contrapositive and inverse of the statement. “A positive integer is a prime only if it has no divisors other than 1 and itself”. (7×5=35)
- (b) “There was a man in a town who used to help those who did not help themselves” – Argue whether this is a proposition.
- (c) Show that $(p \rightarrow q) \rightarrow (r \rightarrow s)$ and $(p \rightarrow r) \rightarrow (q \rightarrow s)$ are not logically equivalent.
- (d) Translate the following nested quantifications into an English statement that expresses a mathematical fact assuming all real numbers to be the domain.

$$\forall x \forall y ((X \geq 0) \wedge (Y < 0)) \rightarrow (X - Y > 0)$$
- (e) Write the numbers 1, 2, ..., 2n on a blackboard, where n is an odd integer. Pick any two numbers, j, k, write, |j – k| on the board and erase j and k. Continue this process until only one integer is left on the board. Prove that this integer must be odd.
2. (a) Use set builder notations and logical equivalences to establish that $\overline{A \cap B} = \overline{A} \cup \overline{B}$. (7×5=35)
- (b) Differentiate injective, bijective and surjective functions with all possible examples.
- (c) Show that the set of real numbers is an uncountable set.
- (d) Let $f(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x + a_0$, where $a_0, a_1, \dots, a_{n-1}, a_n$ are real numbers. Prove that $f(x) = O(x^n)$.
- (e) Prove that there are infinitely many primes.
3. (a) We received the encrypted message 09810461. What is the decrypted message if it was encrypted using the RSA with p = 43, q = 59 and e = 13. (20)
- (b) Calculate $3^{644} \text{ mod } 645$. (15)
4. (a) A man had 3 sons, 5 daughters and 11 grandchildren. If he divides his money among only sons then Tk. 2 is left, among only daughters then Tk. 3 is left, whereas in case of among children Tk. 9 is left. If he had no more than Tk. 1,200 and no less than Tk. 1,000 what is the minimum amount he had? (20)
- (b) Prove that any positive integer has a unique prime factorization. (15)

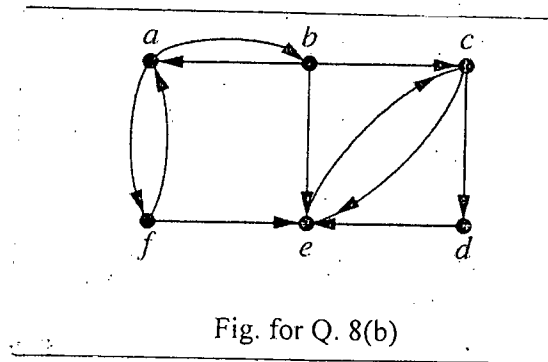
CSE 103

SECTION – B

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

5. (a) In how many ways can a photographer at a wedding arrange six people in a row, including the bride and groom, if the bride is positioned somewhere to the left of the groom? (12)
- (b) How many solutions does the equation $x_1 + x_2 + x_3 = 13$ have where x_1, x_2 and x_3 are nonnegative integers less than 6? (13)
- (c) A string that contains only 0s, 1s, and 2s is called a ternary string. Find a recurrence relation for the number of ternary strings of length n that do not contain consecutive symbols that are the same. Explain how you obtain your answer. What are the initial conditions? (10)
6. (a) In how many ways can the digits 1, 2, 3, 4, 5, 6, 7, 8 be arranged so that no even digit is in its original position? (13)
- (b) Find a recurrence relation for the number of ways to climb n stairs if the person climbing the stairs can take one, two, or three stairs at a time. Explain how you obtain your answer. What are the initial conditions? (7)
- (c) Solve the recurrence relation $a_n = 6a_{n-1} - 12a_{n-2} + 8a_{n-3}$ with $a_0 = -5, a_1 = 4,$ and $a_2 = 88.$ (8)
- (d) How many bit strings of length 5 contain more 0s than 1s? (7)
7. (a) Define simple graph, multigraph, and digraph. Give examples of the following types of graphs: (i) Simple directed graph, (ii) Pseudograph, and (iii) directed pseudograph. Also show the adjacency matrices of your example graphs. (15)
- (b) What is a bipartite graph? Show that a simple graph is bipartite if and only if it is possible to assign one of two different colors to each vertex of the graph so that no two adjacent vertices are assigned the same color. (7)
- (c) How many subgraphs with at least one vertex does W_3 (wheel graph with four vertices) have? (7)
- (d) Show that if a connected multigraph has an Euler path (and not an Euler circuit) then it has exactly two vertices of odd degree. (6)
8. (a) Show that in a simple graph with at least two vertices there must be two vertices that have the same degree. (7)
- (b) Find the strongly connected components of the graph given in Fig. for Q. 8(b). (6)

CSE 103



- (c) Define the following with respect to rooted trees: (i) Ancestor (ii) Leaf (iii) Level (iv) Height. (8)
 - (d) Define the following: (i) Full m-ary tree (ii) Balanced m-ary tree (iii) Complete m-ary tree. Give one example of each type of tree of height 4. (9)
 - (e) How many vertices does a full 5-ary tree with 100 internal vertices have? (5)
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