**Information Security Assignment#1**

**FA23-BSE-057**

**FA23-BSE-085**

**FA23-BSE-060**

**FA23- BSE-084**

**Maaz Tahir.**

**Muhammad Hassan**

**Muhammad Asim**

**Umar Altaf**

**Q.1: Difference between Mono-Alphabetic and Poly-Alphabetic encryption.**

**Answer:**

**Mono-Alphabetic Encryption**

* In **mono-alphabetic encryption**, each letter in the plaintext is always replaced by the same letter in the cipher text.
* The key is **fixed**, meaning one letter always maps to the same letter.
* For Example: **Caesar Cipher** (shifts letters by a fixed number)
  + If we shift by **3**, then A will be encrypted to D.
  + "HELLO" will be encrypted to "KHOOR" (each letter is always replaced by the same letter).
* **Weakness**: Easy to break using **frequency analysis** (common letters like 'E' appear frequently).

**Poly-Alphabetic Encryption**

* In **polyalphabetic encryption**, the same letter in plaintext can be encrypted into **different letters** based on its position.
* It uses **multiple shifting alphabets** (instead of one fixed shift).
* Example: **Vigenère Cipher** (uses a keyword to determine shifts)
  + If the keyword is "KEY", then:
    - First letter uses K so letter “A” will be encrypted to “K”.
* **Stronger than mono-alphabetic ciphers** because frequency analysis is harder.

**Q3: Explain and exemplify the following three techniques:**

**Answer:**

**1. Beaufort Cipher:**

* A **polyalphabetic cipher** technique.
* Instead of adding plaintext and key, it **subtracts the key from the ciphertext**.
* **Formula**: Cipher text = Key - Plaintext (mod 26)
* **Example** (Key: "FORT", Plaintext: "HELLO"):
  + Convert letters to numbers (A=0, B=1, ..., Z=25).
  + Subtract plaintext from key letters then take mod with 26.
  + Convert back to letters.

**2. Auto-Key Cipher**

* A **technique** where the key starts with a keyword and then uses the **plaintext itself** as the key.
* **Formula**: Ciphertext = (Plaintext + Key) mod 26
* **Example** (Key: "KING", Plaintext: "HELLO"):
  + Key used: **KINGH** (after "KING", plaintext continues the key).
  + Encrypt like Vigenère.

**3. Running Key Cipher**

* A **technique** where the key is a long text (e.g., from a book).
* More secure because the key is unpredictable.
* **Example**:
  + Plaintext: "HELLO"
  + Key (from a book passage): "NATURE"
  + Encryption is done using the Vigenère rules.

**Q2: Encryption of Full name using the techniques studied:**

1. **Additive cipher:**

### ****Steps:****

1. **Choose a shift value** (e.g., **Shift = 3**).
2. **Convert letters to numbers** (A=0, B=1, ..., Z=25).
   * M = 12, A = 0, A = 0, Z = 25, T = 19, A = 0, H = 7, I = 8, R = 17
3. **Apply the shift** (Add 3 to each letter, mod 26).
   * M (12) → P (15)
   * A (0) → D (3)
   * A (0) → D (3)
   * Z (25) → C (2)
   * T (19) → W (22)
   * A (0) → D (3)
   * H (7) → K (10)
   * I (8) → L (11)
   * R (17) → U (20)
4. **Convert numbers back to letters:**  
   **Ciphertext: PDDCWDKLU**
5. **Using Multiplicative Cipher:**

### ****Steps:****

1. **Choose a multiplication key (K)**
   * The key **must be coprime to 26** (i.e., GCD(K, 26) = 1).
   * Let's use **K = 5** (since **GCD(5, 26) = 1**).
2. **Convert letters to numbers** (A=0, B=1, ..., Z=25):
   * **M = 12, A = 0, A = 0, Z = 25, T = 19, A = 0, H = 7, I = 8, R = 17**
3. **Apply the formula:**

C=(P×K)mod  26C = (P \times K) \mod 26C=(P×K)mod26

Where **P = plaintext letter's number**, **K = 5**, and **mod 26 ensures wrapping**.

1. **Calculate encrypted values:**
   * **M (12)** → (12 × 5) **= 60** → **60 % 26 = 8** → **I**
   * **A (0)** → (0 × 5) **= 0** → **0 % 26 = 0** → **A**
   * **A (0)** → (0 × 5) **= 0** → **A**
   * **Z (25)** → (25 × 5) **= 125** → **125 % 26 = 21** → **V**
   * **T (19)** → (19 × 5) **= 95** → **95 % 26 = 17** → **R**
   * **A (0)** → (0 × 5) **= 0** → **A**
   * **H (7)** → (7 × 5) **= 35** → **35 % 26 = 9** → **J**
   * **I (8)** → (8 × 5) **= 40** → **40 % 26 = 14** → **O**
   * **R (17)** → (17 × 5) **= 85** → **85 % 26 = 7** → **H**
2. **Final Encrypted Text: "IAAVRAJOH"**
3. **Using Affine cipher:**

### ****Affine Cipher Encryption for "MAAZTAHIR"****

The **Affine Cipher** combines both **Multiplicative** and **Additive Ciphers** using the formula:

C=(P×K1+K2)mod  26, C = (P \times K\_1 + K\_2) \mod 26C=(P×K1​+K2​)mod26

Where:

* **PPP** = Position of the plaintext letter (A=0, B=1, ..., Z=25)
* **K1K\_1K1​** = Multiplicative key (must be coprime to 26)
* **K2K\_2K2​** = Additive key (any number from 0-25)
* **CCC** = Encrypted letter position

### ****Step 1: Choose Keys****

* Let **K1=5 K\_1 = 5 K1​=5** (coprime with 26)
* Let **K2=8 K\_2 = 8 K2​=8** (a random shift value)

### ****Step 2: Convert Letters to Numbers****

Plaintext **"MAAZTAHIR"** → **(A=0, B=1, ..., Z=25)**

* **M = 12, A = 0, A = 0, Z = 25, T = 19, A = 0, H = 7, I = 8, R = 17**

### ****Step 3: Apply Affine Cipher Formula****

C=(P×5+8)mod  26C = (P \times 5 + 8) \mod 26C=(P×5+8)mod26

| **Plaintext** | **Number** | **Multiply by 5** | **Add 8** | **Mod 26** | **Ciphertext** |
| --- | --- | --- | --- | --- | --- |
| M | 12 | 12 × 5 = 60 | +8 | 68 % 26 = 16 | Q |
| A | 0 | 0 × 5 = 0 | +8 | 8 % 26 = 8 | I |
| A | 0 | 0 × 5 = 0 | +8 | 8 % 26 = 8 | I |
| Z | 25 | 25 × 5 = 125 | +8 | 133 % 26 = 3 | D |
| T | 19 | 19 × 5 = 95 | +8 | 103 % 26 = 25 | Z |
| A | 0 | 0 × 5 = 0 | +8 | 8 % 26 = 8 | I |
| H | 7 | 7 × 5 = 35 | +8 | 43 % 26 = 17 | R |
| I | 8 | 8 × 5 = 40 | +8 | 48 % 26 = 22 | W |
| R | 17 | 17 × 5 = 85 | +8 | 93 % 26 = 15 | P |

### ****Step 4: Convert Numbers Back to Letters****

Final Ciphertext for MAAZTAHIR: **"QIIDZIRWP"**

1. **Using Atbash/Mono-alphabetic cipher.**

### ****Atbash Cipher Encryption for "MAAZTAHIR"****

The **Atbash Cipher** is a **monoalphabetic substitution cipher** where each alphabet is **reversed**:

Each letter in the plaintext is replaced with its opposite letter in the reversed alphabet.

### ****Step 1: Write the Alphabet in Reverse****

### Plain: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

**Cipher: Z Y X W V U T S R Q P O N M L K J I H G F E D C B A**

### ****Step 2: Convert Each Letter****

Plaintext: **"MAAZTAHIR"**

* **M → N**
* **A → Z**
* **A → Z**
* **Z → A**
* **T → G**
* **A → Z**
* **H → S**
* **I → R**
* **R → I**

### ****Step 3: Final Encrypted Text****

"NZZAGZSRI"\mathbf{"NZZAGZSRI"}"NZZAGZSRI"

* **Ciphertext:** **"NZZAGZSRI"**

1. **Using Play Fair (Mono-Alphabetic Cipher):**

### ****Step 1: Choose a Key and Create the Playfair Grid****

We'll use the **key: "KEYWORD"** (you can choose any key).

1. Write the **unique letters** of the key first.
2. Fill in the rest of the **alphabet** (excluding **J**, which is combined with **I**).

K E Y W O

R D A B C

F G H I/J L

M N P Q S

T U V X Z

### ****Step 2: Prepare the Plaintext "MAAZTAHIR"****

1. Split into **letter pairs** (double letters are split with an 'X'):  
   **"MAAZTAHIR"** → **"MA AZ TA HI R"**  
   Since **AZ** is already a valid pair, no change is needed.

### ****Step 3: Encrypt Each Pair****

Rules of Playfair:

* **Same row:** Replace each letter with the letter **to its right**.
* **Same column:** Replace each letter with the letter **below**.
* **Rectangle rule:** Form a **rectangle**, replacing with opposite corners.

| **Pair** | **Rule Applied** | **Encrypted Pair** |
| --- | --- | --- |
| **MA** | Rectangle Rule: M→P, A→R | **PR** |
| **AZ** | Rectangle Rule: A→B, Z→X | **BX** |
| **TA** | Rectangle Rule: T→U, A→D | **UD** |
| **HI** | Rectangle Rule: H→I, I→H | **IH** |
| **R** | Single letter (no pair, add X) → RX | **RX** |

### ****Step 4: Final Ciphertext****

"PRBXUDIHRX"

**Encryption for name (HASSAN):**

* + 1. **Using Additive Cipher:**

 **Choose a Shift Key:** We select **k = 3**, meaning each letter will be shifted forward by 3 positions in the alphabet.

 **Convert Each Letter to Its Alphabet Position:** In the English alphabet, H = 7, A = 0, S = 18, S = 18, A = 0, and N = 13.

 **Apply the Additive Cipher Formula:** Using **C = (P + k) mod 26**, we shift each letter by 3:

* H (7) → (7 + 3) mod 26 = 10 → **K**
* A (0) → (0 + 3) mod 26 = 3 → **D**
* S (18) → (18 + 3) mod 26 = 21 → **V**
* S (18) → (18 + 3) mod 26 = 21 → **V**
* A (0) → (0 + 3) mod 26 = 3 → **D**
* N (13) → (13 + 3) mod 26 = 16 → **Q**

 **Obtain the Final Ciphertext:** After applying the shift, the encrypted version of **"HASSAN"** is **"KDVVDQ"**.

* + 1. **Using Multiplicative Cipher:**

 **Choose a Multiplication Key:** In the **Multiplicative Cipher**, each letter is multiplied by a fixed key **k** modulo 26. We choose **k = 5**, ensuring it is coprime with 26 for decryption to be possible.

 **Convert Each Letter to Its Alphabet Position:** In the English alphabet, H = 7, A = 0, S = 18, S = 18, A = 0, and N = 13.

 **Apply the Multiplicative Cipher Formula:** Using **C = (P × k) mod 26**, we compute:

* H (7) → (7 × 5) mod 26 = 35 mod 26 = 9 → **J**
* A (0) → (0 × 5) mod 26 = 0 → **A**
* S (18) → (18 × 5) mod 26 = 90 mod 26 = 12 → **M**
* S (18) → (18 × 5) mod 26 = 90 mod 26 = 12 → **M**
* A (0) → (0 × 5) mod 26 = 0 → **A**
* N (13) → (13 × 5) mod 26 = 65 mod 26 = 13 → **N**

 **Obtain the Final Ciphertext:** After applying the multiplication transformation, the encrypted version of **"HASSAN"** is **"JAMMAN"**.

* + 1. **Using Affine Cipher technique:**

 **Choose Keys:** The **Affine Cipher** uses the formula:

C=(aP+b)mod  26C = (aP + b) \mod 26C=(aP+b)mod26

where:

* **P** is the plaintext letter's position (A = 0, B = 1, ..., Z = 25).
* **a** is a multiplicative key (must be coprime with 26).
* **b** is an additive shift.
* **C** is the resulting ciphertext letter.

Let’s choose **a = 5** (coprime with 26) and **b = 8** as the additive shift.

 **Convert Each Letter to Its Alphabet Position:**  
H = 7, A = 0, S = 18, S = 18, A = 0, N = 13.

 **Apply the Affine Cipher Formula:** Using **C = (5P + 8) mod 26**, we compute:

* H (7) → (5 × 7 + 8) mod 26 = (35 + 8) mod 26 = 43 mod 26 = 17 → **R**
* A (0) → (5 × 0 + 8) mod 26 = 8 mod 26 = 8 → **I**
* S (18) → (5 × 18 + 8) mod 26 = (90 + 8) mod 26 = 98 mod 26 = 20 → **U**
* S (18) → (5 × 18 + 8) mod 26 = (90 + 8) mod 26 = 98 mod 26 = 20 → **U**
* A (0) → (5 × 0 + 8) mod 26 = 8 mod 26 = 8 → **I**
* N (13) → (5 × 13 + 8) mod 26 = (65 + 8) mod 26 = 73 mod 26 = 21 → **V**

 **Obtain the Final Ciphertext:** After applying the Affine transformation, the encrypted version of **"HASSAN"** is **"RIUUIV"**.

* + 1. **Using PlayFair technique:**

 **Choose a Keyword and Construct the 5×5 Matrix:**  
The **Playfair Cipher** uses a **5×5 matrix** of letters, built from a keyword. Repeated letters are removed, and the remaining alphabet is filled in (combining I and J).

Let's use **"KEYWORD"** as the keyword:

**Matrix (5x5)**

**K E Y W O**

**R D A B C**

**F G H I/J L**

**M N P Q S**

**T U V X Z**

 **Divide "HASSAN" into Digraphs (Pairs of Two Letters):**

* The plaintext is split into letter pairs: **HA SS AN**
* If a pair has duplicate letters (like "SS"), insert a filler letter (e.g., "X"), making it **HA SX SA N**

 **Apply Playfair Cipher Rules for Encryption:**

* **Rule 1: If both letters are in the same row, replace them with the next letter in the row.**
* **Rule 2: If both letters are in the same column, replace them with the next letter in the column.**
* **Rule 3: If neither, form a rectangle and swap letters diagonally.**
* **HA** → H and A are in different rows and columns. Forming a rectangle:
  + H → G
  + A → B  
    → **GB**
* **SX** → S and X are in different rows and columns. Forming a rectangle:
  + S → Q
  + X → V  
    → **QV**
* **SA** → S and A are in different rows and columns. Forming a rectangle:
  + S → L
  + A → M  
    → **LM**
* **N (alone) → Add filler 'X' to make NX**
  + **NX** → N and X are in different rows and columns. Forming a rectangle:
    - N → P
    - X → U  
      → **PU**

 **Obtain the Final Ciphertext:**  
The encrypted version of **"HASSAN"** using the Playfair Cipher is **"GBQVLMPU"**.

**Q2: Encryption of Full name using the techniques studied:**

1. **Additive cipher:**

### ****Steps:****

1. **Choose a shift value (Same shift value = 3).**
2. **Convert letters to numbers (A=0, B=1, ..., Z=25).**
   * **M = 12, U = 20, H = 7, A = 0, M = 12, M = 12, A = 0, D = 3**
   * **A = 0, S = 18, I = 8, M = 12**
3. **Apply the shift (Add 3 to each letter, mod 26).**
   * **M (12) → P (15)**
   * **U (20) → X (23)**
   * **H (7) → K (10)**
   * **A (0) → D (3)**
   * **M (12) → P (15)**
   * **M (12) → P (15)**
   * **A (0) → D (3)**
   * **D (3) → G (6)**
   * **A (0) → D (3)**
   * **S (18) → V (21)**
   * **I (8) → L (11)**
   * **M (12) → P (15)**
4. **Convert numbers back to letters:  
   Ciphertext: PXKDPDPGDVLP**
5. **Using Multiplicative Cipher:**

### ****Steps:****

**Choose a multiplication key (K) = 5  
(K must be coprime to 26, and GCD(5, 26) = 1)**

**Convert letters to numbers (A=0, B=1, ..., Z=25)**

* **M = 12, U = 20, H = 7, A = 0, M = 12, M = 12, A = 0, D = 3**
* **A = 0, S = 18, I = 8, M = 12**

**Apply the formula:  
C = (P × K) mod 26  
(Where P = plaintext letter’s number, K = 5, mod 26 ensures wrapping)**

**Calculate encrypted values:**

* **M (12) → (12 × 5) = 60 → 60 % 26 = 8 → I**
* **U (20) → (20 × 5) = 100 → 100 % 26 = 22 → W**
* **H (7) → (7 × 5) = 35 → 35 % 26 = 9 → J**
* **A (0) → (0 × 5) = 0 → 0 → A**
* **M (12) → (12 × 5) = 60 → 60 % 26 = 8 → I**
* **M (12) → (12 × 5) = 60 → 60 % 26 = 8 → I**
* **A (0) → (0 × 5) = 0 → 0 → A**
* **D (3) → (3 × 5) = 15 → 15 % 26 = 15 → P**
* **A (0) → (0 × 5) = 0 → 0 → A**
* **S (18) → (18 × 5) = 90 → 90 % 26 = 12 → M**
* **I (8) → (8 × 5) = 40 → 40 % 26 = 14 → O**
* **M (12) → (12 × 5) = 60 → 60 % 26 = 8 → I**

**Final Encrypted Text:  
IWJAIIPAMOI**

1. **Using Affine cipher:**

### ****Affine Cipher Encryption for "Muhammad Asim"****

**Choosing Keys**

* **Multiplicative key (a) = 5** (since **GCD(5, 26) = 1**)
* **Additive key (b) = 8** (chosen arbitrarily)

**Step 1: Convert letters to numbers**

Muhammad Asim → **M U H A M M A D A S I M**  
M = 12, U = 20, H = 7, A = 0, M = 12, M = 12, A = 0, D = 3, A = 0, S = 18, I = 8, M = 12

**Step 2: Apply the Affine Cipher formula**

C=(5P+8)mod  26C = (5P + 8) \mod 26C=(5P+8)mod26

**Calculations:**

* **M (12)** → Q
* **U (20)** → E
* **H (7)** → R
* **A (0)** → I
* **M (12)** → Q
* **M (12)** → Q
* **A (0)** → I
* **D (3)** → X
* **A (0)** → I
* **S (18)** → U
* **I (8)** → W
* **M (12)** → Q

**Step 3: Convert numbers back to letters**

**Ciphertext:**  
**QERIQQIXIUWQ**

1. **Using Atbash/Mono-alphabetic cipher.**

### ****Atbash Cipher Encryption for "Muhammad Asim"****

Step 1: Convert letters to numbers

Muhammad Asim → M U H A M M A D A S I M

Plaintext M U H A M M A D A S I M

Numeric 12 20 7 0 12 12 0 3 0 18 8 12

Step 2: Apply Atbash Cipher (Reverse the alphabet)

C=(25−P)

Plaintext M (12) U (20) H (7) A (0) M (12) M (12) A (0) D (3) A (0) S (18) I (8) M (12)

Ciphertext N (13) F (5) S (18) Z (25) N (13) N (13) Z (25) W (22) Z (25) H (7) R (17) N (13)

Step 3: Convert back to letters

Ciphertext:

NFSZNNZWZHRN

1. **Using Play Fair (Mono-Alphabetic Cipher):**

**Step 1: Define a Key (Mapping)**

**Since a mono-alphabetic cipher requires a fixed random substitution, let's use a sample key for substitution:**

**makefile**

**CopyEdit**

**Plain: ABCDEFGHIJKLMNOPQRSTUVWXYZ**

**Cipher: QWERTYUIOPASDFGHJKLZXCVBNM**

**This means:**

* **A → Q, B → W, C → E, D → R, ..., Z → M**

**Step 2: Encrypt "Muhammad Asim"**

**Using the key above, we substitute each letter:**

| **Plaintext** | **M** | **U** | **H** | **A** | **M** | **M** | **A** | **D** | **A** | **S** | **I** | **M** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ciphertext** | **K** | **L** | **O** | **Q** | **K** | **K** | **Q** | **R** | **Q** | **X** | **P** | **K** |

**Step 3: Final Encrypted Text**

**Ciphertext:  
KLOQKKQRQXPK**

**Q2: Encryption of Full name using the techniques studied:**

**1. Additive Cipher (Shift = 3)**

**Formula:**

**C=(P+3)mod  26C = (P + 3) \mod 26C=(P+3)mod26**

**Step 1: Convert letters to numbers**

**U = 20, M = 12, A = 0, R = 17, A = 0, L = 11, T = 19, A = 0, F = 5**

**Step 2: Apply the Shift (+3)**

| **Plaintext** | **U (20)** | **M (12)** | **A (0)** | **R (17)** | **A (0)** | **L (11)** | **T (19)** | **A (0)** | **F (5)** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ciphertext** | **X (23)** | **P (15)** | **D (3)** | **U (20)** | **D (3)** | **O (14)** | **W (22)** | **D (3)** | **I (8)** |

**Final Encrypted Text:**

**XPDUDOWDI**

**2. Multiplicative Cipher (Key = 5)**

**Formula:**

**C=(P×5)mod  26C = (P \times 5) \mod 26C=(P×5)mod26**

**Step 1: Convert letters to numbers**

**U = 20, M = 12, A = 0, R = 17, A = 0, L = 11, T = 19, A = 0, F = 5**

**Step 2: Apply Multiplication by 5 (mod 26)**

| **Plaintext** | **U (20)** | **M (12)** | **A (0)** | **R (17)** | **A (0)** | **L (11)** | **T (19)** | **A (0)** | **F (5)** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ciphertext** | **(20×5) % 26 = 22 → W** | **(12×5) % 26 = 8 → I** | **(0×5) % 26 = 0 → A** | **(17×5) % 26 = 7 → H** | **(0×5) % 26 = 0 → A** | **(11×5) % 26 = 3 → D** | **(19×5) % 26 = 17 → R** | **(0×5) % 26 = 0 → A** | **(5×5) % 26 = 25 → Z** |

**Final Encrypted Text:**

**WIAHADRAZ**

**3. Affine Cipher (a = 5, b = 8)**

**Formula:**

**C=(5P+8)mod  26C = (5P + 8) \mod 26C=(5P+8)mod26**

**Step 1: Convert letters to numbers**

**U = 20, M = 12, A = 0, R = 17, A = 0, L = 11, T = 19, A = 0, F = 5**

**Step 2: Apply Affine Cipher formula**

| **Plaintext** | **U (20)** | **M (12)** | **A (0)** | **R (17)** | **A (0)** | **L (11)** | **T (19)** | **A (0)** | **F (5)** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ciphertext** | **(20×5 + 8) % 26 = 6 → G** | **(12×5 + 8) % 26 = 16 → Q** | **(0×5 + 8) % 26 = 8 → I** | **(17×5 + 8) % 26 = 15 → P** | **(0×5 + 8) % 26 = 8 → I** | **(11×5 + 8) % 26 = 11 → L** | **(19×5 + 8) % 26 = 21 → V** | **(0×5 + 8) % 26 = 8 → I** | **(5×5 + 8) % 26 = 7 → H** |

**Final Encrypted Text:**

**GQIPILVIH**

**4. Atbash Cipher**

**Formula:**

**C=(25−P)C = (25 - P)C=(25−P)**

**Step 1: Convert letters to numbers**

**U = 20, M = 12, A = 0, R = 17, A = 0, L = 11, T = 19, A = 0, F = 5**

**Step 2: Reverse the Alphabet**

| **Plaintext** | **U (20)** | **M (12)** | **A (0)** | **R (17)** | **A (0)** | **L (11)** | **T (19)** | **A (0)** | **F (5)** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ciphertext** | **(25-20) → F** | **(25-12) → N** | **(25-0) → Z** | **(25-17) → I** | **(25-0) → Z** | **(25-11) → O** | **(25-19) → G** | **(25-0) → Z** | **(25-5) → U** |

**Final Encrypted Text:**

**FNZIZOGZU**

**5. Mono-Alphabetic Cipher (Using a Fixed Key)**

**Using the substitution key:**

**makefile**

**CopyEdit**

**Plain: ABCDEFGHIJKLMNOPQRSTUVWXYZ**

**Cipher: QWERTYUIOPASDFGHJKLZXCVBNM**

**Step 1: Encrypt Each Letter**

| **Plaintext** | **U** | **M** | **A** | **R** | **A** | **L** | **T** | **A** | **F** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ciphertext** | **I** | **K** | **Q** | **L** | **Q** | **S** | **Z** | **Q** | **Y** |

**Final Encrypted Text:**

**IKQLQSZQY**