Q1:
Plaintext: VuNguyens4010423@student.
01010110 01110101 01001110 01100111 01110101 01111001 01100101 01101110
01110011 00110100 00110000 00110001 00110000 00110100 00110010 00110011
01000000 01110011 01110100 01110101 01100100 01100101 01101110 01110100
00101110

1. θ mapping

C[x] Operation

01010110	01110101	01001110	01100111	01110101
01111001	01100101	01101110	01110011	00110100
00110000	00110001	00110000	00110100	00110010
00110011	01000000	01110011	01110100	01110101
01100100	01100101	01101110	01110100	00101110

C[0] = A[0][0] ⊕ A[0][1] ⊕ A[0][2] ⊕ A[0][3] ⊕ A[0][4]

01010110 ⊕ 01111001 = 00101111
00101111 ⊕ 00110000 = 00011111
00011111 ⊕ 00100111 = 00111000
00111000 ⊕ 01100100 = 01011100

C[0] = 01011100

C[0]	C[1]	C[2]	C[3]	C[4]
01011100	00010100	00011101	00100000	00110111

D[x] = operation

$$C[x] = A[x,0] \oplus A[x,1] \oplus A[x,2] \oplus A[x,3] \oplus A[x,4]$$
$$D[x] = C[x-1] \oplus \text{rot}(C[x+1],1)$$
$$A[x,y] = A[x,y] \oplus D[x]$$

D[0] = C[4] ⊕ rot(C[1], 1)
D[0] = 00110111 ⊕ rot(00010100, 1)
D[0] = 00110111 ⊕ 00101000
D[0] = 00011111

D[0]	D[1]	D[2]	D[3]	D[4]
00011111	01100110	01010100	01110011	10011000

A[x,y] operation

A[x,y] = A[x,y] ⊕ D[x]

01010110	01110101	01001110	01100111	01110101
01111001	01100101	01101110	01110011	00110100
00110000	00110001	00110000	00110100	00110010
00110011	01000000	01110011	01110100	01110101
01100100	01100101	01101110	01110100	00101110

D[0]	D[1]	D[2]	D[3]	D[4]
00011111	01100110	01010100	01110011	10011000

A[x,y]	0	1	2	3	4
0	01001001	00010011	00011010	00010100	11101101
1	01100110	00000011	00111010	00000000	10101100
2	00101111	01000111	01100100	00010111	10111010
3	00111000	00100110	00110111	00000110	11110010
4	01111011	00000011	00111010	00000111	10110110

2. ϱ mapping

	x = 3	x = 4	x = 0	x = 1	x = 2
y=2	25	39	3	10	43
y=1	55	20	36	44	6
y=0	28	27	0	1	62
y=4	56	14	18	2	61
y=3	21	8	41	45	15

A[x,y]	0	1	2	3	4
0	01001001	00010011	00011010	00010100	11101101
1	01100110	00000011	00111010	00000000	10101100
2	00101111	01000111	01100100	00010111	10111010
3	00111000	00100110	00110111	00000110	11110010
4	01111011	00000011	00111010	00000111	10110110

A[0,2] = 00101111
ϱ[0,2] = 3

3 mod 8 = 3

rotl(00101111 ,3) =01111001

A[0,1] = 01100110
ϱ[0,1] = 36

36 mod 8 = 4
rotl(01100110 ,4) =01100110

01001001	00100110	10000110	01000001	01101111
01100110	00110000	10001110	00000000	11001010
01111001	00011101	00100011	00101110	01011101
01110000	11000100	10011011	11000000	11110010
11101101	00001100	01000111	00000111	10101101

3. π Mapping

ϱ[x,y]	0	1	2	3	4
0	01001001	00100110	10000110	01000001	01101111
1	01100110	00110000	10001110	00000000	11001010
2	01111001	00011101	00100011	00101110	01011101
3	01110000	11000100	10011011	11000000	11110010
4	11101101	00001100	01000111	00000111	10101101

ϱ[x,y]	0	1	2	3	4
0	ϱ[0,0]	ϱ[1,0]	ϱ[2,0]	ϱ[3,0]	ϱ[4,0]
1	ϱ[0,1]	ϱ1,1]	ϱ[2,1]	ϱ[3,1]	ϱ[4,1]
2	ϱ[0,2]	ϱ[1,2]	ϱ[2,2]	ϱ[3,2]	ϱ[4,2]
3	ϱ[0,3]	ϱ[1,3]	ϱ[2,3]	ϱ[3,3]	ϱ[4,3]
4	ϱ[0,4]	ϱ[1,4]	ϱ[2,4]	ϱ[3,4]	ϱ[4,4]

π(x, y) = ϱ[y][(2x + 3y) mod 5]

π(0, 0) = ϱ[0][(2*0+ 3*0) mod 5]
π(0, 0) = ϱ(0,0)

π(1, 0) = ϱ[0][(2*1 + 3*0) mod 5]
π(1, 0) = ϱ(0,2)

π[x,y]	0	1	2	3	4
0	ϱ[0,0]	ϱ[0,2]	ϱ[0,4]	ϱ[0,1]	ϱ[0,3]
1	ϱ[1,3]	ϱ[1,0]	ϱ[1,2]	ϱ[1,4]	ϱ[1,1]
2	ϱ[2,1]	ϱ[2,3]	ϱ[2,0]	ϱ[2,2]	ϱ[2,4]
3	ϱ[3,4]	ϱ[3,1]	ϱ[3,3]	ϱ[3,0]	ϱ[3,2]
4	ϱ[4,2]	ϱ[4,4]	ϱ[4,1]	ϱ[4,3]	ϱ[4,0]

π[x,y]	0	1	2	3	4
0	01001001	00110000	00100011	11000000	10101101
1	01000001	11001010	01111001	11000100	01000111
2	00100110	10001110	00101110	11110010	11101101
3	01101111	01100110	00011101	10011011	00000111
4	10000110	00000000	01011101	01110000	00001100

4. χ mapping

$$A[x,y] = B[x,y] \oplus ((\bar{B}[x+1,y]) \wedge B[x+2,y]) \quad , \quad x,y = 0,1,2,3,4$$

χ(0,0)=A[0][0] $\oplus$ (¬A[1][0] $\wedge$ A[2][0])
01001001$\oplus$ (¬00110000 $\wedge$ 10000110)
01001001$\oplus$ (11001111 $\wedge$ 10000110)
01001001$\oplus$10000110
χ(0,0) = 01001010

χ(1,0) = A[1][0]$\oplus$(¬A[2][0] $\wedge$ A[3][0])
00110000$\oplus$(¬10000110 $\wedge$ 11000000)
00110000$\oplus$(01111001 $\wedge$ 11000000)
00110000$\oplus$01000000
χ(1,0) = 11110000

χ[x,y]	0	1	2	3	4
0	01001010	11110000	00001110	10000000	10011101
1	01110000	01001110	01111010	11000100	11001101
2	00000110	01011110	00100011	11110000	01100101
3	01110110	11100100	00011001	11110011	00000111
4	11011011	00100000	01010001	11110010	00001100

5. ι mapping

ι[x,y]	0	1	2	3	4
0	01001011	11110000	00001110	10000000	10011101
1	01110000	01001110	01111010	11000100	11001101
2	00000110	01011110	00100011	11110000	01100101
3	01110110	11100100	00011001	11110011	00000111
4	11011011	00100000	01010001	11110010	00001100

Q2:
K = 4010423/K7MDENG+bPxRfiCYEXAMPLEKEY =
343031303432332f4b374d44454e472b6250785266694359455841 4d504c454b4559000000
0000000000000000000000000000000000000000000000000000000000000000

m =
AWS4-HMAC-SHA256
20250415M123600Z
20250415/us-east-1/iam/aws4_request
F536975d06c0309214f805bb90ccff089219ecd68b2577efef23edd43b7e1a59

415753342d484d41432d5348413235360d0a32303235303431354d3132333630305a0d0a3
2303235303431352f75732d656173742d312f69616d2f617773345f726571756573740d0a66
353336393735643036633033303932313466383035626239306363666630383932313965 6
364363862323537376566656632336564643433623765316135390d0a

Q3:

Keys and timestamp:

KC = 7c87b7e19d52cd8663223cad6b9233ab
KS = 39ffe3021bcad0da66bc4efc46ef0360
nC = f04981feda3674db9223bb95eda3da2f
timestamp = 11/05/2025, 21:56:00

Ticket:

c524f78ebb017a214e31bf4b53033bd410b4823c7fd81005966d8f6467f02c35

Authenticator:

03705b3885e4d1a7737a13f147bd8c26940a8f0f4c027410d7a215899d5b27d29f030c238afb
88cfe9d33055c4c400230b323be14d3550543c6d53a480c9c8b4

Authenticator Decrypted

f04981feda3674db9223bb95eda3da2f11/05/2025, 21:56:00

Q5:
1)
e= s4010423 = 3D31B7

Ephemeral key =
B3D72C1F8EAD6B4AB9A39D531CE1EF2175A7623D0924BAF95358B028369D4ACF
5ED9D2C0A88D7E94E6CE41BE349B4D67E2C108D1AEAA3935371B7A3CF4C2A23C
1195D184B1B8FA32BFA2A75888EECFBD2D11E91A0C6ED79A1E6B8B730BCDA3FD
43C9A93BA2BB6974B81FC438C19D3AD4F6BB7DF31D4C8BA3F9913EF49C867B51

2)
Ephemeral key + e =
B3D72C1F8EAD6B4AB9A39D531CE1EF2175A7623D0924BAF95358B028369D4ACF5ED
9D2C0A88D7E94E6CE41BE349B4D67E2C108D1AEAA3935371B7A3CF4C2A23C1195D1
84B1B8FA32BFA2A75888EECFBD2D11E91A0C6ED79A1E6B8B730BCDA3FD43C9A93B
A2BB6974B81FC438C19D3AD4F6BB7DF31D4C8BA3F9913EF49C867B513D31B7

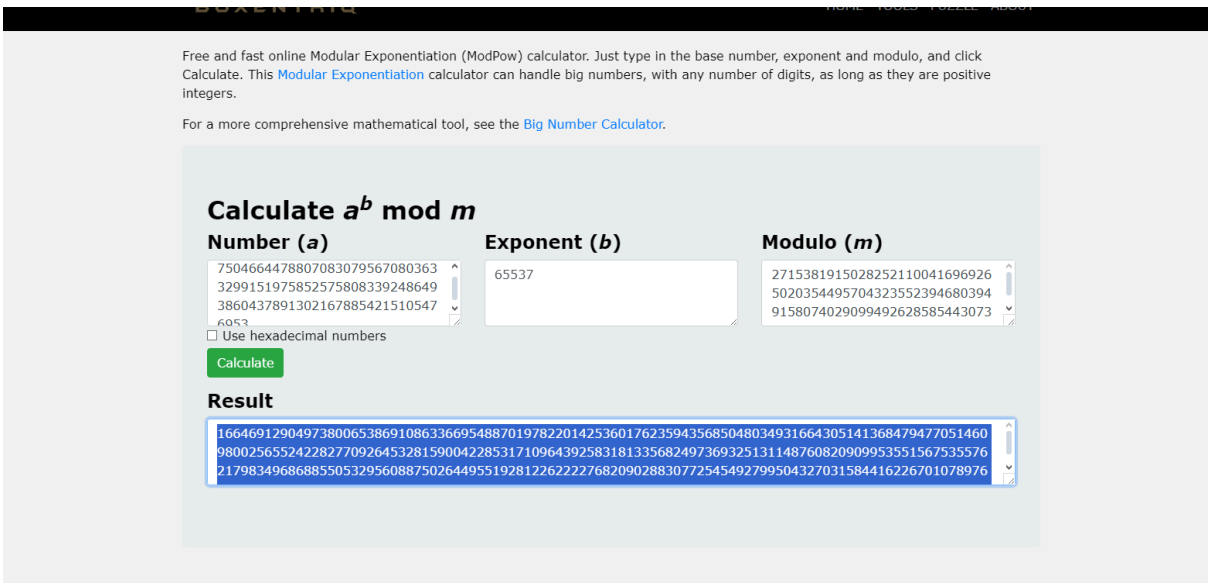
After hashed
Cfa64e36a57718a7ffa84c9227ec60f506286b94aaf455ace9fcbea0bf87029c

a^b mod m =
96aa0ab0f5eaf060e61f925bc8e713fa166b0ec9eff9c66d697079a68dca59b04ac16bfe760de
5451cf5bc7ba6312d63e1c8b018bc8329000ed45919989ae18a454f58418a3814b456c2aa68
172482bb7ed21e8e4fd41bd479f791e099109a9a1aa9eb4fb1f4068739dd756f740fe0862adef
fb6dd0fdff0706d7c209d0ab21cd55857ad1b3e67874b79179e2d92a75b6d7d2ec7979c2b229
de37273f70aacf3d6c45f80eabeda6b9d35387e6ef097d6b6b5ba273cf6f880bcc917a4b51e0a
275a4b69af2d5d6016abef5acdf12dbf77f957983bb76325c2fbb36a2df482121a1387345dfb68
28aa9615a4f287f6580f7815c494a070d417367104dd2d8e2dd6

3)Pre_master_secret= s4010423@student.rmit.edu.au =
5b6295b95611541897ef2591f488f94b083a892d9e75cf533e23636533e2c334b93ab469e8e3
c7b7f6586a9d27777959

Converted to decimal

140654537595593535731368052775046644788070830795670803633299151975852575808339248649386043789130216788542151054769 53



166469129049738006538691086336695488701978220142536017623594356850480349316643051413684794770514609800256552422827709264532815900422853171096439258318133568249736932513114876082090995355156753557621798349686885505329560887502644955192812262222768209028830772545492799504327031584416226701078976766154294581789387520327401576239775824033875835059702809448310507367629770767291199932185658247778201662151924311055150350768183527726349909996580521572358488103526989942563372052384040060097567168180333890595860101620967708730384126405761538170436036017887458136703768833880541406057404927403902536842894964571248956467893 6

4)In the SSL handshake protocol, the authentication is achieved through using a digital certificate. When a user connects, it verifies the certificate and confirming the server’s identity

5) Forward security ensures that if a private key of a server is breached and compromised, past communication will still be safe. This is possible through the usage of ephemeral key exchange