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School of Computer Science and Engineering

Winter Semester 2023-24

Continuous Assessment Test – I

SLOT E1+TE1

Programme Name & Branch: B.Tech & Computer Science and Engineering

Course Name & Code: Cryptography and Network Security & BCSE309L

Class Number (s): Applicable to all

Faculty Name (s): Applicable to all

Exam Duration: 90 Min. **Maximum Marks: 50**

General instruction(s):

Answer All the Questions and calculator is allowed

Q. No.	Question	Max Marks
1.	a) Find GCD, variables S and T by construct a table for the following inputs using Extended Euclidean Algorithm. 291, 41.	5

- We use the following table:

q	r_1	r_2	r	s_1	s_2	s	t_1	t_2	t
6	291	42	39	1	0	1	0	1	−6
1	42	39	3	0	1	−1	1	−6	7
13	39	3	0	1	−1	14	−6	7	−97
	3	0		−1	14		7	−97	
	↑ gcd			↑ s			↑ t		

$$\gcd(291, 42) = 3 \quad \rightarrow \quad (291)(-1) + (42)(7) = 3$$

	b) Find the remainder for $2^{20} + 3^{30} + 4^{40} + 5^{50} + 6^{60}$ mod 7 using Fermat's Little Theorem.	5

Find $2^{20} + 3^{30} + 4^{40} + 5^{50} + 6^{60}$ mod 7.

[Solution: $2^{20} + 3^{30} + 4^{40} + 5^{50} + 6^{60} \equiv 0 \bmod 7$]

By Fermat's Little Theorem, $2^6 \equiv 3^6 \equiv 4^6 \equiv 5^6 \equiv 6^6 \equiv 1 \bmod 7$. Thus, $2^{20} + 3^{30} + 4^{40} + 5^{50} + 6^{60} \equiv 2^2 + 3^0 + 4^4 + 5^2 + 6^0 \equiv 4 + 1 + 2^8 + 25 + 1 \equiv 4 + 1 + 4 + 4 + 1 \equiv 14 \equiv 0 \bmod 7$.

2.	A hoard of gold pieces comes into the possession of' a band of 15 pirates. When they come to divide up the coins, they find that 3 are left over. Their discussion of what to do with these extra coins becomes animated, and by the time some semblance of order returns there remain only 7 pirates capable of making an effective claim on the hoard. When, however, the hoard is divided between these seven it is found that 2 pieces are left over. There ensues an unfortunate repetition of the earlier disagreement, but this does at least have the consequence that the 4 pirates who remain are able to divide up the hoard evenly between them. What is the minimum number of gold pieces which could have been in the hoard?	10

$x \equiv 3 \mod 15$

$x \equiv 2 \mod 7$

$x \equiv 0 \mod 4$

$GCD(15,7)$, $GCD(15,4)$, $GCD(7,4) = 1$

1) $M = m_1 \times m_2 \times m_3$

$M = 15 \times 7 \times 4$

$\boxed{M = 420}$

2) $M_1 = M / m_1$

$= 420/15 = \boxed{M_1 = 28}$

$M_2 = 420/7 = \boxed{M_2 = 60}$

$M_3 = 420/4 = \boxed{M_3 = 105}$

$m_1^{-1} = 28^{-1} (\mod 15)$

$= 28 \times ? \mod 15 = 1$

$= 28 \times 7 \mod 15 = 1$

$= 196 \mod 15 = 1$

$\boxed{m_1^{-1} = 7}$

$m_2^{-1} = 60^{-1} (\mod 7)$

$= 60 \times ? \mod 7 = 1$

$= 60 \times 2 \mod 7 = 1$

$= 120 \mod 7 = 1$

$\boxed{m_2^{-1} = 2}$

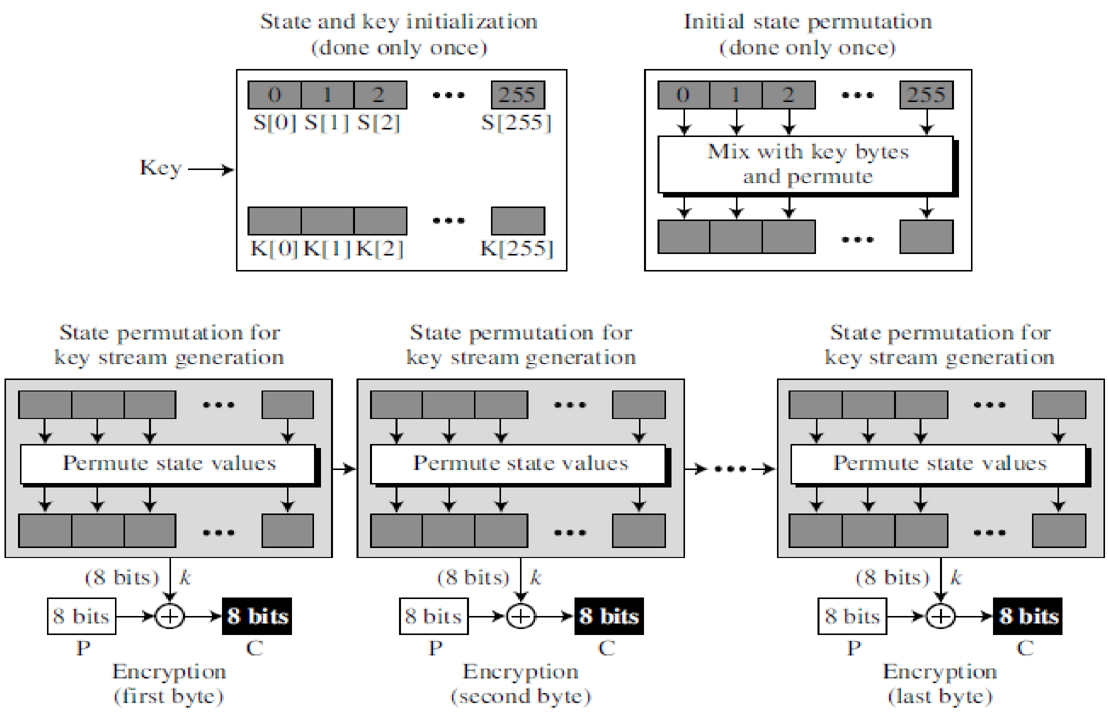
$$x = [(3 \times 28 \times 7) + (2 \times 60 \times 2)] \bmod 420$$

$$x = [588 + 240] \bmod 420$$

$$x = 828 \bmod 420$$

$$\boxed{x = 408}$$

3. Draw an architecture of RC4 algorithm and discuss the process of initialization, initial state permutation, key stream generation and encryption in detail. 10



Architecture – 2
Initialization process - 2
Initial state permutation - 2
Key stream generation - 2
Encryption - 2

4. a) Explain the DES feistel structure in detail with neat diagram. 5

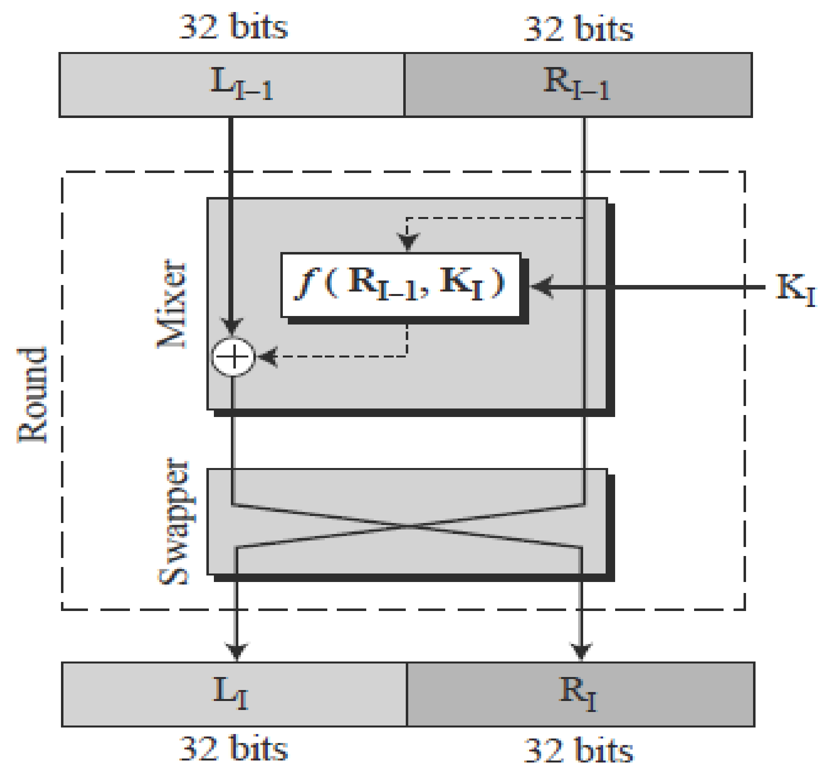


Fig. 6.4 *A round in DES (encryption site)*

b) Answer the following questions about S-boxes in DES:

i) Show the result of passing the input 111111 through S-box 2. 5
ii) Show the result of passing the input 000000 through S-box 7.

S-box 2 Table

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	15	01	08	14	06	11	03	04	09	07	02	13	12	00	05	10
1	03	13	04	07	15	02	08	14	12	00	01	10	06	09	11	05
2	00	14	07	11	10	04	13	01	05	08	12	06	09	03	02	15
3	13	08	10	01	03	15	04	02	11	06	07	12	00	05	14	09

S-box 7 Table

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	4	11	2	14	15	00	08	13	03	12	09	07	05	10	06	01
1	13	00	11	07	04	09	01	10	14	03	05	12	02	15	08	06
2	01	04	11	13	12	03	07	14	10	15	06	08	00	05	09	02
3	06	11	13	08	01	04	10	07	09	05	00	15	14	02	03	12

i)

Input: 1 1111 1 → 3, 15 → Output: 09 (1001)

ii)

Input: 0 0000 0 → 0, 0 → Output: 04 (0100)

5. Find the third round key of AES 128 using the following second round key which is given in hexadecimal, S-Box table and round constant 04. 10

Second Round Key

56	C7	76	A0
08	1A	43	3A
20	B1	55	F7
07	8F	69	FA

S-Box Table

		Y															
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
x	0	63	7C	77	7B	F2	6B	6F	C5	30	01	67	2B	FE	D7	AB	76
	1	CA	82	C9	7D	FA	59	47	F0	AD	D4	A2	AF	9C	A4	72	C0
	2	B7	FD	93	26	36	3F	F7	CC	34	A5	E5	F1	71	D8	31	15
	3	04	C7	23	C3	18	96	05	9A	07	12	80	E2	EB	27	B2	75
	4	09	83	2C	1A	1B	6E	5A	A0	52	3B	D6	B3	29	E3	2F	84
	5	53	D1	00	ED	20	FC	B1	5B	6A	CB	BE	39	4A	4C	58	CF
	6	D0	EF	AA	FB	43	4D	33	85	45	F9	02	7F	50	3C	9F	A8
	7	51	A3	40	8F	92	9D	38	F5	BC	B6	DA	21	10	FF	F3	D2
	8	CD	0C	13	EC	5F	97	44	17	C4	A7	7E	3D	64	5D	19	73
	9	60	81	4F	DC	22	2A	90	88	46	EE	B8	14	DE	5E	0B	DB
	A	E0	32	3A	0A	49	06	24	5C	C2	D3	AC	62	91	95	E4	79
	B	E7	C8	37	6D	8D	D5	4E	A9	6C	56	F4	EA	65	7A	AE	08
	C	BA	78	25	2E	1C	A6	B4	C6	E8	DD	74	1F	4D	BD	8B	8A
	D	70	3E	B5	66	48	03	F6	0E	61	35	57	B9	86	C1	1D	9E
	E	E1	F8	98	11	69	D9	8E	94	9B	1E	87	E9	CE	55	28	DF
	F	8C	A1	89	0D	BF	E6	42	68	41	99	2D	0F	B0	54	BB	16

Second Round Key = 56 C7 76 A0
08 1A 43 3A
20 B1 55 F7
07 8F 69 FA

$\uparrow$ W_4 $\uparrow$ W_5 $\uparrow$ W_6 $\uparrow$ W_7

Find

g(w7) = g(A0 3A F7 FA)

1) Rotword one byte circular shift
= 3A F7 FA A0

2) Sub word = 80 68 2D E0

3) EX OR with RC
= 80 68 2D E0 XOR
04 00 00 00

$\boxed{g(W7) = 84\ 68\ 2D\ E0}$

4) $w8 = w4 \oplus g(w7)$

$= 56\ 08\ 20\ 07$

$\ 84\ 68\ 2D\ E0$

$w8 = D2\ 60\ 0D\ E7$

5) $w9 = w5 \oplus w8$

$= C7\ 1A\ B1\ 8F$

$\ D2\ 60\ 0D\ E7$

$w9 = 15\ 7A\ BC\ 68$

6) $w10 = w6 \oplus w9$

$= 76\ 43\ 55\ 69$

$\ 15\ 7A\ BC\ 68$

$w10 = 63\ 39\ E9\ 01$

7 $w11 = w7 \oplus w10$

$= A0\ 3A\ F7\ FA$

$\ 63\ 39\ E9\ 01$

$w11 = C3\ 03\ 1E\ FB$

Round 3 key:

D2 60 0D E7 15 7A BC 68 63 39 E9 01 C3 03 1E FB