```
################################################################

   Block Cipher Modes of Operation

       Electronic Codebook (ECB)

Plaintext is
     6BC1BEE2 2E409F96 E93D7E11 7393172A
     AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51
     30C81C46 A35CE411 E5FBC119 1A0A52EF
     F69F2445 DF4F9B17 AD2B417B E66C3710


################################################################

ECB-AES128 (Encryption)
----------------------------------------------------------------

Key is
     2B7E1516 28AED2A6 ABF71588 09CF4F3C

Plaintext is
     6BC1BEE2 2E409F96 E93D7E11 7393172A
     AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51
     30C81C46 A35CE411 E5FBC119 1A0A52EF
     F69F2445 DF4F9B17 AD2B417B E66C3710

KeyAddition    40BFABF4 06EE4D30 42CA6B99 7A5C5816

Round = 1
  Substitution   090862BF 6F28E304 2C747FEE DA4A6A47
  ShiftRow       09287F47 6F746ABF 2C4A6204 DA08E3EE
  MixColumn      529F16C2 978615CA E01AAE54 BA1A2659
  KeyAddition    F265E8D5 1FD2397B C3B9976D 9076505C

Round = 2
  Substitution   894D9B03 C0B51221 2E56883C 6038534A
  ShiftRow       89B5884A C0565303 2E389B21 604D123C
  MixColumn      0F31E929 319A3558 AEC95893 39F04D87
  KeyAddition    FDF37CDB 4B0C8C1B F7FCD8E9 4AA9BBF8

Round = 3
  Substitution   540D10B9 B3FE64AF 68B0611E D6D3EA41
  ShiftRow       54FE6141 B3B0EAB9 68D310AF D60D641E
  MixColumn      9151ABE1 E5541CFD 014A713E DA7E3134
  KeyAddition    ACD1EC9C A242E2C3 1F690F7A B704B90F
```

```
Round = 4
  Substitution   913ECEDE  3A2C982E  C0F976DA  A9F25676
  ShiftRow       912C7676  3AF956DE  C0F2CE2E  A93E98DA
  MixColumn      4D25CB1E  ECF71646  7658C73B  49BCC9E9
  KeyAddition    A2616E5F  44A54D39  C029E200  92B764E9

Round = 5
  Substitution   3AEF9FCF  1B06E312  BAA59863  4FA9431E
  ShiftRow       3A06981E  1BA543CF  BAA99F12  4FEFE363
  MixColumn      F89B35EC  4E40724E  025B00C7  34D7D81B
  KeyAddition    2C4AF314  32C3EFC9  C8A9B87B  252ECDA7

Round = 6
  Substitution   71D60DFA  232EDFDD  E8D36C21  3F31BD5C
  ShiftRow       712E6C5C  23D3BDFA  E8310DDD  3FD6DF21
  MixColumn      A0C56369  6FB884E4  4840BFBE  E1D32F0A
  KeyAddition    CD4DC013  7EB3BA19  93B939FF  2BD3BCF7

Round = 7
  Substitution   BDE3BA7D  F36DF4D4  DC561216  F1666568
  ShiftRow       BD6D1268  F356657D  DC66BAD4  F1E3F416
  MixColumn      AC394C73  1F8DE8C7  6711B210  253DDB33
  KeyAddition    E26DBB7D  40D22134  E3B7FDA2  6B9B077C

Round = 8
  Substitution   983CEAFF  09B5FD18  11A9543A  7F14C510
  ShiftRow       98B55410  09A9C5FF  1114EA18  7F3CFD3A
  MixColumn      AB05B572  C8EB2B92  EC04E2FD  7D21EC34
  KeyAddition    41D7C653  7D669140  DD2F179D  02ACC51B

Round = 9
  Substitution   830EB4ED  FF338109  C115F05E  7791A6AF
  ShiftRow       8333F0AF  FF15A6ED  C191B409  770E815E
  MixColumn      1741A118  91C99168  8C36386F  23AD82AA
  KeyAddition    BB36C7EB  88334D49  A4E7112E  74F182C4

Substitution   EA05C6E9  C4C3E33B  49948231  92A1131C
ShiftRow       EAC3821C  C49413E9  49A1C63B  9205E331
KeyAddition    3AD77BB4  0D7A3660  A89ECAF3  2466EF97

KeyAddition    85539F41  36AD7E3A  35407A24  4C60C16D

Round = 1
  Substitution   97EDDB83  0595F380  9609DA36  29D0783C
  ShiftRow       9795DA3C  05097883  96D0DB80  29EDF336
  MixColumn      77EFE995  EA1C6263  07DB70B1  BBD06309
```

```
   KeyAddition     D7151782 62484ED2 24784988 91BC150C

Round = 2
  Substitution   0E59F013 AA522FB5 36BC3BC4 816559FE
  ShiftRow       0E523BFE AABC5913 3665F0B5 81592FC4
  MixColumn      2F19339C DA319126 86426CBE 1986D17D
  KeyAddition    DDDBA66E A0A72865 DF77ECC4 6ADF2702

Round = 3
  Substitution   C1B9249F E05C344D 9EF5CE1C 029ECC77
  ShiftRow       C15CCE77 E0F5CC9F 9E9E244D 02B9341C
  MixColumn      C4478324 8CC12C27 F7989F99 FC2BF7B3
  KeyAddition    F9C7C459 CBD7D219 E9BBE1DD 91517F88

Round = 4
  Substitution   99C61CCB 1F0EB5D4 1EEAF8C1 81D1D2C4
  ShiftRow       990EF8C4 1FEAD2CB 1ED11CD4 81C6B5C1
  MixColumn      07522BD5 02760C94 9C57905C 3C136E72
  KeyAddition    E8168E94 AA2457EB 2A26B567 E718C372

Round = 5
  Substitution   9B471922 AC365BE9 E5F7D585 94AD2E40
  ShiftRow       9B36D540 ACF72E22 E5AD19E9 94475B85
  MixColumn      E2D3DCD5 4D096172 CD665A49 2472F1AA
  KeyAddition    36021A2D 318AFCF5 0794E2F5 358BE416

Round = 6
  Substitution   0577A2D8 C77EB0E6 C52298E6 963D6947
  ShiftRow       057E9847 C72269D8 C53DA2E6 9677B0E6
  MixColumn      570D9967 42E044B2 92A4961C F855ABB1
  KeyAddition    3A853A1D 53EB7A4F 495D105D 3255384C

Round = 7
  Substitution   809780A4 EDE9DA84 3B4CCA4C 23FC0729
  ShiftRow       80E9CA29 ED4C07A4 3BFC8084 2397DA4C
  MixColumn      D8259DEA B6D85834 6DC74B22 722FCFB0
  KeyAddition    96716AE4 E98791C7 E9610490 3C8913FF

Round = 8
  Substitution   90A30269 1E1781C6 1EEFF260 EBA77D16
  ShiftRow       9017F216 1EEF7D69 1EA702C6 EBA38160
  MixColumn      E6A54262 0235B062 0A8BEC10 D24EF1C4
  KeyAddition    0C773143 B7B80AB0 3BA01970 ADC3D8EB

Round = 9
  Substitution   FEF5C71A A96C67E7 E2E0D451 952E61E9
```

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  ShiftRow       FE6CD4E9 A9E0611A E22EC7E7 95F56751
  MixColumn      6EA80168 09CBA555 8D0B6B01 039C5D94
  KeyAddition    C2DF679B 10317974 A5DA4240 54C05DFA

Substitution   259E8514 CAC7B692 06572C09 20BA4C2D
ShiftRow       25C72C2D CA574C14 06BA8592 209EB609
KeyAddition    F5D3D585 03B9699D E785895A 96FDBAAF

KeyAddition    1BB60950 8BF236B7 4E0CD491 13C51DD3

Round = 1
  Substitution   AF4E0153 3D8905A9 2FFE4881 7DA6A466
  ShiftRow       AF894866 3DFEA453 2FA601A9 7D4E0581
  MixColumn      EB181CE7 947E65BB 07D26B9F AC6FA1D5
  KeyAddition    4BE2E2F0 1C2A490A 247152A6 8603D7D0

Round = 2
  Substitution   B398988C 9CE53B67 36A30024 447B0E70
  ShiftRow       B3E50070 9CA30E8C 367B9867 44983B24
  MixColumn      3912C6CB 5F5FAC11 1E14CF77 2406C627
  KeyAddition    CBD05339 25C91552 47214F0D 575F3058

Round = 3
  Substitution   1F70ED12 3FDD5900 A0FD84D7 5BCF046A
  ShiftRow       1FDD846A 3FFD0412 A0CFED00 5B7059D7
  MixColumn      AC436FAC 74C0FC9C FC09AED9 A887FB71
  KeyAddition    91C328D1 33D602A2 E22AD09D C5FD734A

Round = 4
  Substitution   812E343E C3F6773A 98E5705E A6548FD6
  ShiftRow       81F670D6 C3E58F3E 9854343A A62E775E
  MixColumn      BE30F6A9 18A66148 D956EAA7 0C3D8414
  KeyAddition    517453E8 B0F43A37 6F27CF9C D7362914

Round = 5
  Substitution   D192ED9B E7BF809A A8CC8ADE 0E05A5FA
  ShiftRow       D1BF8AFA E7CCA59B A805ED9A 0E9280DE
  MixColumn      13CB74B2 A40BCC76 3314D924 EF74FEA7
  KeyAddition    C71AB24A D88851F1 F9E66198 FE8DEB1B

Round = 6
  Substitution   C6A237D6 61C4D1A1 998EEF46 BB5DE9AF
  ShiftRow       C6C4EFAF 618EE9D6 995D37A1 BBA2D146
  MixColumn      80D02D3F 74904773 58DB5283 07CA6A29
  KeyAddition    ED588E45 659B798E 8322D4C2 CDCAF9D4
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```
Round = 7
  Substitution   556A196E 4D14B619 EC934825 BD749948
  ShiftRow       55144848 4D93996E EC741919 BD6AB625
  MixColumn      96ED0933 C3AE4501 5F368170 4C8DCF4A
  KeyAddition    D8B9FE3D 9CF18CF2 DB90CEC2 022B1305

Round = 8
  Substitution   6156BB27 DEA16489 B9608B25 77F17D6B
  ShiftRow       61A18B6B DE607D27 B9F1BB89 77566425
  MixColumn      DAD5705F 5DBE2D2A 531FA593 555286E1
  KeyAddition    3007037E E83397F8 623450F3 2ADFAFCE

Round = 9
  Substitution   04C57BF3 9BC38841 AA18530D E59E798B
  ShiftRow       04C3538B 9B1879F3 AA9E7B41 E5C5880D
  MixColumn      8EE7E791 8FD37F2A CC410182 00FA3C63
  KeyAddition    22908162 9629A30B E49028C3 57A63C0D

Substitution   93600CAA 90A50A2B 6960342E 5B24EBD7
ShiftRow       93A534D7 9060EBAA 69240C2B 5B600A2E
KeyAddition    43B1CD7F 598ECE23 881B00E3 ED030688

KeyAddition    DDE13153 F7E149B1 06DC54F3 EFA3782C

Round = 1
  Substitution   C1F8C7ED 68F83BC8 6F86200D DF0ABC71
  ShiftRow       C1F82071 6886BCED 6F0AC7C8 DFF83B0D
  MixColumn      DB3BEA62 104DA143 CFE1B3F7 807446A3
  KeyAddition    7BC11475 98198DF2 EC428ACE AA1830A6

Round = 2
  Substitution   2178FA9D 46D45D89 CE2C7E8B ACAD0424
  ShiftRow       21D47E24 462C049D CEADFA89 AC785D8B
  MixColumn      7F346581 618FDEC3 18130C17 1D30E8C7
  KeyAddition    8DF6F073 1B196780 41268C6D 6E691EB8

Round = 3
  Substitution   5D428C8F AFD485CD 83F7643C 9FF9726C
  ShiftRow       5DD4646C AFF7728F 83F98CCD 9F42853C
  MixColumn      D52EF58F BA43366A 4C28356A 5AB38805
  KeyAddition    E8AEB2F2 FD55C854 520B4B2E 37C9003E

Round = 4
  Substitution   9BE43789 54FCE820 002BB331 9ADD63B2
  ShiftRow       9BFCB3B2 542B6389 00DD3720 9AE4E831
  MixColumn      3304D786 3F2E39BD 6BD8D3AA C15BE6DB
```

```
    KeyAddition    DC4072C7 977C62C2 DDA9F691 1A504BDB

Round = 5
  Substitution    860940C6 8810AA25 C1D34281 A253B3B9
  ShiftRow        861042B9 88D3B3C6 C1534025 A209AA81
  MixColumn       DCD9C2AA 103D7774 09827D01 6FD47C47
  KeyAddition     08080452 6CBEEAF3 C370C5BD 7E2D69FB

Round = 6
  Substitution    3030F200 50AE870D 2E51A67A F3D8F90F
  ShiftRow        30AEA60F 5051F900 2ED8F20D F330877A
  MixColumn       2089D846 AAE2E858 D0851E42 507B584D
  KeyAddition     4D017B3C BBE9D6A5 0B7C9803 9A7BCBB0

Round = 7
  Substitution    E37C21EB EA1EF606 2B10467B B8211FE7
  ShiftRow        E31E46E7 EA101FEB 2B212106 B87CF67B
  MixColumn       5EF243B3 0B00E2E7 120C4271 623ABEAF
  KeyAddition     10A6B4BD 545F2B14 96AA0DC3 2C9C62E0

Round = 8
  Substitution    CA248D7A 20CFF1FA 90ACD72E 71DEAAE1
  ShiftRow        CACFD7E1 20ACAA7A 90DE8DFA 7124F12E
  MixColumn       F3CC8884 7FFC4D92 35415A17 511FDE1A
  KeyAddition     191EFBA5 CA71F740 046AAF77 2E92F735

Round = 9
  Substitution    D4720F06 74A36809 F20279F5 314F6896
  ShiftRow        D4A37996 74026806 F24F0F09 317268F5
  MixColumn       A294248A 80CEACFA 2874B85F 699897B8
  KeyAddition     0EE34279 993470DB 00A5911E 3EC497D6

Substitution  AB112CB6 EE1851B9 63068172 B21C88F6
ShiftRow      AB1881F6 EE0688B6 631C2CB9 B2115172
KeyAddition   7B0C785E 27E8AD3F 82232071 04725DD4


Ciphertext is
    3AD77BB4 0D7A3660 A89ECAF3 2466EF97
    F5D3D585 03B9699D E785895A 96FDBAAF
    43B1CD7F 598ECE23 881B00E3 ED030688
    7B0C785E 27E8AD3F 82232071 04725DD4


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ECB-AES128 (Decryption)
```
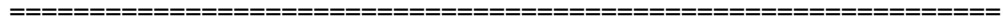
```
------------------------------------------------------------

Key is
    2B7E1516 28AED2A6 ABF71588 09CF4F3C

Ciphertext is
    3AD77BB4 0D7A3660 A89ECAF3 2466EF97
    F5D3D585 03B9699D E785895A 96FDBAAF
    43B1CD7F 598ECE23 881B00E3 ED030688
    7B0C785E 27E8AD3F 82232071 04725DD4

KeyAddition    EAC3821C C49413E9 49A1C63B 9205E331
Substitution   BB3311C4 88E782EB A4F1C749 74364D2E
ShiftRow       BB36C7EB 88334D49 A4E7112E 74F182C4
Round = 9
  KeyAddition    1741A118 91C99168 8C36386F 23AD82AA
  InvMixColumn   8333F0AF FF15A6ED C191B409 770E815E
  Substitution   4166171B 7D2FC553 DDACC640 02D7919D
  ShiftRow       41D7C653 7D669140 DD2F179D 02ACC51B
Round = 8
  KeyAddition    AB05B572 C8EB2B92 EC04E2FD 7D21EC34
  InvMixColumn   98B55410 09A9C5FF 1114EA18 7F3CFD3A
  Substitution   E2D2FD7C 40B7077D E39BBB34 6B6D21A2
  ShiftRow       E26DBB7D 40D22134 E3B7FDA2 6B9B077C
Round = 7
  KeyAddition    AC394C73 1F8DE8C7 6711B210 253DDB33
  InvMixColumn   BD6D1268 F356657D DC66BAD4 F1E3F416
  Substitution   CDB339F7 7EB9BC13 93D3C019 2B4DBAFF
  ShiftRow       CD4DC013 7EB3BA19 93B939FF 2BD3BCF7
Round = 6
  KeyAddition    A0C56369 6FB884E4 4840BFBE E1D32F0A
  InvMixColumn   712E6C5C 23D3BDFA E8310DDD 3FD6DF21
  Substitution   2CC3B8A7 32A9CD14 C82EF3C9 254AEF7B
  ShiftRow       2C4AF314 32C3EFC9 C8A9B87B 252ECDA7
Round = 5
  KeyAddition    F89B35EC 4E40724E 025B00C7 34D7D81B
  InvMixColumn   3A06981E 1BA543CF BAA99F12 4FEFE363
  Substitution   A2A5E2E9 4429645F C0B76E39 92614D00
  ShiftRow       A2616E5F 44A54D39 C029E200 92B764E9
Round = 4
  KeyAddition    4D25CB1E ECF71646 7658C73B 49BCC9E9
  InvMixColumn   912C7676 3AF956DE C0F2CE2E A93E98DA
  Substitution   AC420F0F A269B99C 1F04ECC3 B7D1E27A
  ShiftRow       ACD1EC9C A242E2C3 1F690F7A B704B90F
Round = 3
  KeyAddition    9151ABE1 E5541CFD 014A713E DA7E3134
```

```
  InvMixColumn    54FE6141 B3B0EAB9 68D310AF D60D641E
  Substitution    FD0CD8F8 4BFCBBDB F7A97C1B 4AF38CE9
  ShiftRow        FDF37CDB 4B0C8C1B F7FCD8E9 4AA9BBF8
Round = 2
  KeyAddition     0F31E929 319A3558 AEC95893 39F04D87
  InvMixColumn    89B5884A C0565303 2E389B21 604D123C
  Substitution    F2D2975C 1FB950D5 C376E87B 9065396D
  ShiftRow        F265E8D5 1FD2397B C3B9976D 9076505C
Round = 1
  KeyAddition     529F16C2 978615CA E01AAE54 BA1A2659
  InvMixColumn    09287F47 6F746ABF 2C4A6204 DA08E3EE
  Substitution    40EE6B16 06CA58F4 425CAB30 7ABF4D99
  ShiftRow        40BFABF4 06EE4D30 42CA6B99 7A5C5816
KeyAddition     6BC1BEE2 2E409F96 E93D7E11 7393172A

KeyAddition     25C72C2D CA574C14 06BA8592 209EB609
Substitution    C23142FA 10DA5D9B A5C06774 54DF7940
ShiftRow        C2DF679B 10317974 A5DA4240 54C05DFA
Round = 9
  KeyAddition     6EA80168 09CBA555 8D0B6B01 039C5D94
  InvMixColumn    FE6CD4E9 A9E0611A E22EC7E7 95F56751
  Substitution    0CB819EB B7A0D843 3BC331B0 AD770A70
  ShiftRow        0C773143 B7B80AB0 3BA01970 ADC3D8EB
Round = 8
  KeyAddition     E6A54262 0235B062 0A8BEC10 D24EF1C4
  InvMixColumn    9017F216 1EEF7D69 1EA702C6 EBA38160
  Substitution    968704FF E96113E4 E9896AC7 3C719190
  ShiftRow        96716AE4 E98791C7 E9610490 3C8913FF
Round = 7
  KeyAddition     D8259DEA B6D85834 6DC74B22 722FCFB0
  InvMixColumn    80E9CA29 ED4C07A4 3BFC8084 2397DA4C
  Substitution    3AEB104C 535D381D 49553A4F 32857A5D
  ShiftRow        3A853A1D 53EB7A4F 495D105D 3255384C
Round = 6
  KeyAddition     570D9967 42E044B2 92A4961C F855ABB1
  InvMixColumn    057E9847 C72269D8 C53DA2E6 9677B0E6
  Substitution    368AE216 3194E42D 078B1AF5 3502FCF5
  ShiftRow        36021A2D 318AFCF5 0794E2F5 358BE416
Round = 5
  KeyAddition     E2D3DCD5 4D096172 CD665A49 2472F1AA
  InvMixColumn    9B36D540 ACF72E22 E5AD19E9 94475B85
  Substitution    E824B572 AA26C394 2A188EEB E7165767
  ShiftRow        E8168E94 AA2457EB 2A26B567 E718C372
Round = 4
  KeyAddition     07522BD5 02760C94 9C57905C 3C136E72
  InvMixColumn    990EF8C4 1FEAD2CB 1ED11CD4 81C6B5C1
```

```
   Substitution   F9D7E188 CBBB7F59 E951C419 91C7D2DD
   ShiftRow       F9C7C459 CBD7D219 E9BBE1DD 91517F88
Round = 3
  KeyAddition     C4478324 8CC12C27 F7989F99 FC2BF7B3
  InvMixColumn    C15CCE77 E0F5CC9F 9E9E244D 02B9341C
  Substitution    DDA7EC02 A077276E DFDFA665 6ADB28C4
  ShiftRow        DDDBA66E A0A72865 DF77ECC4 6ADF2702
Round = 2
  KeyAddition     2F19339C DA319126 86426CBE 1986D17D
  InvMixColumn    0E523BFE AABC5913 3665F0B5 81592FC4
  Substitution    D748490C 62781582 24BC17D2 91154E88
  ShiftRow        D7151782 62484ED2 24784988 91BC150C
Round = 1
  KeyAddition     77EFE995 EA1C6263 07DB70B1 BBD06309
  InvMixColumn    9795DA3C 05097883 96D0DB80 29EDF336
  Substitution    85AD7A6D 3640C141 35609F3A 4C537E24
  ShiftRow        85539F41 36AD7E3A 35407A24 4C60C16D
KeyAddition    AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51

KeyAddition    93A534D7 9060EBAA 69240C2B 5B600A2E
Substitution   2229280D 96903C62 E4A6810B 5790A3C3
ShiftRow       22908162 9629A30B E49028C3 57A63C0D
Round = 9
  KeyAddition     8EE7E791 8FD37F2A CC410182 00FA3C63
  InvMixColumn    04C3538B 9B1879F3 AA9E7B41 E5C5880D
  Substitution    303350CE E834AF7E 62DF03F8 2A0797F3
  ShiftRow        3007037E E83397F8 623450F3 2ADFAFCE
Round = 8
  KeyAddition     DAD5705F 5DBE2D2A 531FA593 555286E1
  InvMixColumn    61A18B6B DE607D27 B9F1BB89 77566425
  Substitution    D8F1CE05 9C90133D DB2BFEF2 02B98CC2
  ShiftRow        D8B9FE3D 9CF18CF2 DB90CEC2 022B1305
Round = 7
  KeyAddition     96ED0933 C3AE4501 5F368170 4C8DCF4A
  InvMixColumn    55144848 4D93996E EC741919 BD6AB625
  Substitution    ED9BD4D4 6522F945 83CA8E8E CD5879C2
  ShiftRow        ED588E45 659B798E 8322D4C2 CDCAF9D4
Round = 6
  KeyAddition     80D02D3F 74904773 58DB5283 07CA6A29
  InvMixColumn    C6C4EFAF 618EE9D6 995D37A1 BBA2D146
  Substitution    C788611B D8E6EB4A F98DB2F1 FE1A5198
  ShiftRow        C71AB24A D88851F1 F9E66198 FE8DEB1B
Round = 5
  KeyAddition     13CB74B2 A40BCC76 3314D924 EF74FEA7
  InvMixColumn    D1BF8AFA E7CCA59B A805ED9A 0E9280DE
  Substitution    51F4CF14 B02729E8 6F365337 D7743A9C
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  ShiftRow       517453E8 B0F43A37 6F27CF9C D7362914
Round = 4
  KeyAddition    BE30F6A9 18A66148 D956EAA7 0C3D8414
  InvMixColumn   81F670D6 C3E58F3E 9854343A A62E775E
  Substitution   91D6D04A 332A73D1 E2FD28A2 C5C3029D
  ShiftRow       91C328D1 33D602A2 E22AD09D C5FD734A
Round = 3
  KeyAddition    AC436FAC 74C0FC9C FC09AED9 A887FB71
  InvMixColumn   1FDD846A 3FFD0412 A0CFED00 5B7059D7
  Substitution   CBC94F58 25213039 475F5352 57D0150D
  ShiftRow       CBD05339 25C91552 47214F0D 575F3058
Round = 2
  KeyAddition    3912C6CB 5F5FAC11 1E14CF77 2406C627
  InvMixColumn   B3E50070 9CA30E8C 367B9867 44983B24
  Substitution   4B2A52D0 1C71D7F0 2403E20A 86E249A6
  ShiftRow       4BE2E2F0 1C2A490A 247152A6 8603D7D0
Round = 1
  KeyAddition    EB181CE7 947E65BB 07D26B9F AC6FA1D5
  InvMixColumn   AF894866 3DFEA453 2FA601A9 7D4E0581
  Substitution   1BF2D4D3 8B0C1D50 4EC509B7 13B63691
  ShiftRow       1BB60950 8BF236B7 4E0CD491 13C51DD3
KeyAddition    30C81C46 A35CE411 E5FBC119 1A0A52EF

KeyAddition    AB1881F6 EE0688B6 631C2CB9 B2115172
Substitution   0E3491D6 99A59779 00C442DB 3EE3701E
ShiftRow       0EE34279 993470DB 00A5911E 3EC497D6
Round = 9
  KeyAddition    A294248A 80CEACFA 2874B85F 699897B8
  InvMixColumn   D4A37996 74026806 F24F0F09 317268F5
  Substitution   1971AF35 CA6AF7A5 0492FB40 2E1EF777
  ShiftRow       191EFBA5 CA71F740 046AAF77 2E92F735
Round = 8
  KeyAddition    F3CC8884 7FFC4D92 35415A17 511FDE1A
  InvMixColumn   CACFD7E1 20ACAA7A 90DE8DFA 7124F12E
  Substitution   105F0DE0 54AA62BD 969CB414 2CA62BC3
  ShiftRow       10A6B4BD 545F2B14 96AA0DC3 2C9C62E0
Round = 7
  KeyAddition    5EF243B3 0B00E2E7 120C4271 623ABEAF
  InvMixColumn   E31E46E7 EA101FEB 2B212106 B87CF67B
  Substitution   4DE998B0 BB7CCB3C 0B7B7BA5 9A01D603
  ShiftRow       4D017B3C BBE9D6A5 0B7C9803 9A7BCBB0
Round = 6
  KeyAddition    2089D846 AAE2E858 D0851E42 507B584D
  InvMixColumn   30AEA60F 5051F900 2ED8F20D F330877A
  Substitution   08BEC5FB 6C706952 C32D04F3 7E08EABD
  ShiftRow       08080452 6CBEEAF3 C370C5BD 7E2D69FB
```

```
Round = 5
  KeyAddition    DCD9C2AA 103D7774 09827D01 6FD47C47
  InvMixColumn   861042B9 88D3B3C6 C1534025 A209AA81
  Substitution   DC7CF6DB 97A94BC7 DD5072C2 1A406291
  ShiftRow       DC4072C7 977C62C2 DDA9F691 1A504BDB
Round = 4
  KeyAddition    3304D786 3F2E39BD 6BD8D3AA C15BE6DB
  InvMixColumn   9BFCB3B2 542B6389 00DD3720 9AE4E831
  Substitution   E8554B3E FD0B00F2 52C9B254 37AEC82E
  ShiftRow       E8AEB2F2 FD55C854 520B4B2E 37C9003E
Round = 3
  KeyAddition    D52EF58F BA43366A 4C28356A 5AB38805
  InvMixColumn   5DD4646C AFF7728F 83F98CCD 9F42853C
  Substitution   8D198CB8 1B261E73 4169F080 6EF6676D
  ShiftRow       8DF6F073 1B196780 41268C6D 6E691EB8
Round = 2
  KeyAddition    7F346581 618FDEC3 18130C17 1D30E8C7
  InvMixColumn   21D47E24 462C049D CEADFA89 AC785D8B
  Substitution   7B198AA6 98423075 EC1814F2 AAC18DCE
  ShiftRow       7BC11475 98198DF2 EC428ACE AA1830A6
Round = 1
  KeyAddition    DB3BEA62 104DA143 CFE1B3F7 807446A3
  InvMixColumn   C1F82071 6886BCED 6F0AC7C8 DFF83B0D
  Substitution   DDE1542C F7DC7853 06A331B1 EFE149F3
  ShiftRow       DDE13153 F7E149B1 06DC54F3 EFA3782C
KeyAddition    F69F2445 DF4F9B17 AD2B417B E66C3710


Plaintext is
    6BC1BEE2 2E409F96 E93D7E11 7393172A
    AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51
    30C81C46 A35CE411 E5FBC119 1A0A52EF
    F69F2445 DF4F9B17 AD2B417B E66C3710

**************************************************************
```

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################################################################

   Block Cipher Modes of Operation

       Electronic Codebook (ECB)

Plaintext is
     6BC1BEE2 2E409F96 E93D7E11 7393172A
     AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51
     30C81C46 A35CE411 E5FBC119 1A0A52EF
     F69F2445 DF4F9B17 AD2B417B E66C3710


################################################################

================================================================

ECB-AES192 (Encryption)
----------------------------------------------------------------

Key is
     8E73B0F7 DA0E6452 C810F32B 809079E5
     62F8EAD2 522C6B7B

Plaintext is
     6BC1BEE2 2E409F96 E93D7E11 7393172A
     AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51
     30C81C46 A35CE411 E5FBC119 1A0A52EF
     F69F2445 DF4F9B17 AD2B417B E66C3710

KeyAddition    E5B20E15 F44EFBC4 212D8D3A F3036ECF

Round = 1
  Substitution   D937AB59 BF2F0F1C FDD85D80 0D7B9F8A
  ShiftRow       D92F5D8A BFD89F59 FD7BAB1C 0D370F80
  MixColumn      0FEAC90D D0F7A92F DBF1EFF4 CCF2BF34
  KeyAddition    6D1223DF 82DBC254 25FD7E03 E8F04A91

Round = 2
  Substitution   3CC9269E 13B92520 3F54F37B 9B8CD681
  ShiftRow       3CB9F381 1354D69E 3F8C2620 9BC9257B
  MixColumn      DADAE017 92444990 F7769FAB 330695AC
  KeyAddition    36C8E699 FEC636FB F90C0A12 6F506B6E

Round = 3
  Substitution   05E88EEE BBB4050F 99FE67C9 A8537F9F
  ShiftRow       05B4679F BBFE7FEE 99538E0F A8E805C9
```

```
  MixColumn      3540C5F9 E5339290 5DB9DC73 A4A50A87
  KeyAddition    78F77144 8C86D388 D81E9BE5 4D80327A


Round = 4
  Substitution   BC68A31B 644466C4 617214D9 E3CD23DA
  ShiftRow       BC4414DA 6472231B 61CDA3C4 E36866D9
  MixColumn      61D2A520 66FE7DCB E9DAA65E DA403799
  KeyAddition    868D0864 DDF72E4D A1805609 FBAF86D6


Round = 5
  Substitution   445D3043 C16831E3 32CDB101 0F7944F6
  ShiftRow       4468B1F6 C1CD4443 327930E3 0F5D3101
  MixColumn      77AA54E2 D2CF4157 3C7315C2 C9E7337F
  KeyAddition    D3E2A23B 9FA28F73 964176A2 D8DC0399


Round = 6
  Substitution   66983AE2 DB3A738F 9083383A 61867BEE
  ShiftRow       663A38EE DB837BE2 90863A8F 6198733A
  MixColumn      54B4056F AAA99351 1F46E812 38E5513C
  KeyAddition    F6EA7BBA 29185CCB 38BFD151 5271A65B


Round = 7
  Substitution   428721F4 A5AD4A1F 07083ED1 00A32439
  ShiftRow       42AD3E39 A50824F4 07A3211F 00874AD1
  MixColumn      6F78D827 992DE22B CE26C7B5 091A7B74
  KeyAddition    AFDE4C20 48B046CA 2231415E 66BC3205


Round = 8
  Substitution   791D29B7 52E75A74 93C78358 3365236B
  ShiftRow       79E7836B 52C723B7 93652974 331D5A58
  MixColumn      28593E39 62151167 CF56380A 43BF72A2
  KeyAddition    60064E0B 40DE9632 2D3B2B58 704FC511


Round = 9
  Substitution   D06F2F2B 091D9023 D8E2F16A 5184A682
  ShiftRow       D01DF182 09E2A62B D8842F23 516F906A
  MixColumn      EF60A998 A20CC109 3099679E E94EBBD8
  KeyAddition    AFDE42B0 8D146350 57DEB5F5 ACC2EEE6


Round = 10
  Substitution   791D2CE7 5DFAFB53 5B1DD5E6 9125288E
  ShiftRow       79FAD58E 5D1D28E7 5B252C53 911DFBE6
  MixColumn      BC7CBBA3 52F82207 A636D342 035B5099
  KeyAddition    1B9DFDCF C6E9D3D8 2429A648 AE5C87CA


Round = 11
```

```
   Substitution   AF5E548A B41E6661 36A52452 E44A1774
   ShiftRow       AF1E2474 B4A5178A 364A5461 E45E6652
   MixColumn      378B6538 1A56BA7A 873F7786 05A080AB
   KeyAddition    FDCB6000 959AEA7C AF1261EC B99C671E


Substitution   541FD063 2AB88710 79C9EFCE 56DE8572
ShiftRow       54B8EF72 2AC98563 79DED010 561F87CE
KeyAddition    BD334F1D 6E45F25F F712A214 571FA5CC


KeyAddition    205E3AA0 C40DC8CE 56A79C87 C53FF7B4


Round = 1
   Substitution   B75880E0 1CD7E88B B15CDE17 A675688D
   ShiftRow       B7D7DE8D 1C5C68E0 B175808B A658E817
   MixColumn      44F64BCA 54FCABCB ED4B5930 40220C6F
   KeyAddition    260EA118 06D0C0B0 1347C8C7 6420F9CA


Round = 2
   Substitution   F7AB32AD 6F70BAE7 7DA0E8C6 43B79974
   ShiftRow       F770E874 6FA099AD 7DB732E7 43ABBAC6
   MixColumn      F940D072 11290AC9 EDB99CD7 1C1DD643
   KeyAddition    1552D6FC 7DAB75A2 E3C3096E 404B2881


Round = 3
   Substitution   5900F6B0 FF629D3A 112E019F 09B3340C
   ShiftRow       5962010C FF2E34B0 11B3F63A 09009D9F
   MixColumn      19922D90 134F727B 20571B02 102A92A3
   KeyAddition    5425992D 7AFA3363 A5F05C94 F90FAA5E


Round = 4
   Substitution   203FEED8 DA2DC3FB 068C4A22 9976AC58
   ShiftRow       202D4A58 DA8CACD8 0676EEFB 993FC322
   MixColumn      25FC71B7 54EE66FE 8338A17F 899B5D08
   KeyAddition    C2A3DCF3 EFE73578 CB625128 A874EC47


Round = 5
   Substitution   250A860D DF9496BC 1FAAD134 C292CEA0
   ShiftRow       2594D1A0 DFAACE0D 1F9286BC C20A9634
   MixColumn      9CDEF371 83D4E504 A90D4556 2343A3A9
   KeyAddition    389605A8 CEB92B20 033F2636 3278934F


Round = 6
   Substitution   07906BC2 8B56F1B7 7B75F705 23BCDC84
   ShiftRow       0756F784 8B75DCC2 7BBC6BB7 2390F105
   MixColumn      872D33BB 8CDC00B0 F512D32F 1915450E
   KeyAddition    25734D6E 0F6DCF2A D2EBEA6C 7381B269
```

Round = 7
  Substitution   3F8FE39F 763C8AE5 B5E98750 8F0C37F9
  ShiftRow   3F3C87F9 76E9379F B50CE3E5 8F8F8A50
  MixColumn   442C0613 64794B61 637650FA 555FFF2F
  KeyAddition   848A9214 B5E4EF80 8F61D611 3AF9B65E

Round = 8
  Substitution   5F7E4FFA D569DFCD 73EFF682 80994E58
  ShiftRow   5F69F658 D5EF4EFA 73994FCD 807EDF82
  MixColumn   ABD429CE 2F38B32A D44638C2 C484C625
  KeyAddition   E38B59FC 0DF3347F 362B2B90 F7747196

Round = 9
  Substitution   113DCBB0 D70D18D2 05F1F160 6892A390
  ShiftRow   110DF190 D7F1A3B0 0592CBD2 683D1860
  MixColumn   54934EF4 AE60B04B BEAE77E9 EF5AC55D
  KeyAddition   142DA5DC 81781212 D9E9A582 AAD69063

Round = 10
  Substitution   FAD80686 0CBCC9C9 351E0613 ACF660FB
  ShiftRow   FABC06FB 0C1E6086 35F606C9 ACD8C913
  MixColumn   CD685C42 DC16437D A4018F26 EA54C8D8
  KeyAddition   6A891A2E 4807B2A2 261EFA2C 47531F8B

Round = 11
  Substitution   02A7A231 52C5373A F7722D71 A0EDC03D
  ShiftRow   02C52D3D 5272C031 F7EDA23A A0A73771
  MixColumn   40D9DA94 C3DCE826 41F10B39 EFDDFA89
  KeyAddition   8A99DFAC 4C10B820 69DC1D53 53E11D3C

Substitution   7EEE9E91 29CA6CB7 F986A4ED EDF8A4EB
ShiftRow   7ECAA4EB 2986A491 F9F89EB7 EDEE6CED
KeyAddition   97410484 6D0AD3AD 7734ECB3 ECEE4EEF

KeyAddition   BEBBACB1 79528043 2DEB3232 9A9A2B0A

Round = 1
  Substitution   AEEA91C8 B600CD1A D8E92323 B8B8F167
  ShiftRow   AE002367 B6E9F1C8 D8B8911A B8EACD23
  MixColumn   03AC4104 6EBFE552 F301776E A018B6B2
  KeyAddition   6154ABD6 3C938E29 0D0DE699 841A4317

Round = 2
  Substitution   EF2062F6 EBDC19A5 D7D78EEE 5FA21AF0
  ShiftRow   EFDC8EF0 EBD71AF6 D7A262A5 5F2019EE

```
  MixColumn      C4353F83 4386091C 8F8B45F3 29DA641F
  KeyAddition    2827390D 2F047677 81F1D04A 758C9ADD


Round = 3
  Substitution   34CC12D7 15F238F5 0CA170D6 9D64B8C1
  ShiftRow       34F270C1 15A1B8D7 0C6412F5 9DCC38D6
  MixColumn      D49A7E47 BD48BD93 53074893 808040FF
  KeyAddition    992DCAFA D4FDFC8B D6A00F05 69A57802


Round = 4
  Substitution   EED8742D 4854B03D F6E0766B F906BC77
  ShiftRow       EE547677 48E0BC2D F606743D F9D8B06B
  MixColumn      3AABCFE5 3A61BCDE B45B5F09 41F2E7AE
  KeyAddition    DDF462A1 8168EF58 FC01AF5E 601D56E1


Round = 5
  Substitution   C1BFAA32 0C45DF6A B07C7958 D0A4B1F8
  ShiftRow       C14579F8 0C7CB132 B0A4AA6A D0BFDF58
  MixColumn      D738658F 1F0E5FBD 4C6CE511 E69722BB
  KeyAddition    73709356 52639199 E65E8671 F7AC125D


Round = 6
  Substitution   8F51DCB1 00FB81EE 8E5844A3 6891C94C
  ShiftRow       8FFB444C 0058C9B1 8E91DCEE 685181A3
  MixColumn      1BE228AD 904119E8 9D269503 01F1DE35
  KeyAddition    B9BC5678 13F0D672 BADFAC40 6B652952


Round = 7
  Substitution   5665B1BC 7D8CF640 F49E9109 7F4DA500
  ShiftRow       568C9100 7D9EA5BC F44DB140 7F65F609
  MixColumn      B2FDE3E7 5A126DDF D5E6007B AEBDF600
  KeyAddition    725B77E0 8B8FC93E 39F18690 C11BBF71


Round = 8
  Substitution   4039F5E1 3D73DDB2 12A14460 78AF08A3
  ShiftRow       407344A3 3DA108E1 12AFF5B2 7839DD60
  MixColumn      F2C945AA 6B9DB437 89E18113 061640AC
  KeyAddition    BA963598 49563362 6B8C9241 35E6F71F


Round = 9
  Substitution   F4909646 3BB1C3AA 7F644F83 968E68C0
  ShiftRow       F4B14FC0 3B646846 7F8E96AA 9690C383
  MixColumn      B49C8062 F40D45CD 4B7323D6 DC7005EF
  KeyAddition    F4226B4A DB15E794 2C34F1BD 99FC50D1


Round = 10
```

```
  Substitution    BF937FD6  B9599422  7118A17A  EEB0533E
  ShiftRow        BF59A13E  B91853D6  71B07F22  EE93947A
  MixColumn       11CBFD5E  C4AA662C  74A95918  870EC0DA
  KeyAddition     B62ABB32  50BB97F3  F6B62C12  2A091789


Round = 11
  Substitution    4EE5EA23  53EA880D  424E71C9  E501F0A7
  ShiftRow        4EEA71A7  534EF023  4201EA0D  E5E588C9
  MixColumn       6FB5B41C  A7E7830D  60689B37  A47E4BD0
  KeyAddition     A5F5B124  282BD30B  48458D5D  1842AC65


Substitution  06E6C836  34F1662B  526E5D4C  AD2C914D
ShiftRow      06F15D4D  346E9136  522CC82B  ADE6664C
KeyAddition   EF7AFD22  70E2E60A  DCE0BA2F  ACE6444E


KeyAddition   78EC94B2  0541FF45  653BB250  66FC4EF5


Round = 1
  Substitution    BCCE2237  6B83166E  4DE23753  33B02FE6
  ShiftRow        BC8337E6  6BE22F37  4DB0226E  33CE1653
  MixColumn       2C1E60BC  F3F28E1E  1D3E0B99  6ADD242B
  KeyAddition     4EE68A6E  A1DEE565  E3329A6E  4EDFD18E


Round = 2
  Substitution    2F8E7E9F  321DD94D  1123B89F  2F9E3E19
  ShiftRow        2F1DB819  32233E9F  119E7E4D  2F8ED99F
  MixColumn       D8DF72E6  A0A9D76E  A8F9A449  91C7B203
  KeyAddition     34CD7468  CC2BA805  A68331F0  CD914CC1


Round = 3
  Substitution    18BD9245  4BF1C26B  24ECC78C  BD812978
  ShiftRow        18F1C778  4BEC2945  2481926B  BDBDC28C
  MixColumn       87CBF4EE  D5B63A92  29FB27A9  F30D10A0
  KeyAddition     CA7C4053  BC037B8A  AC5C603F  1A28285D


Round = 4
  Substitution    741009ED  657B217E  914AD075  A234344C
  ShiftRow        747BD04C  654A34ED  9134097E  A2102175
  MixColumn       F9A560AF  CD406B10  129C3569  3B946F26
  KeyAddition     1EFACDEB  76493896  5AC6C53E  1A7BDE69


Round = 5
  Substitution    722DBDE9  383B0790  BEB4A6B2  A2211DF9
  ShiftRow        723BA6F9  38B41DE9  BE21BD90  A22D07B2
  MixColumn       F60C0EE2  43859628  29B0557E  9D434CA8
  KeyAddition     5244F83B  0EE8580C  8382361E  8C787C4E
```

```
Round = 6
  Substitution   001B41E2 AB9B6AFE EC130572 64BC102F
  ShiftRow       009B052F AB1310E2 ECBC41FE 641B6A72
  MixColumn      9C0DE0C0 8A5FA53A A3B2CB35 FD9E3D39
  KeyAddition    3E539E15 09EE6AA0 844BF276 970ACA5E

Round = 7
  Substitution   B2ED0B59 012802E0 5FB38938 88677458
  ShiftRow       B2288958 01B37459 5F670BE0 88ED0238
  MixColumn      D63A7BDC E1B9B176 FC6C1556 1D77291C
  KeyAddition    169CEFDB 30241597 107B93BD 72D1606D

Round = 8
  Substitution   47DEDFB9 04365988 CA21DC7A 403ED03C
  ShiftRow       4736DC3C 0421D0B9 CA3EDF88 40DE597A
  MixColumn      3468965B 02944E94 9A44D2AF DA76A2B3
  KeyAddition    7C37E669 205FC9C1 7829C1FD E9861500

Round = 9
  Substitution   109A8EF9 B7CFDD78 BCA57854 1E445963
  ShiftRow       10CF7863 B7A559F9 BC448E78 1E9ADD54
  MixColumn      717E8A41 21F4B0D7 59C577E5 0019D9CD
  KeyAddition    31C06169 0EEC128E 3E82A58E 45958CF3

Round = 10
  Substitution   C7BAEFF9 ABCEC919 B2130619 6E2A640D
  ShiftRow       C7CE060D AB1364F9 B22AEF19 6EBAC919
  MixColumn      D7471280 E5D86078 F7D5763A D95876F3
  KeyAddition    70A654EC 71C991A7 75CA0330 745FA1A0

Round = 11
  Substitution   512420CE A3DD815C 9D747B04 92CF32E0
  ShiftRow       51DD7BE0 A37432CE 9DCF205C 92248104
  MixColumn      459D418E 3DD3FA3F 1724F6EB D646A300
  KeyAddition    8FDD44B6 B21FAA39 3F09E081 6A7A44B5

Substitution   73C11B4E 37C0AC12 7501E10C 02DA1BD5
ShiftRow       73C0E1D5 37011B4E 75DA1B12 02C1AC0C
KeyAddition    9A4B41BA 738D6C72 FB166916 03C18E0E


Ciphertext is
    BD334F1D 6E45F25F F712A214 571FA5CC
    97410484 6D0AD3AD 7734ECB3 ECEE4EEF
    EF7AFD22 70E2E60A DCE0BA2F ACE6444E
```

```
      9A4B41BA 738D6C72 FB166916 03C18E0E


===============================================================

ECB-AES192 (Decryption)
----------------------------------------------------------------

Key is
    8E73B0F7 DA0E6452 C810F32B 809079E5
    62F8EAD2 522C6B7B

Ciphertext is
    BD334F1D 6E45F25F F712A214 571FA5CC
    97410484 6D0AD3AD 7734ECB3 ECEE4EEF
    EF7AFD22 70E2E60A DCE0BA2F ACE6444E
    9A4B41BA 738D6C72 FB166916 03C18E0E

KeyAddition    54B8EF72 2AC98563 79DED010 561F87CE
Substitution   FD9A611E 95126700 AF9C607C B9CBEAEC
ShiftRow       FDCB6000 959AEA7C AF1261EC B99C671E
Round = 11
  KeyAddition    378B6538 1A56BA7A 873F7786 05A080AB
  InvMixColumn   AF1E2474 B4A5178A 364A5461 E45E6652
  Substitution   1BE9A6CA C62987CF 245CFDD8 AE9DD348
  ShiftRow       1B9DFDCF C6E9D3D8 2429A648 AE5C87CA
Round = 10
  KeyAddition    BC7CBBA3 52F82207 A636D342 035B5099
  InvMixColumn   79FAD58E 5D1D28E7 5B252C53 911DFBE6
  Substitution   AF14B5E6 8DDEEEB0 57C24250 ACDE63F5
  ShiftRow       AFDE42B0 8D146350 57DEB5F5 ACC2EEE6
Round = 9
  KeyAddition    EF60A998 A20CC109 3099679E E94EBBD8
  InvMixColumn   D01DF182 09E2A62B D8842F23 516F906A
  Substitution   60DE2B11 403BC50B 2D4F4E32 70069658
  ShiftRow       60064E0B 40DE9632 2D3B2B58 704FC511
Round = 8
  KeyAddition    28593E39 62151167 CF56380A 43BF72A2
  InvMixColumn   79E7836B 52C723B7 93652974 331D5A58
  Substitution   AFB04105 48313220 22BC4CCA 66DE465E
  ShiftRow       AFDE4C20 48B046CA 2231415E 66BC3205
Round = 7
  KeyAddition    6F78D827 992DE22B CE26C7B5 091A7B74
  InvMixColumn   42AD3E39 A50824F4 07A3211F 00874AD1
  Substitution   F618D15B 29BFA6BA 38717BCB 52EA5C51
  ShiftRow       F6EA7BBA 29185CCB 38BFD151 5271A65B
Round = 6
```

```
   KeyAddition     54B4056F AAA99351 1F46E812 38E5513C
   InvMixColumn    663A38EE DB837BE2 90863A8F 6198733A
   Substitution    D3A27699 9F41033B 96DCA273 D8E28FA2
   ShiftRow        D3E2A23B 9FA28F73 964176A2 D8DC0399
Round = 5
   KeyAddition     77AA54E2 D2CF4157 3C7315C2 C9E7337F
   InvMixColumn    4468B1F6 C1CD4443 327930E3 0F5D3101
   Substitution    86F756D6 DD808664 A1AF084D FB8D2E09
   ShiftRow        868D0864 DDF72E4D A1805609 FBAF86D6
Round = 4
   KeyAddition     61D2A520 66FE7DCB E9DAA65E DA403799
   InvMixColumn    BC4414DA 6472231B 61CDA3C4 E36866D9
   Substitution    78869B7A 8C1E3244 D8807188 4DF7D3E5
   ShiftRow        78F77144 8C86D388 D81E9BE5 4D80327A
Round = 3
   KeyAddition     3540C5F9 E5339290 5DB9DC73 A4A50A87
   InvMixColumn    05B4679F BBFE7FEE 99538E0F A8E805C9
   Substitution    36C60A6E FE0C6B99 F950E6FB 6FC83612
   ShiftRow        36C8E699 FEC636FB F90C0A12 6F506B6E
Round = 2
   KeyAddition     DADAE017 92444990 F7769FAB 330695AC
   InvMixColumn    3CB9F381 1354D69E 3F8C2620 9BC9257B
   Substitution    6DDB7E91 82FD4ADF 25F02354 E812C203
   ShiftRow        6D1223DF 82DBC254 25FD7E03 E8F04A91
Round = 1
   KeyAddition     0FEAC90D D0F7A92F DBF1EFF4 CCF2BF34
   InvMixColumn    D92F5D8A BFD89F59 FD7BAB1C 0D370F80
   Substitution    E54E8DCF F42D6E15 21030EC4 F3B2FB3A
   ShiftRow        E5B20E15 F44EFBC4 212D8D3A F3036ECF
KeyAddition     6BC1BEE2 2E409F96 E93D7E11 7393172A

KeyAddition     7ECAA4EB 2986A491 F9F89EB7 EDEE6CED
Substitution    8A101D3C 4CDC1DAC 69E1DF20 5399B853
ShiftRow        8A99DFAC 4C10B820 69DC1D53 53E11D3C
Round = 11
   KeyAddition     40D9DA94 C3DCE826 41F10B39 EFDDFA89
   InvMixColumn    02C52D3D 5272C031 F7EDA23A A0A73771
   Substitution    6A07FA8B 481E1F2E 26531AA2 4789B22C
   ShiftRow        6A891A2E 4807B2A2 261EFA2C 47531F8B
Round = 10
   KeyAddition     CD685C42 DC16437D A4018F26 EA54C8D8
   InvMixColumn    FABC06FB 0C1E6086 35F606C9 ACD8C913
   Substitution    1478A563 81E990DC D9D6A512 AA2D1282
   ShiftRow        142DA5DC 81781212 D9E9A582 AAD69063
Round = 9
   KeyAddition     54934EF4 AE60B04B BEAE77E9 EF5AC55D
```

```
   InvMixColumn   110DF190 D7F1A3B0 0592CBD2 683D1860
   Substitution   E3F32B96 0D2B71FC 3674597F F78B3490
   ShiftRow       E38B59FC 0DF3347F 362B2B90 F7747196
Round = 8
   KeyAddition    ABD429CE 2F38B32A D44638C2 C484C625
   InvMixColumn   5F69F658 D5EF4EFA 73994FCD 807EDF82
   Substitution   84E4D65E B561B614 8FF99280 3A8AEF11
   ShiftRow       848A9214 B5E4EF80 8F61D611 3AF9B65E
Round = 7
   KeyAddition    442C0613 64794B61 637650FA 555FFF2F
   InvMixColumn   3F3C87F9 76E9379F B50CE3E5 8F8F8A50
   Substitution   256DEA69 0FEBB26E D2814D2A 7373CF6C
   ShiftRow       25734D6E 0F6DCF2A D2EBEA6C 7381B269
Round = 6
   KeyAddition    872D33BB 8CDC00B0 F512D32F 1915450E
   InvMixColumn   0756F784 8B75DCC2 7BBC6BB7 2390F105
   Substitution   38B9264F CE3F93A8 03780520 32962B36
   ShiftRow       389605A8 CEB92B20 033F2636 3278934F
Round = 5
   KeyAddition    9CDEF371 83D4E504 A90D4556 2343A3A9
   InvMixColumn   2594D1A0 DFAACE0D 1F9286BC C20A9634
   Substitution   C2E75147 EF62ECF3 CB74DC78 A8A33528
   ShiftRow       C2A3DCF3 EFE73578 CB625128 A874EC47
Round = 4
   KeyAddition    25FC71B7 54EE66FE 8338A17F 899B5D08
   InvMixColumn   202D4A58 DA8CACD8 0676EEFB 993FC322
   Substitution   54FA5C5E 7AF0AA2D A50F9963 F9253394
   ShiftRow       5425992D 7AFA3363 A5F05C94 F90FAA5E
Round = 3
   KeyAddition    19922D90 134F727B 20571B02 102A92A3
   InvMixColumn   5962010C FF2E34B0 11B3F63A 09009D9F
   Substitution   15AB0981 7DC328FC E34BD6A2 4052756E
   ShiftRow       1552D6FC 7DAB75A2 E3C3096E 404B2881
Round = 2
   KeyAddition    F940D072 11290AC9 EDB99CD7 1C1DD643
   InvMixColumn   F770E874 6FA099AD 7DB732E7 43ABBAC6
   Substitution   26D0C8CA 0647F918 1320A1B0 640EC0C7
   ShiftRow       260EA118 06D0C0B0 1347C8C7 6420F9CA
Round = 1
   KeyAddition    44F64BCA 54FCABCB ED4B5930 40220C6F
   InvMixColumn   B7D7DE8D 1C5C68E0 B175808B A658E817
   Substitution   200D9CB4 C4A7F7A0 563F3ACE C55EC887
   ShiftRow       205E3AA0 C40DC8CE 56A79C87 C53FF7B4
KeyAddition     AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51

KeyAddition     06F15D4D 346E9136 522CC82B ADE6664C
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Substitution   A52B8D65 2845AC24 4842B10B 18F5D35D
ShiftRow       A5F5B124 282BD30B 48458D5D 1842AC65
Round = 11
  KeyAddition    6FB5B41C A7E7830D 60689B37 A47E4BD0
  InvMixColumn   4EEA71A7 534EF023 4201EA0D E5E588C9
  Substitution   B6BB2C89 50B61732 F609BBF3 2A2A9712
  ShiftRow       B62ABB32 50BB97F3 F6B62C12 2A091789
Round = 10
  KeyAddition    11CBFD5E C4AA662C 74A95918 870EC0DA
  InvMixColumn   BF59A13E B91853D6 71B07F22 EE93947A
  Substitution   F415F1D1 DB34504A 2CFC6B94 9922E7BD
  ShiftRow       F4226B4A DB15E794 2C34F1BD 99FC50D1
Round = 9
  KeyAddition    B49C8062 F40D45CD 4B7323D6 DC7005EF
  InvMixColumn   F4B14FC0 3B646846 7F8E96AA 9690C383
  Substitution   BA56921F 498CF798 6BE63562 35963341
  ShiftRow       BA963598 49563362 6B8C9241 35E6F71F
Round = 8
  KeyAddition    F2C945AA 6B9DB437 89E18113 061640AC
  InvMixColumn   407344A3 3DA108E1 12AFF5B2 7839DD60
  Substitution   728F8671 8BF1BFE0 391B773E C15BC990
  ShiftRow       725B77E0 8B8FC93E 39F18690 C11BBF71
Round = 7
  KeyAddition    B2FDE3E7 5A126DDF D5E6007B AEBDF600
  InvMixColumn   568C9100 7D9EA5BC F44DB140 7F65F609
  Substitution   B9F0AC52 13DF2978 BA655672 6BBCD640
  ShiftRow       B9BC5678 13F0D672 BADFAC40 6B652952
Round = 6
  KeyAddition    1BE228AD 904119E8 9D269503 01F1DE35
  InvMixColumn   8FFB444C 0058C9B1 8E91DCEE 685181A3
  Substitution   7363865D 525E1256 E6AC9399 F7709171
  ShiftRow       73709356 52639199 E65E8671 F7AC125D
Round = 5
  KeyAddition    D738658F 1F0E5FBD 4C6CE511 E69722BB
  InvMixColumn   C14579F8 0C7CB132 B0A4AA6A D0BFDF58
  Substitution   DD68AFE1 810156A1 FC1D6258 60F4EF5E
  ShiftRow       DDF462A1 8168EF58 FC01AF5E 601D56E1
Round = 4
  KeyAddition    3AABCFE5 3A61BCDE B45B5F09 41F2E7AE
  InvMixColumn   EE547677 48E0BC2D F606743D F9D8B06B
  Substitution   99FD0F02 D4A078FA D6A5CA8B 692DFC05
  ShiftRow       992DCAFA D4FDFC8B D6A00F05 69A57802
Round = 3
  KeyAddition    D49A7E47 BD48BD93 53074893 808040FF
  InvMixColumn   34F270C1 15A1B8D7 0C6412F5 9DCC38D6
  Substitution   2804D0DD 2FF19A0D 818C3977 7527764A
```

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   ShiftRow        2827390D 2F047677 81F1D04A 758C9ADD
Round = 2
  KeyAddition     C4353F83 4386091C 8F8B45F3 29DA641F
  InvMixColumn    EFDC8EF0 EBD71AF6 D7A262A5 5F2019EE
  Substitution    6193E617 3C0D43D6 0D1AAB29 84548E99
  ShiftRow        6154ABD6 3C938E29 0D0DE699 841A4317
Round = 1
  KeyAddition     03AC4104 6EBFE552 F301776E A018B6B2
  InvMixColumn    AE002367 B6E9F1C8 D8B8911A B8EACD23
  Substitution    BE52320A 79EB2BB1 2D9AAC43 9ABB8032
  ShiftRow        BEBBACB1 79528043 2DEB3232 9A9A2B0A
KeyAddition    30C81C46 A35CE411 E5FBC119 1A0A52EF

KeyAddition    73C0E1D5 37011B4E 75DA1B12 02C1AC0C
Substitution   8F1FE0B5 B20944B6 3F7A4439 6ADDAA81
ShiftRow       8FDD44B6 B21FAA39 3F09E081 6A7A44B5
Round = 11
  KeyAddition     459D418E 3DD3FA3F 1724F6EB D646A300
  InvMixColumn    51DD7BE0 A37432CE 9DCF205C 92248104
  Substitution    70C903A0 71CAA1EC 755F54A7 74A69130
  ShiftRow        70A654EC 71C991A7 75CA0330 745FA1A0
Round = 10
  KeyAddition     D7471280 E5D86078 F7D5763A D95876F3
  InvMixColumn    C7CE060D AB1364F9 B22AEF19 6EBAC919
  Substitution    31ECA5F3 0E828C69 3E95618E 45C0128E
  ShiftRow        31C06169 0EEC128E 3E82A58E 45958CF3
Round = 9
  KeyAddition     717E8A41 21F4B0D7 59C577E5 0019D9CD
  InvMixColumn    10CF7863 B7A559F9 BC448E78 1E9ADD54
  Substitution    7C5FC100 20291569 7886E6C1 E937C9FD
  ShiftRow        7C37E669 205FC9C1 7829C1FD E9861500
Round = 8
  KeyAddition     3468965B 02944E94 9A44D2AF DA76A2B3
  InvMixColumn    4736DC3C 0421D0B9 CA3EDF88 40DE597A
  Substitution    1624936D 307B60DB 10D1EF97 729C15BD
  ShiftRow        169CEFDB 30241597 107B93BD 72D1606D
Round = 7
  KeyAddition     D63A7BDC E1B9B176 FC6C1556 1D77291C
  InvMixColumn    B2288958 01B37459 5F670BE0 88ED0238
  Substitution    3EEEF25E 094BCA15 840A9EA0 97536A76
  ShiftRow        3E539E15 09EE6AA0 844BF276 970ACA5E
Round = 6
  KeyAddition     9C0DE0C0 8A5FA53A A3B2CB35 FD9E3D39
  InvMixColumn    009B052F AB1310E2 ECBC41FE 641B6A72
  Substitution    52E8364E 0E827C3B 8378F80C 8C44581E
  ShiftRow        5244F83B 0EE8580C 8382361E 8C787C4E
```

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Round = 5
  KeyAddition    F60C0EE2 43859628 29B0557E 9D434CA8
  InvMixColumn   723BA6F9 38B41DE9 BE21BD90 A22D07B2
  Substitution   1E49C569 76C6DEEB 5A7BCD96 1AFA383E
  ShiftRow       1EFACDEB 76493896 5AC6C53E 1A7BDE69
Round = 4
  KeyAddition    F9A560AF CD406B10 129C3569 3B946F26
  InvMixColumn   747BD04C 654A34ED 9134097E A2102175
  Substitution   CA03605D BC5C2853 AC28408A 1A7C7B3F
  ShiftRow       CA7C4053 BC037B8A AC5C603F 1A28285D
Round = 3
  KeyAddition    87CBF4EE D5B63A92 29FB27A9 F30D10A0
  InvMixColumn   18F1C778 4BEC2945 2481926B BDBDC28C
  Substitution   342B31C1 CC834C68 A6917405 CDCDA8F0
  ShiftRow       34CD7468 CC2BA805 A68331F0 CD914CC1
Round = 2
  KeyAddition    D8DF72E6 A0A9D76E A8F9A449 91C7B203
  InvMixColumn   2F1DB819 32233E9F 119E7E4D 2F8ED99F
  Substitution   4EDE9A8E A132D16E E3DF8A65 4EE6E56E
  ShiftRow       4EE68A6E A1DEE565 E3329A6E 4EDFD18E
Round = 1
  KeyAddition    2C1E60BC F3F28E1E 1D3E0B99 6ADD242B
  InvMixColumn   BC8337E6 6BE22F37 4DB0226E 33CE1653
  Substitution   7841B2F5 053B4EB2 65FC9445 66ECFF50
  ShiftRow       78EC94B2 0541FF45 653BB250 66FC4EF5
KeyAddition    F69F2445 DF4F9B17 AD2B417B E66C3710


Plaintext is
    6BC1BEE2 2E409F96 E93D7E11 7393172A
    AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51
    30C81C46 A35CE411 E5FBC119 1A0A52EF
    F69F2445 DF4F9B17 AD2B417B E66C3710

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##############################################################

   Block Cipher Modes of Operation

      Electronic Codebook (ECB)

Plaintext is
    6BC1BEE2 2E409F96 E93D7E11 7393172A
    AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51
    30C81C46 A35CE411 E5FBC119 1A0A52EF
    F69F2445 DF4F9B17 AD2B417B E66C3710


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ECB-AES256 (Encryption)
----------------------------------------------------------------

Key is
    603DEB10 15CA71BE 2B73AEF0 857D7781
    1F352C07 3B6108D7 2D9810A3 0914DFF4

Plaintext is
    6BC1BEE2 2E409F96 E93D7E11 7393172A
    AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51
    30C81C46 A35CE411 E5FBC119 1A0A52EF
    F69F2445 DF4F9B17 AD2B417B E66C3710

KeyAddition   0BFC55F2 3B8AEE28 C24ED0E1 F6EE60AB

Round = 1
  Substitution  2BB0FC89 E27E2834 252F70F8 4228D062
  ShiftRow      2B7E7062 E22FD089 2528FC34 42B028F8
  MixColumn     C62513B7 F75EF6CB FA5EB2D3 9FB9B1B5
  KeyAddition   D9103FB0 CC3FFE1C D7C6A270 96AD6E41

Round = 2
  Substitution  35CA75E7 4B75BB9C 0EB43A51 90959F83
  ShiftRow      35753A83 4BB49FE7 0E95759C 90CABB51
  MixColumn     4C12AA0D 2965E823 513CCED1 9498C478
  KeyAddition   D7B1FE1C A70CCD8C F426458E B4FF38A6

Round = 3
  Substitution  0EC8BB9C 5CFEBD64 BFF76E19 8D160724
  ShiftRow      0EFE6E24 5CF7079C BF16BB64 8DC8BD19
```

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  MixColumn      4F7F40CA 213C1A37 802168BF E6C30FCB
  KeyAddition    E7CFDCD0 B2ED8EFA 3E68ECD1 519E5451


Round = 4
  Substitution   948A8670 3755192D B245CE3E D10B20D1
  ShiftRow       9455CED1 37452070 B20B862D D18A193E
  MixColumn      D3A62E85 F1ADA2DC C918D91A 1BCB2B87
  KeyAddition    063CC23D AA5E6BCB 37F19B52 C5459511


Round = 5
  Substitution   6FEB2527 AC587F1F 9AA11400 A66E2A82
  ShiftRow       6F581482 ACA12A27 9A6E251F A6EB7F00
  MixColumn      A06182E2 B6AC302A A7369FC0 0EEAB365
  KeyAddition    15C8B068 90D4966D 3F07BDE9 2186CAD6


Round = 6
  Substitution   59E8E745 6048903C 75C57A1E FD4474F6
  ShiftRow       59487AF6 60C57445 7544E73C FDE8901E
  MixColumn      E6B1E42E A528829B FDF3A044 4C830C58
  KeyAddition    679D6583 7FF7CA21 D9C5AAB6 B63BB83C


Round = 7
  Substitution   855E4DEC D26874FD 35A6AC4E 4EE26CEB
  ShiftRow       8568ACEB D2A66CEC 35E24DFD 4E5E744E
  MixColumn      EE51889D CEDD8364 E7C05111 44202A64
  KeyAddition    76943754 70609AEA C14C6AB6 4DC06870


Round = 8
  Substitution   38229A20 51D0B887 7829024E E3BA4551
  ShiftRow       38D00251 51294520 78BA9A87 E322B84E
  MixColumn      48D41F38 BCEC92DF 38257FBD 4D3A7838
  KeyAddition    20D46494 0E33A1C9 AECC4659 216BF5B8


Round = 9
  Substitution   B7484322 ABC332DD E44B5ACB FD7FE66C
  ShiftRow       B7C35A6C AB4BE622 E47F43DD FD4832CB
  MixColumn      1DA87483 542E510F CC0261AA C0F097EB
  KeyAddition    D5BC9687 2287AA85 9C27A187 993515D2


Round = 10
  Substitution   03659017 9317AC97 DECC3217 EE9659B5
  ShiftRow       031732B5 93CC5917 DE969097 EE65AC17
  MixColumn      B8CEB451 3CECD415 01D5D14A D3DCF1CE
  KeyAddition    66DDDD36 50208E64 FBF0B2DF 45A81FDB


Round = 11
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```
   Substitution   33C1C105 53B71943 0F8C379E 6EC2C0B9
   ShiftRow       33B737B9 538CC005 0FC2C143 6EC1199E
   MixColumn      2AA63ABC EC0E4BB3 C18B9194 0342244D
   KeyAddition    7220F0E1 C2217A64 BF81606E 248D578E

Round = 12
   Substitution   40B78CF8 25FDDA43 080CD09F 365D5B19
   ShiftRow       40FDD019 250C5BF8 085D8C43 36B7DA9F
   MixColumn      55D32DDF FD288CD3 387E934F EBA99412
   KeyAddition    214F6A74 E5789109 DA0BED00 9FA80448

Round = 13
   Substitution   FD840292 D9BC8101 572B5563 DBC2F252
   ShiftRow       FDBC5552 D92BF292 57C20201 DB848163
   MixColumn      39331D51 B410A096 F0CF923B D833E3B5
   KeyAddition    F3C9B7B2 50C53BA2 6A10F8F5 6523FAB8

Substitution   0DDDA937 53A6E23A 02CA41E6 4D262D6C
ShiftRow       0DA6416C 53CA2D37 0226A93A 4DDDE2E6
KeyAddition    F3EED1BD B5D2A03C 064B5A7E 3DB181F8

KeyAddition    CE106147 0BC9DD22 B5C4C15C C0D2F9D0

Round = 1
   Substitution   8BCAEFA0 2BDDC193 D51C784A BAB59970
   ShiftRow       8BDD7870 2B1C99A0 D5B5EF93 BACAC14A
   MixColumn      79D236C3 4B03E5A3 091D0B03 A127374A
   KeyAddition    66E71AC4 7062ED74 24851BA0 A833E8BE

Round = 2
   Substitution   3394A21C 51AA5592 3697AFE0 C2C39BAE
   ShiftRow       33AAAFAE 51979B1C 36C3A292 C29455E0
   MixColumn      82383517 87CECFC7 02C40704 8DEEC747
   KeyAddition    199B6106 09A7EA68 A7DE8C5B AD893B99

Round = 3
   Substitution   D414EF6F 015C8745 5C1D6439 95A7E2EE
   ShiftRow       D45C64EE 011DE26F 5CA7EF45 95148739
   MixColumn      DD2E6998 A8697222 E066F126 B316DF45
   KeyAddition    759EF582 3BB8E6EF 5E2F7548 044B84DF

Round = 4
   Substitution   9D0BE613 E26C8EDF 58159D52 F2B35F9E
   ShiftRow       9D6C9D9E E2155F13 58B3E6DF F20B8E52
   MixColumn      9667696A AC3A7C51 47CB4618 3E3F082C
   KeyAddition    43FD85D2 F7C9B546 B9220450 E0B1B6BA
```

```
Round = 5
  Substitution   1A5497B5 68DDD55A 5693F253 E1C84EF4
  ShiftRow       1ADDF2F4 68934EB5 56C8975A E154D553
  MixColumn      4E423FF2 8532A314 22254511 A37EF11F
  KeyAddition    FBEB0D78 A34A0553 BA146738 8C1288AC

Round = 6
  Substitution   0FE9D7BC 0AD66BED F4FA8507 64C9C491
  ShiftRow       0FD68591 0AFAC4BC F4C9D7ED 64E96B07
  MixColumn      6BBD607B 790EBC43 89F2A4D8 84175220
  KeyAddition    EA91E1D6 A3D1F4F9 ADC4AE2A 7EAFE644

Round = 7
  Substitution   8781F8F6 0A3EBF99 951CE4E5 F3798E1B
  ShiftRow       873EE41B 0A1C8EF6 9579F899 F381BFE5
  MixColumn      A8D7477E 484D107B DBEDB70C 3FD523E1
  KeyAddition    3012F8B7 F6F009F5 FD618CAB 363561F5

Round = 8
  Substitution   04C941A9 428C01E6 54EF6462 0596EFE6
  ShiftRow       048C64E6 42EFEFA9 549641E6 05C90162
  MixColumn      054D7133 E804888F AE4671FC 29ED6803
  KeyAddition    6D4D0A9F 5ADBBB99 38AF4818 45BCE583

Round = 9
  Substitution   3CE367DB BEB9EAEE 077952AD 6E65D9EC
  ShiftRow       3CB952EC BE79D9DB 076567EE 6EE3EAAD
  MixColumn      164F0E6C EEE718D4 288A85CC A53BAEFA
  KeyAddition    DE5BEC68 984EE35E 78AF45E1 FCFE2CC3

Round = 10
  Substitution   1D39CE45 462F1158 BC796EF8 B0BB712E
  ShiftRow       1D2F6E2E 46797145 BCBBCE58 B03911F8
  MixColumn      0BDF9C3A 33621248 23C0681A D909B808
  KeyAddition    D5CCF55D 5FAE4839 D9E50B8F 4F7D561D

Round = 11
  Substitution   034BE64C CFE45212 35D92B73 84FFB1A4
  ShiftRow       03E42BA4 CFD9B14C 35FFE612 844B5273
  MixColumn      BE094699 08E2BBBA 84F32B62 EF97FE68
  KeyAddition    E68F8CC4 26CD8A6D FAF9DA98 C8588DAB

Round = 12
  Substitution   8E73641C F7BD7E3C 2D995746 E86A5D62
  ShiftRow       8EBD5762 F7995D1C 2D6A643C E8737E46
```

```
   MixColumn      EE743BA7 0425F0FE BC69CB01 66CAADA2
   KeyAddition    9AE87C0C 1C75ED24 5E1CB54E 12CB3DF8


Round = 13
   Substitution   B89B10FE 9C9D5536 589CD52F C91F2741
   ShiftRow       B89DD541 9C9C27FE 581F1036 C99B552F
   MixColumn      43BC5719 452857E3 B7603D8B 453489D0
   KeyAddition    8946FDFA A1FDCCD7 2DBF5745 F82490DD


Substitution   A75A542D 32544B0E D8085B6E 413660C1
ShiftRow       A7545BC1 3208602D D836540E 415A4B6E
KeyAddition    591CCB10 D410ED26 DC5BA74A 31362870


KeyAddition    50F5F756 B69695AF CE886FE9 9F77256E


Round = 1
   Substitution   53E668B1 4E902A79 8BC4A81E DBF53F9F
   ShiftRow       5390A89F 4EC43FB1 8BF56879 DBE62A1E
   MixColumn      3A1432E8 452D3C50 18BB25E9 A86C4B86
   KeyAddition    25211EEF 7E4C3487 3523354A A1789472


Round = 2
   Substitution   3FFD72DF F3291817 962696D6 32BC2240
   ShiftRow       3F299640 F32622DF 96BC7217 32FD18D6
   MixColumn      D38CE17E 6A06EBAF 8D74F741 B62D9E04
   KeyAddition    482FB56F E46FCE00 286E7C1E 964A62DA


Round = 3
   Substitution   5215D5A8 69A88B63 349F1072 90D6AA57
   ShiftRow       52A81057 699FAAA8 34D6D563 90158B72
   MixColumn      007E23E0 6A015AC5 BF84F699 FD4E1ED1
   KeyAddition    A8CEBFFA F9D0CE08 01CD72F7 4A13454B


Round = 4
   Substitution   C28B082D 99708B30 7CBD4068 D67D6EB3
   ShiftRow       C27040B3 99BD6E2D 7C7D0830 D68B8B68
   MixColumn      FC51FC10 B6678F39 47AE4191 D235E8B1
   KeyAddition    29CB10A8 ED94462E B94703D9 0CBB5627


Round = 5
   Substitution   A51FCAC2 55225A31 56A07B35 FEEAB1CC
   ShiftRow       A5227BCC 55A0B1C2 56EACA31 FE1F5A35
   MixColumn      80A03E2E 2204D171 72ED60B8 A91B0A36
   KeyAddition    35090CA4 047C7736 EADC4291 86777385


Round = 6
```

```
  Substitution   9601FE49 F210F505 87862C81 44F58F97
  ShiftRow       96102C97 F2868F49 87F5FE05 4401F581
  MixColumn      BC557CA8 A826AA96 EA6A9A93 FFC32C21
  KeyAddition    3D79FD05 72F9E22C CE5C9061 057B9845

Round = 7
  Substitution   27B6546B 40999871 8B4A60EF 6B21466E
  ShiftRow       2799606E 404A466B 8B215471 6BB698EF
  MixColumn      F0C0CC4C 73753B1A 4B449111 6040DC56
  KeyAddition    68057385 CDC82294 6DC8AAB6 69A09E42

Round = 8
  Substitution   456B8F97 BDE89322 3CE8AC4E F9E00B2C
  ShiftRow       45E8AC2C BDE80B97 3CE08F22 F96B934E
  MixColumn      294D9AD3 DEFCE10A EE4FBF6F 89CF7D74
  KeyAddition    414DE17F 6C23D21C 78A6868B E59EF0F4

Round = 9
  Substitution   83E3F8D2 5026B59C BC24443D D90B8CBF
  ShiftRow       832644BF 50248CD2 BC0BF89C D9E3B53D
  MixColumn      8CBCF799 92451AE7 1A25E30F 1FFD0C5C
  KeyAddition    44A8159D E4ECE16D 4A002322 46388E65

Round = 10
  Substitution   1BC2595E 69CEF83C D6632693 5A07194D
  ShiftRow       1BCE264D 6963195E D607593C 5AC2F893
  MixColumn      14BB4E5F 30DADA7D DB0F2747 8245DDE9
  KeyAddition    CAA82738 5C16800C 212A44D2 143133FC

Round = 11
  Substitution   74C2CC07 4A47CDFE FDE51BB5 FAC7C3B0
  ShiftRow       74471BB0 4AE5C307 FDC7CCFE FAC2CDB5
  MixColumn      8A67CEBB 64C23BF6 81D9A0F0 CA9C7D6B
  KeyAddition    D2E104E6 4AED0A21 FFD3510A ED530EA8

Round = 12
  Substitution   B5F8F28E D65567FD 1666D167 55EDABC2
  ShiftRow       B555D1C2 D666AB8E 16EDF2FD 55F86767
  MixColumn      9DB504DF 387274AB 0F2718C4 B970CAAE
  KeyAddition    E9294374 20226971 ED52668B CD715AF4

Round = 13
  Substitution   1EA51A92 B793F9A3 5500333D BDA3BEBF
  ShiftRow       1E9333BF B700BE92 55A31AA3 BDA5F93D
  MixColumn      1EC931E7 59FC7D43 ED853C1B 51C1B6FA
  KeyAddition    D4339B04 BD29E677 775A56D5 ECD1AFF7
```

```
Substitution   48C314F2 7AA58EF5 F5BEB103 CE3E7968
ShiftRow       48A5B168 7ABE79F2 F53E14F5 CEC38E03
KeyAddition    B6ED21B9 9CA6F4F9 F153E7B1 BEAFED1D

KeyAddition    96A2CF55 CA85EAA9 8658EF8B 63114091

Round = 1
  Substitution   903A8AFC 749787D3 446ADF3D FB820981
  ShiftRow       9097DF81 746A09FC 44828AD3 FB3A873D
  MixColumn      C75E3AFA A347131C 4C0DA779 192093D1
  KeyAddition    D86B16FD 98261BCB 6195B7DA 10344C25

Round = 2
  Substitution   617F4754 46F7AF1F EF2AA957 CA18293F
  ShiftRow       61F7A93F 462A2954 EF18471F CA7FAF57
  MixColumn      564B9E83 8F3DC261 B509584B F689093B
  KeyAddition    CDE8CA92 0154E7CE 1013D314 D6EEF5E5

Round = 3
  Substitution   BD9B744F 7C20948B CA7D66FA F628E6D9
  ShiftRow       BD2066D9 7C7DE64F CA28748B F69B94FA
  MixColumn      BE8E2133 D6F80781 088D8C14 2F864BE1
  KeyAddition    163EBD29 4529934C B6C4087A 98DB107B

Round = 4
  Substitution   47B27AA5 6EA5DC29 4E1C30DA 46B9CA21
  ShiftRow       47A53021 6E1CCAA5 4EB97A29 46B2DCDA
  MixColumn      6B67E11E 97B60935 1F807843 479C220B
  KeyAddition    BEFD0DA6 CC45C022 E1693A0B 99129C9D

Round = 5
  Substitution   AE54D724 4B6EBA93 F8F9802B EEC9DE5E
  ShiftRow       AE6E805E 4BF9DE24 F8C9D793 EE54BA2B
  MixColumn      2BB739BB 7CFF79B2 EF802A30 AAB8A891
  KeyAddition    9E1E0B31 5A87DFF5 77B10819 85D4D122

Round = 6
  Substitution   0B722BC7 BE179EE6 F5C830D4 97483E93
  ShiftRow       0B173093 BEC83EC7 F5482BE6 97729ED4
  MixColumn      8CE6D207 DDB058BA E4FEDAB0 E91EA5FD
  KeyAddition    0DCA53AA 076F1000 C0C8D042 13A61199

Round = 7
  Substitution   D774EDAC C5A8CA63 BAE8702C 7D2482EE
  ShiftRow       D7A870EE C5E882AC BA24ED63 7D74CA2C
```

```
  MixColumn      C8E2B67D 9C3FDD7D 8DBDFADA 80FCF261
  KeyAddition    502709B4 2282C4F3 AB31C17D 891CB075


Round = 8
  Substitution   53CC018D 93131C0D 62C778FF A79CE79D
  ShiftRow       5313789D 93C7E78D 629C010D A7CC1CFF
  MixColumn      76600CBF 05B90D8F 774FEB21 F9FF49C7
  KeyAddition    1E607713 B7663E99 E1A6D2C5 95AEC447


Round = 9
  Substitution   72D0F57D A933B2EE F824B5A6 2AE41CA0
  ShiftRow       7233B5A0 A9241C7D F8E4F5EE 2AD0B2A6
  MixColumn      A470CB4B 44B83222 C7C1C4C5 2BFA744B
  KeyAddition    6C64294F 3211C9A8 97E404E8 723FF672


Round = 10
  Substitution   5043A584 2382DDC2 8869F29B 40754240
  ShiftRow       5082F240 23694284 8875A5C2 4043DD9B
  MixColumn      8F02ED00 3BB3595D F354F1CC 03211473
  KeyAddition    51118467 577F032C 09719259 9555FA66


Round = 11
  Substitution   D1825F85 5BD27B71 01A34FCB 2AFC2D33
  ShiftRow       D1D24F33 5BA32D85 01FC5F71 2A827BCB
  MixColumn      A88CC893 E0F43672 3372D042 7973180A
  KeyAddition    F00A02CE CEDB07A5 4D7821B8 5EBC6BC9


Round = 12
  Substitution   8C67778B 8BB9C506 E3BCFD6C 58657FDD
  ShiftRow       8CB9FDDD 8BBC7F8B E3657706 5867C56C
  MixColumn      F324A86A 26E24F48 03B66220 B0AE1A92
  KeyAddition    87B8EFC1 3EB25292 E1C31C6F C4AF8AC8


Round = 13
  Substitution   176CDF78 B237004F F82E9CA8 1C797EE8
  ShiftRow       17379CE8 B22E7E78 F879DF4F 1C6C00A8
  MixColumn      032E2059 0B14E86D F03FF52B 246C9303
  KeyAddition    C9D48ABA EFC17359 6AE09FE5 997C8A0E


Substitution   DD487EF4 DF788FCB 02E1DBD9 EE107EAB
ShiftRow       DD78DBAB DFE17EF4 02107ECB EE488FD9
KeyAddition    23304B7A 39F9F3FF 067D8D8F 9E24ECC7



Ciphertext is
    F3EED1BD B5D2A03C 064B5A7E 3DB181F8
```

```
    591CCB10 D410ED26 DC5BA74A 31362870
    B6ED21B9 9CA6F4F9 F153E7B1 BEAFED1D
    23304B7A 39F9F3FF 067D8D8F 9E24ECC7


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ECB-AES256 (Decryption)
---------------------------------------------------------------

Key is
    603DEB10 15CA71BE 2B73AEF0 857D7781
    1F352C07 3B6108D7 2D9810A3 0914DFF4

Ciphertext is
    F3EED1BD B5D2A03C 064B5A7E 3DB181F8
    591CCB10 D410ED26 DC5BA74A 31362870
    B6ED21B9 9CA6F4F9 F153E7B1 BEAFED1D
    23304B7A 39F9F3FF 067D8D8F 9E24ECC7

KeyAddition    0DA6416C 53CA2D37 0226A93A 4DDDE2E6
Substitution   F3C5F8B8 5010FAB2 6A23B7A2 65C93BF5
ShiftRow       F3C9B7B2 50C53BA2 6A10F8F5 6523FAB8
Round = 13
  KeyAddition    39331D51 B410A096 F0CF923B D833E3B5
  InvMixColumn   FDBC5552 D92BF292 57C20201 DB848163
  Substitution   2178ED48 E50B0474 DAA86A09 9F4F9100
  ShiftRow       214F6A74 E5789109 DA0BED00 9FA80448
Round = 12
  KeyAddition    55D32DDF FD288CD3 387E934F EBA99412
  InvMixColumn   40FDD019 250C5BF8 085D8C43 36B7DA9F
  Substitution   7221608E C28157E1 BF8DF064 24207A6E
  ShiftRow       7220F0E1 C2217A64 BF81606E 248D578E
Round = 11
  KeyAddition    2AA63ABC EC0E4BB3 C18B9194 0342244D
  InvMixColumn   33B737B9 538CC005 0FC2C143 6EC1199E
  Substitution   6620B2DB 50F01F36 FBA8DD64 45DD8EDF
  ShiftRow       66DDDD36 50208E64 FBF0B2DF 45A81FDB
Round = 10
  KeyAddition    B8CEB451 3CECD415 01D5D14A D3DCF1CE
  InvMixColumn   031732B5 93CC5917 DE969097 EE65AC17
  Substitution   D587A1D2 22271587 9C359685 99BCAA87
  ShiftRow       D5BC9687 2287AA85 9C27A187 993515D2
Round = 9
  KeyAddition    1DA87483 542E510F CC0261AA C0F097EB
  InvMixColumn   B7C35A6C AB4BE622 E47F43DD FD4832CB
  Substitution   203346B8 0ECCF594 AE6B64C9 21D4A159
```

```
  ShiftRow        20D46494 0E33A1C9 AECC4659 216BF5B8
Round = 8
  KeyAddition     48D41F38 BCEC92DF 38257FBD 4D3A7838
  InvMixColumn    38D00251 51294520 78BA9A87 E322B84E
  Substitution    76606A70 704C6854 C1C037EA 4D949AB6
  ShiftRow        76943754 70609AEA C14C6AB6 4DC06870
Round = 7
  KeyAddition     EE51889D CEDD8364 E7C05111 44202A64
  InvMixColumn    8568ACEB D2A66CEC 35E24DFD 4E5E744E
  Substitution    67F7AA3C 7FC5B883 D93B6521 B69DCAB6
  ShiftRow        679D6583 7FF7CA21 D9C5AAB6 B63BB83C
Round = 6
  KeyAddition     E6B1E42E A528829B FDF3A044 4C830C58
  InvMixColumn    59487AF6 60C57445 7544E73C FDE8901E
  Substitution    15D4BDD6 9007CA68 3F86B06D 21C896E9
  ShiftRow        15C8B068 90D4966D 3F07BDE9 2186CAD6
Round = 5
  KeyAddition     A06182E2 B6AC302A A7369FC0 0EEAB365
  InvMixColumn    6F581482 ACA12A27 9A6E251F A6EB7F00
  Substitution    065E9B11 AAF1953D 3745C2CB C53C6B52
  ShiftRow        063CC23D AA5E6BCB 37F19B52 C5459511
Round = 4
  KeyAddition     D3A62E85 F1ADA2DC C918D91A 1BCB2B87
  InvMixColumn    9455CED1 37452070 B20B862D D18A193E
  Substitution    E7EDEC51 B26854D0 3E9EDCFA 51CF8ED1
  ShiftRow        E7CFDCD0 B2ED8EFA 3E68ECD1 519E5451
Round = 3
  KeyAddition     4F7F40CA 213C1A37 802168BF E6C30FCB
  InvMixColumn    0EFE6E24 5CF7079C BF16BB64 8DC8BD19
  Substitution    D70C45A6 A726381C F4FFFE8C B4B1CD8E
  ShiftRow        D7B1FE1C A70CCD8C F426458E B4FF38A6
Round = 2
  KeyAddition     4C12AA0D 2965E823 513CCED1 9498C478
  InvMixColumn    35753A83 4BB49FE7 0E95759C 90CABB51
  Substitution    D93FA241 CCC66EB0 D7AD3F1C 9610FE70
  ShiftRow        D9103FB0 CC3FFE1C D7C6A270 96AD6E41
Round = 1
  KeyAddition     C62513B7 F75EF6CB FA5EB2D3 9FB9B1B5
  InvMixColumn    2B7E7062 E22FD089 2528FC34 42B028F8
  Substitution    0B8AD0AB 3B4E60F2 C2EE5528 F6FCEEE1
  ShiftRow        0BFC55F2 3B8AEE28 C24ED0E1 F6EE60AB
KeyAddition    6BC1BEE2 2E409F96 E93D7E11 7393172A

KeyAddition    A7545BC1 3208602D D836540E 415A4B6E
Substitution   89FD57DD A1BF90FA 2D24FDD7 F846CC45
ShiftRow       8946FDFA A1FDCCD7 2DBF5745 F82490DD
```

```
Round = 13
  KeyAddition    43BC5719 452857E3 B7603D8B 453489D0
  InvMixColumn   B89DD541 9C9C27FE 581F1036 C99B552F
  Substitution   9A75B5F8 1C1C3D0C 5ECB7C24 12E8ED4E
  ShiftRow       9AE87C0C 1C75ED24 5E1CB54E 12CB3DF8
Round = 12
  KeyAddition    EE743BA7 0425F0FE BC69CB01 66CAADA2
  InvMixColumn   8EBD5762 F7995D1C 2D6A643C E8737E46
  Substitution   E6CDDAAB 26F98DC4 FA588C6D C88F8A98
  ShiftRow       E68F8CC4 26CD8A6D FAF9DA98 C8588DAB
Round = 11
  KeyAddition    BE094699 08E2BBBA 84F32B62 EF97FE68
  InvMixColumn   03E42BA4 CFD9B14C 35FFE612 844B5273
  Substitution   D5AE0B1D 5FE5565D D97DF539 4FCC488F
  ShiftRow       D5CCF55D 5FAE4839 D9E50B8F 4F7D561D
Round = 10
  KeyAddition    0BDF9C3A 33621248 23C0681A D909B808
  InvMixColumn   1D2F6E2E 46797145 BCBBCE58 B03911F8
  Substitution   DE4E45C3 98AF2C68 78FEEC5E FC5BE3E1
  ShiftRow       DE5BEC68 984EE35E 78AF45E1 FCFE2CC3
Round = 9
  KeyAddition    164F0E6C EEE718D4 288A85CC A53BAEFA
  InvMixColumn   3CB952EC BE79D9DB 076567EE 6EE3EAAD
  Substitution   6DDB4883 5AAFE59F 38BC0A99 454DBB18
  ShiftRow       6D4D0A9F 5ADBBB99 38AF4818 45BCE583
Round = 8
  KeyAddition    054D7133 E804888F AE4671FC 29ED6803
  InvMixColumn   048C64E6 42EFEFA9 549641E6 05C90162
  Substitution   30F08CF5 F66161B7 FD35F8F5 361209AB
  ShiftRow       3012F8B7 F6F009F5 FD618CAB 363561F5
Round = 7
  KeyAddition    A8D7477E 484D107B DBEDB70C 3FD523E1
  InvMixColumn   873EE41B 0A1C8EF6 9579F899 F381BFE5
  Substitution   EAD1AE44 A3C4E6D6 ADAFE1F9 7E91F42A
  ShiftRow       EA91E1D6 A3D1F4F9 ADC4AE2A 7EAFE644
Round = 6
  KeyAddition    6BBD607B 790EBC43 89F2A4D8 84175220
  InvMixColumn   0FD68591 0AFAC4BC F4C9D7ED 64E96B07
  Substitution   FB4A67AC A3148878 BA120D53 8CEB0538
  ShiftRow       FBEB0D78 A34A0553 BA146738 8C1288AC
Round = 5
  KeyAddition    4E423FF2 8532A314 22254511 A37EF11F
  InvMixColumn   1ADDF2F4 68934EB5 56C8975A E154D553
  Substitution   43C904BA F722B6D2 B9B18546 E0FDB550
  ShiftRow       43FD85D2 F7C9B546 B9220450 E0B1B6BA
Round = 4
```

```
   KeyAddition     9667696A AC3A7C51 47CB4618 3E3F082C
   InvMixColumn    9D6C9D9E E2155F13 58B3E6DF F20B8E52
   Substitution    75B875DF 3B2F8482 5E4BF5EF 049EE648
   ShiftRow        759EF582 3BB8E6EF 5E2F7548 044B84DF
Round = 3
   KeyAddition     DD2E6998 A8697222 E066F126 B316DF45
   InvMixColumn    D45C64EE 011DE26F 5CA7EF45 95148739
   Substitution    19A78C99 09DE3B06 A7896168 AD9BEA5B
   ShiftRow        199B6106 09A7EA68 A7DE8C5B AD893B99
Round = 2
   KeyAddition     82383517 87CECFC7 02C40704 8DEEC747
   InvMixColumn    33AAAFAE 51979B1C 36C3A292 C29455E0
   Substitution    66621BBE 7085E8C4 24331A74 A8E7EDA0
   ShiftRow        66E71AC4 7062ED74 24851BA0 A833E8BE
Round = 1
   KeyAddition     79D236C3 4B03E5A3 091D0B03 A127374A
   InvMixColumn    8BDD7870 2B1C99A0 D5B5EF93 BACAC14A
   Substitution    CEC9C1D0 0BC4F947 B5D26122 C010DD5C
   ShiftRow        CE106147 0BC9DD22 B5C4C15C C0D2F9D0
KeyAddition    AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51

KeyAddition    48A5B168 7ABE79F2 F53E14F5 CEC38E03
Substitution   D42956F7 BD5AAF04 77D19B77 EC33E6D5
ShiftRow       D4339B04 BD29E677 775A56D5 ECD1AFF7
Round = 13
   KeyAddition     1EC931E7 59FC7D43 ED853C1B 51C1B6FA
   InvMixColumn    1E9333BF B700BE92 55A31AA3 BDA5F93D
   Substitution    E92266F4 20525A74 ED714371 CD29698B
   ShiftRow        E9294374 20226971 ED52668B CD715AF4
Round = 12
   KeyAddition     9DB504DF 387274AB 0F2718C4 B970CAAE
   InvMixColumn    B555D1C2 D666AB8E 16EDF2FD 55F86767
   Substitution    D2ED51A8 4AD30EE6 FF530421 EDE10A0A
   ShiftRow        D2E104E6 4AED0A21 FFD3510A ED530EA8
Round = 11
   KeyAddition     8A67CEBB 64C23BF6 81D9A0F0 CA9C7D6B
   InvMixColumn    74471BB0 4AE5C307 FDC7CCFE FAC2CDB5
   Substitution    CA1644FC 5C2A3338 2131270C 14A880D2
   ShiftRow        CAA82738 5C16800C 212A44D2 143133FC
Round = 10
   KeyAddition     14BB4E5F 30DADA7D DB0F2747 8245DDE9
   InvMixColumn    1BCE264D 6963195E D607593C 5AC2F893
   Substitution    44EC2365 E4008E9D 4A38156D 46A8E122
   ShiftRow        44A8159D E4ECE16D 4A002322 46388E65
Round = 9
   KeyAddition     8CBCF799 92451AE7 1A25E30F 1FFD0C5C
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```
   InvMixColumn   832644BF 50248CD2 BC0BF89C D9E3B53D
   Substitution   412386F4 6CA6F07F 789EE11C E54DD28B
   ShiftRow       414DE17F 6C23D21C 78A6868B E59EF0F4
Round = 8
   KeyAddition    294D9AD3 DEFCE10A EE4FBF6F 89CF7D74
   InvMixColumn   45E8AC2C BDE80B97 3CE08F22 F96B934E
   Substitution   68C8AA42 CDC89E85 6DA07394 690522B6
   ShiftRow       68057385 CDC82294 6DC8AAB6 69A09E42
Round = 7
   KeyAddition    F0C0CC4C 73753B1A 4B449111 6040DC56
   InvMixColumn   2799606E 404A466B 8B215471 6BB698EF
   Substitution   3DF99045 725C9805 CE7BFD2C 0579E261
   ShiftRow       3D79FD05 72F9E22C CE5C9061 057B9845
Round = 6
   KeyAddition    BC557CA8 A826AA96 EA6A9A93 FFC32C21
   InvMixColumn   96102C97 F2868F49 87F5FE05 4401F581
   Substitution   357C4285 04DC73A4 EA770C36 86097791
   ShiftRow       35090CA4 047C7736 EADC4291 86777385
Round = 5
   KeyAddition    80A03E2E 2204D171 72ED60B8 A91B0A36
   InvMixColumn   A5227BCC 55A0B1C2 56EACA31 FE1F5A35
   Substitution   29940327 ED4756A8 B9BB102E 0CCB46D9
   ShiftRow       29CB10A8 ED94462E B94703D9 0CBB5627
Round = 4
   KeyAddition    FC51FC10 B6678F39 47AE4191 D235E8B1
   InvMixColumn   C27040B3 99BD6E2D 7C7D0830 D68B8B68
   Substitution   A8D0724B F9CD45FA 0113BF08 4ACECEF7
   ShiftRow       A8CEBFFA F9D0CE08 01CD72F7 4A13454B
Round = 3
   KeyAddition    007E23E0 6A015AC5 BF84F699 FD4E1ED1
   InvMixColumn   52A81057 699FAAA8 34D6D563 90158B72
   Substitution   486F7CDA E46E626F 284AB500 962FCE1E
   ShiftRow       482FB56F E46FCE00 286E7C1E 964A62DA
Round = 2
   KeyAddition    D38CE17E 6A06EBAF 8D74F741 B62D9E04
   InvMixColumn   3F299640 F32622DF 96BC7217 32FD18D6
   Substitution   254C3572 7E2394EF 35781E87 A121344A
   ShiftRow       25211EEF 7E4C3487 3523354A A1789472
Round = 1
   KeyAddition    3A1432E8 452D3C50 18BB25E9 A86C4B86
   InvMixColumn   5390A89F 4EC43FB1 8BF56879 DBE62A1E
   Substitution   50966F6E B6882556 CE77F7AF 9FF595E9
   ShiftRow       50F5F756 B69695AF CE886FE9 9F77256E
KeyAddition    30C81C46 A35CE411 E5FBC119 1A0A52EF

KeyAddition    DD78DBAB DFE17EF4 02107ECB EE488FD9
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```
Substitution   C9C19F0E EFE08ABA 6A7C8A59 99D473E5
ShiftRow       C9D48ABA EFC17359 6AE09FE5 997C8A0E
Round = 13
  KeyAddition    032E2059 0B14E86D F03FF52B 246C9303
  InvMixColumn   17379CE8 B22E7E78 F879DF4F 1C6C00A8
  Substitution   87B21CC8 3EC38AC1 E1AFEF92 C4B8526F
  ShiftRow       87B8EFC1 3EB25292 E1C31C6F C4AF8AC8
Round = 12
  KeyAddition    F324A86A 26E24F48 03B66220 B0AE1A92
  InvMixColumn   8CB9FDDD 8BBC7F8B E3657706 5867C56C
  Substitution   F0DB21C9 CE786BCE 4DBC02A5 5E0A07B8
  ShiftRow       F00A02CE CEDB07A5 4D7821B8 5EBC6BC9
Round = 11
  KeyAddition    A88CC893 E0F43672 3372D042 7973180A
  InvMixColumn   D1D24F33 5BA32D85 01FC5F71 2A827BCB
  Substitution   517F9266 5771FA67 0955842C 95110359
  ShiftRow       51118467 577F032C 09719259 9555FA66
Round = 10
  KeyAddition    8F02ED00 3BB3595D F354F1CC 03211473
  InvMixColumn   5082F240 23694284 8875A5C2 4043DD9B
  Substitution   6C110472 32E4F64F 973F29A8 7264C9E8
  ShiftRow       6C64294F 3211C9A8 97E404E8 723FF672
Round = 9
  KeyAddition    A470CB4B 44B83222 C7C1C4C5 2BFA744B
  InvMixColumn   7233B5A0 A9241C7D F8E4F5EE 2AD0B2A6
  Substitution   1E66D247 B7A6C413 E1AE7799 95603EC5
  ShiftRow       1E607713 B7663E99 E1A6D2C5 95AEC447
Round = 8
  KeyAddition    76600CBF 05B90D8F 774FEB21 F9FF49C7
  InvMixColumn   5313789D 93C7E78D 629C010D A7CC1CFF
  Substitution   5082C175 2231B0B4 AB1C09F3 8927C47D
  ShiftRow       502709B4 2282C4F3 AB31C17D 891CB075
Round = 7
  KeyAddition    C8E2B67D 9C3FDD7D 8DBDFADA 80FCF261
  InvMixColumn   D7A870EE C5E882AC BA24ED63 7D74CA2C
  Substitution   0D6FD099 07C811AA C0A65300 13CA1042
  ShiftRow       0DCA53AA 076F1000 C0C8D042 13A61199
Round = 6
  KeyAddition    8CE6D207 DDB058BA E4FEDAB0 E91EA5FD
  InvMixColumn   0B173093 BEC83EC7 F5482BE6 97729ED4
  Substitution   9E870822 5AB1D131 77D40BF5 851EDF19
  ShiftRow       9E1E0B31 5A87DFF5 77B10819 85D4D122
Round = 5
  KeyAddition    2BB739BB 7CFF79B2 EF802A30 AAB8A891
  InvMixColumn   AE6E805E 4BF9DE24 F8C9D793 EE54BA2B
  Substitution   BE453A9D CC699CA6 E1120D22 99FDC00B
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    ShiftRow       BEFD0DA6 CC45C022 E1693A0B 99129C9D
Round = 4
  KeyAddition     6B67E11E 97B60935 1F807843 479C220B
  InvMixColumn    47A53021 6E1CCAA5 4EB97A29 46B2DCDA
  Substitution    1629087B 45C41029 B6DBBD4C 983E937A
  ShiftRow        163EBD29 4529934C B6C4087A 98DB107B
Round = 3
  KeyAddition     BE8E2133 D6F80781 088D8C14 2F864BE1
  InvMixColumn    BD2066D9 7C7DE64F CA28748B F69B94FA
  Substitution    CD54D3E5 0113F592 10EECACE D6E8E714
  ShiftRow        CDE8CA92 0154E7CE 1013D314 D6EEF5E5
Round = 2
  KeyAddition     564B9E83 8F3DC261 B509584B F689093B
  InvMixColumn    61F7A93F 462A2954 EF18471F CA7FAF57
  Substitution    D826B725 98954CFD 613416CB 106B1BDA
  ShiftRow        D86B16FD 98261BCB 6195B7DA 10344C25
Round = 1
  KeyAddition     C75E3AFA A347131C 4C0DA779 192093D1
  InvMixColumn    9097DF81 746A09FC 44828AD3 FB3A873D
  Substitution    9685EF91 CA584055 8611CFA9 63A2EA8B
  ShiftRow        96A2CF55 CA85EAA9 8658EF8B 63114091
KeyAddition    F69F2445 DF4F9B17 AD2B417B E66C3710


Plaintext is
    6BC1BEE2 2E409F96 E93D7E11 7393172A
    AE2D8A57 1E03AC9C 9EB76FAC 45AF8E51
    30C81C46 A35CE411 E5FBC119 1A0A52EF
    F69F2445 DF4F9B17 AD2B417B E66C3710


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