Project No. 2 Due 4:00pm, June 27, 2023

You are expected to produce a computer program capable of decoding the (63, 42) Reed-Solomon code over $GF(2^6)$, which was used in Cinema Digital Sound. This code consists of all vectors (C_0, \ldots, C_{62}) , with each $C_i \in GF(2^6)$, such that

$$\sum_{i=0}^{62} C_i \alpha^{ij} = 0, \quad \text{for } j = 1, 2, \dots, 21$$

where α is a primitive element in GF(2⁶) satisfying $\alpha^6 + \alpha + 1 = 0$. Assume that the first 21 characters C_0, \ldots, C_{20} are the parity-check characters, and the last 42 characters C_{21}, \ldots, C_{62} are the information characters.

The deliverable will consist of three parts:

• Part I, Demonstration. At the time of demonstration, we will test your program by giving it several garbled codewords of the form (R_0, \ldots, R_{62}) , differing from a codeword by t_0 erasures and t_1 errors. If $t_0 + 2t_1 \le 21$, your program should find the codeword; but if $t_0 + 2t_1 > 21$, your program should output an appropriate failure message.

The elements of GF(2⁶) will be encoded as integers in the range 0 to 63, with integer 0 corresponding to [000000], 1 corresponding to [000001], 2 corresponding to [000010], ..., and 63 corresponding to [111111]. (Here $[a_5a_4a_3a_2a_1a_0]$ corresponds to the element $a_5\alpha^5 + a_4\alpha^4 + a_3\alpha^3 + a_2\alpha^2 + a_1\alpha + a_0$ in GF(2⁶).) An erasure will be represented by a * sign. The input to the program will be a file consisting of several garbled codewords in the following format:

```
45 63 * 0 2 \cdots 15 (the first garbled codeword) \cdots 13 0 5 * * \cdots 0 (the last garbled codeword)
```

- Part II, Report. When the project is due (and after the demonstration is passed), you need to hand in a *report* (in a hard copy), which should include, among other things, description of your project, discussions, etc. Your computer program *with comments* should be attached at the end of the report.
- Part III, Program file. You also need to submit, before the deadline, your program file. Please put all of your programs into a single file with your registration number and proj2 as the file name, say, 105064851_proj2.c or 105064851_proj2.cpp. (If, after all kinds of attempts, you are still unable to put all of your programs in a single file, please compress your files into a single rar or zip file and use your registration number along with proj2 as the file name, say, 105064851_proj2.rar or 105064851_proj2.zip.) Upload your file to the eeclass system.

The coefficients of the generator polynomial for the (63, 42) RS code:

```
a[11]=43
q[0]=58
q[1]=62
           q[12]=44
g[2]=59
           q[13]=27
           q[14] = 7
g[3] = 7
g[4]=35
           g[15]=53
q[5]=58
           a[16]=39
g[6]=63
           q[17]=62
g[7]=47
           g[18]=52
q[8]=51
           q[19]=41
g[9] = 6
           g[20]=44
g[10]=33
           g[21] = 1
```

The values of the polynomial:

```
g(alpha^0) = 34
                                     alpha^32 = 9
                                                      q(alpha^32) = 22
alpha^0 = 1
                                                      g(alpha^33) = 20
                 q(alpha^1) =
                                     alpha^33 = 18
alpha^1 =
           2
                                     alpha^34 = 36
alpha^2 = 4
                                                      q(alpha^34) = 28
                 q(alpha^2) =
                                0
                                                      g(alpha^35) = 17
                                     alpha^35 = 11
                 g(alpha^3) =
                                0
alpha^3 = 8
alpha^4 = 16
                 g(alpha^4) =
                                     alpha^36 = 22
                                                      q(alpha^36) = 13
                                0
                                     alpha^37 = 44
                                                      q(alpha^37) = 19
alpha^5 = 32
                 g(alpha^5) =
                                0
                                     alpha^38 = 27
                                                      g(alpha^38) = 14
alpha^6 = 3
                 q(alpha^6) =
                                0
                 g(alpha^7) =
                                0
                                     alpha^39 = 54
                                                      g(alpha^39) = 56
alpha^7 = 6
                                     alpha^40 = 47
                                                      g(alpha^40) = 25
alpha^8 = 12
                 q(alpha^8) =
                                0
                 g(alpha^9) =
                                     alpha^41 = 29
                                                      q(alpha^41) = 45
alpha^9 = 24
                                0
                                                       g(alpha^42) = 10
                                      alpha^42 = 58
                                0
alpha^{10} = 48
                 q(alpha^10) =
                                     alpha^43 = 55
                                                       q(alpha^43) = 46
alpha^11 = 35
                 g(alpha^11) =
                                0
                 g(alpha^12) =
                                      alpha^44 = 45
                                                       q(alpha^44) = 45
                                0
alpha^12 = 5
                                      alpha^45 = 25
                                                       q(alpha^45) = 8
alpha^13 = 10
                 g(alpha^13) =
                                0
                                      alpha^46 = 50
                                                       q(alpha^46) = 12
alpha^14 = 20
                 q(alpha^14) =
                                0
                                                       g(alpha^47) = 14
                 g(alpha^15) =
                                      alpha^47 = 39
alpha^15 = 40
                                0
                                                       g(alpha^48) = 44
                                      alpha^48 = 13
                 a(a|pha^16) =
                                0
alpha^16 = 19
                                                       g(alpha^49) = 14
                 g(alpha^17) =
                                      alpha^49 = 26
alpha^17 = 38
                                0
                                      alpha^50 = 52
                                                       q(alpha^50) = 17
alpha^18 = 15
                 q(alpha^18) =
                                0
                                                       q(alpha^51) = 26
alpha^19 = 30
                                      alpha^51 = 43
                 q(alpha^19) =
                                0
                                                       g(alpha^52) = 31
                                      alpha^52 = 21
                 q(alpha^20) =
                                0
alpha^20 = 60
                                      alpha^53 = 42
                                                       q(alpha^53) = 22
alpha^21 = 59
                 g(alpha^21) =
                               0
                                     alpha^54 = 23
                                                       q(alpha^54) = 59
alpha^22 = 53
                 g(alpha^22) = 16
                                      alpha^55 = 46
                                                       q(alpha^55) = 29
alpha^23 = 41
                 q(alpha^23) = 13
                                                       g(alpha^56) = 52
                                      alpha^56 = 31
                 g(alpha^24) = 43
alpha^24 = 17
                                      alpha^57 = 62
                                                       q(alpha^57) = 31
alpha^25 = 34
                 q(alpha^25) = 41
                                      alpha^58 = 63
                                                       g(alpha^58) = 57
                 q(alpha^26) = 48
alpha^26 = 7
                                      alpha^59 = 61
                                                       g(alpha^59) = 48
alpha^27 = 14
                 g(alpha^27) = 15
                                      alpha^60 = 57
                                                       q(alpha^60) = 45
alpha^28 = 28
                 q(alpha^28) = 11
                                                       q(alpha^61) = 51
alpha^29 = 56
                                      alpha^61 = 49
                 q(alpha^29) = 52
                                      alpha^62 = 33
alpha^30 = 51
                 g(alpha^30) = 33
                                                       q(alpha^62) = 13
                 q(alpha^31) = 1
alpha^31 = 37
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