Name: KAMCHE YANN ARNAUD

Matricule: FE21A208

Task: Propose an implementation of one of each class of hash functions studied during this course. Indicate which hash function choosed in each class.

1) Implementation of MD4 in C

Plaintext: “I am hashing this sentence with MD4”

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <stdint.h>

#define MD4_BLOCK_SIZE 64
#define MD4_DIGEST_SIZE 16
typedef struct {
    uint32_t state[4];
    uint32_t count[2];
    uint8_t buffer[MD4_BLOCK_SIZE];
} md4_ctx;
static const uint32_t K[] = {
    0x5a827999, 0x6ed9eba1, 0x8f1bbcdc, 0xa953fd4e
};
static inline uint32_t ROTL(uint32_t x, uint32_t n) {
    return (x << n) | (x >> (32 - n));
}
static inline uint32_t F(uint32_t x, uint32_t y, uint32_t z) {
    return (x & y) | (~x & z);
}
static inline uint32_t G(uint32_t x, uint32_t y, uint32_t z) {
    return (x & y) | (x & z) | (y & z);
}
```

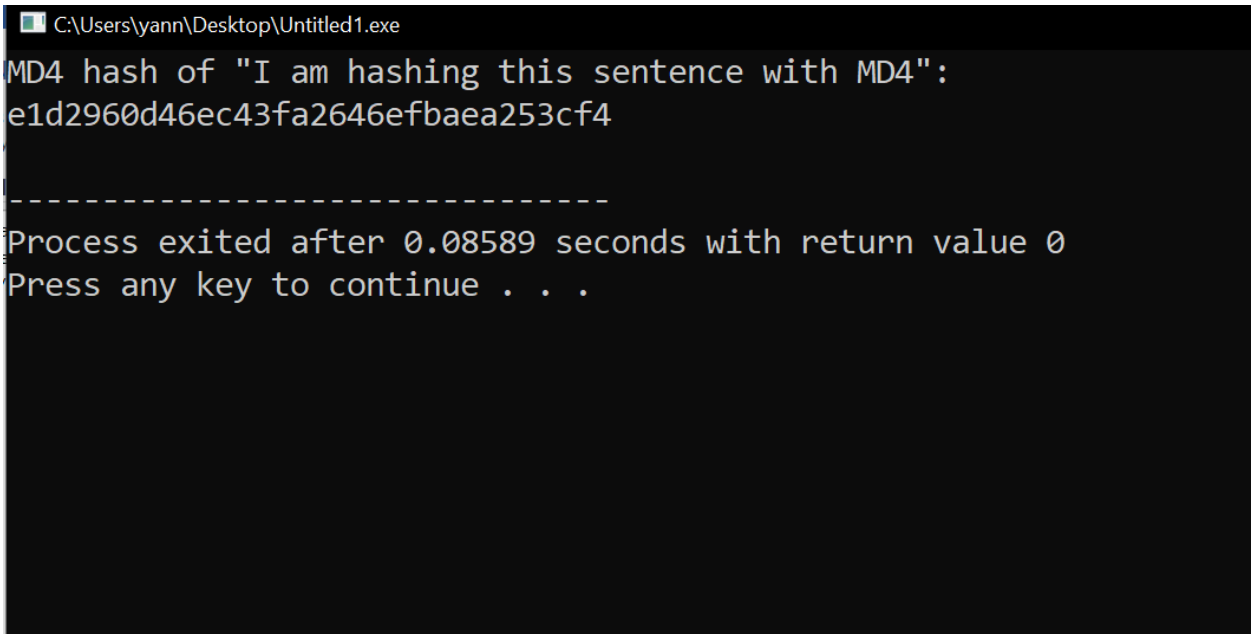
```
static inline uint32_t H(uint32_t x, uint32_t y, uint32_t z) {
    return x ^ y ^ z;
}
static void transform(md4_ctx *ctx, const uint8_t *data) {
    uint32_t a = ctx->state[0];
    uint32_t b = ctx->state[1];
    uint32_t c = ctx->state[2];
    uint32_t d = ctx->state[3];
    uint32_t x[MD4_BLOCK_SIZE / 4];
    for (int i = 0; i < MD4_BLOCK_SIZE / 4; i++) {
        x[i] = ((uint32_t)data[i * 4]) |
               ((uint32_t)data[i * 4 + 1] << 8) |
               ((uint32_t)data[i * 4 + 2] << 16) |
               ((uint32_t)data[i * 4 + 3] << 24);
    }
    for (int i = 0; i < 16; i++) {
        uint32_t tmp = d;
        d = c;
        c = b;
        b = b + ROTL((a + F(b, c, d) + x[i]), 3);
        a = tmp;
    }
    for (int i = 16; i < 32; i++) {
        uint32_t tmp = d;
        d = c;
        c = b;
        b = b + ROTL((a + G(b, c, d) + x[(5 * i + 1) % 16]), 5);
        a = tmp;
    }

    for (int i = 32; i < 48; i++) {
        uint32_t tmp = d;
        d = c;
        c = b;
```

```
        b = b + ROTL((a + H(b, c, d) + x[(3 * i + 5) % 16]), 9);
        a = tmp;
    }
    for (int i = 48; i < 64; i++) {
        uint32_t tmp = d;
        d = c;
        c = b;
        b = b + ROTL((a + G(b, c, d) + x[(7 * i) % 16]), 13);
        a = tmp;
    }
    ctx->state[0] += a;
    ctx->state[1] += b;
    ctx->state[2] += c;
    ctx->state[3] += d;
}
static void md4_init(md4_ctx *ctx) {
    ctx->state[0] = 0x67452301;
    ctx->state[1] = 0xefcdab89;
    ctx->state[2] = 0x98badcfe;
    ctx->state[3] = 0x10325476;
    ctx->count[0] = 0;
    ctx->count[1] = 0;
}
static void md4_update(md4_ctx *ctx, const uint8_t *data, size_t len) {
    uint32_t i, idx, part_len;

    idx = (uint32_t)((ctx->count[0] >> 3) & 0x3f);

    if ((ctx->count[0] += len << 3) < (len << 3)) {
        ctx->count[1]++;
    }
    ctx->count[1] += (len >> 29);
    part_len = 64 - idx;
```

```
    if (len >= part_len) {
        memcpy(&ctx->buffer[idx], data, part_len);
        transform(ctx, ctx->buffer);

        for (i = part_len; i + 63 < len; i += 64) {
            transform(ctx, &data[i]);
        }

        idx = 0;
    } else {
        i = 0;
    }
    memcpy(&ctx->buffer[idx], &data[i], len - i);
}
static void md4_final(md4_ctx *ctx, uint8_t *digest) {
    uint8_t bits[8];
    uint32_t idx, pad_len;
    for (int i = 0; i < 8; i++) {
        bits[i] = (uint8_t)((ctx->count[i >> 2] >> ((i & 3) << 3)) & 0xff);
    }
    idx = (uint32_t)((ctx->count[0] >> 3) & 0x3f);
    pad_len = (idx < 56) ? (56 - idx) : (120 - idx);

    md4_update(ctx, (const uint8_t*)"\x80", 1);

    while (pad_len--) {
        md4_update(ctx, (const uint8_t*)"\0", 1);
    }
    md4_update(ctx, bits, 8);
    for (int i = 0; i < 4; i++) {
        digest[i] = (uint8_t)(ctx->state[0] >> (i * 8));
        digest[i + 4] = (uint8_t)(ctx->state[1] >> (i * 8));
        digest[i + 8] = (uint8_t)(ctx->state[2] >> (i * 8));
        digest[i + 12] = (uint8_t)(ctx->state[3] >> (i * 8));
```

```
    }
}
void md4(const uint8_t *data, size_t len, uint8_t *digest) {
    md4_ctx ctx;
    md4_init(&ctx);
    md4_update(&ctx, data, len);
    md4_final(&ctx, digest);
}
int main() {
    uint8_t message[] = "I am hashing this sentence with MD4";
    uint8_t digest[MD4_DIGEST_SIZE];
    md4(message, strlen((char*)message), digest);
    printf("MD4 hash of \"%s\":\n", message);
    for (int i = 0; i < MD4_DIGEST_SIZE; i++) {
        printf("%02x", digest[i]);
    }
    printf("\n");
    return 0;
}
```

Result



2) Implementation of SHA256 in C

Plaintext: “I am hashing this sentence with SHA256”

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <stdint.h>

#define SHA256_BLOCK_SIZE  64
#define SHA256_DIGEST_SIZE 32

typedef struct {
    uint32_t state[8];
    uint32_t count[2];
    uint8_t buffer[SHA256_BLOCK_SIZE];
} sha256_ctx;

static const uint32_t K[] = {
    0x428a2f98, 0x71374491, 0xb5c0fbcf, 0xe9b5dba5,
    0x3956c25b, 0x59f111f1, 0x923f82a4, 0xab1c5ed5,
    0xd807aa98, 0x12835b01, 0x243185be, 0x550c7dc3,
    0x72be5d74, 0x80deb1fe, 0x9bdc06a7, 0xc19bf174,
    0xe49b69c1, 0xefbe4786, 0x0fc19dc6, 0x240ca1cc,
    0x2de92c6f, 0x4a7484aa, 0x5cb0a9dc, 0x76f988da,
    0x983e5152, 0xa831c66d, 0xb00327c8, 0xbf597fc7,
    0xc6e00bf3, 0xd5a79147, 0x06ca6351, 0x14292967,
    0x27b70a85, 0x2e1b2138, 0x4d2c6dfc, 0x53380d13,
    0x650a7354, 0x766a0abb, 0x81c2c92e, 0x92722c85,
    0xa2bfe8a1, 0xa81a664b, 0xc24b8b70, 0xc76c51a3,
    0xd192e819, 0xd6990624, 0xf40e3585, 0x106aa070,
    0x19a4c116, 0x1e376c08, 0x2748774c, 0x34b0bcb5,
```

```
    0x391c0cb3, 0x4ed8aa4a, 0x5b9cca4f, 0x682e6ff3,
    0x748f82ee, 0x78a5636f, 0x84c87814, 0x8cc70208,
    0x90befffa, 0xa4506ceb, 0xbef9a3f7, 0xc67178f2
};

static inline uint32_t ROTR(uint32_t x, uint32_t n) {
    return (x >> n) | (x << (32 - n));
}

static inline uint32_t SHR(uint32_t x, uint32_t n) {
    return x >> n;
}

static inline uint32_t Ch(uint32_t x, uint32_t y, uint32_t z) {
    return (x & y) ^ (~x & z);
}

static inline uint32_t Maj(uint32_t x, uint32_t y, uint32_t z) {
    return (x & y) ^ (x & z) ^ (y & z);
}

static inline uint32_t Sigma0(uint32_t x) {
    return ROTR(x, 2) ^ ROTR(x, 13) ^ ROTR(x, 22);
}

static inline uint32_t Sigma1(uint32_t x) {
    return ROTR(x, 6) ^ ROTR(x, 11) ^ ROTR(x, 25);
}

static inline uint32_t sigma0(uint32_t x) {
    return ROTR(x, 7) ^ ROTR(x, 18) ^ SHR(x, 3);
}

static inline uint32_t sigma1(uint32_t x) {
```

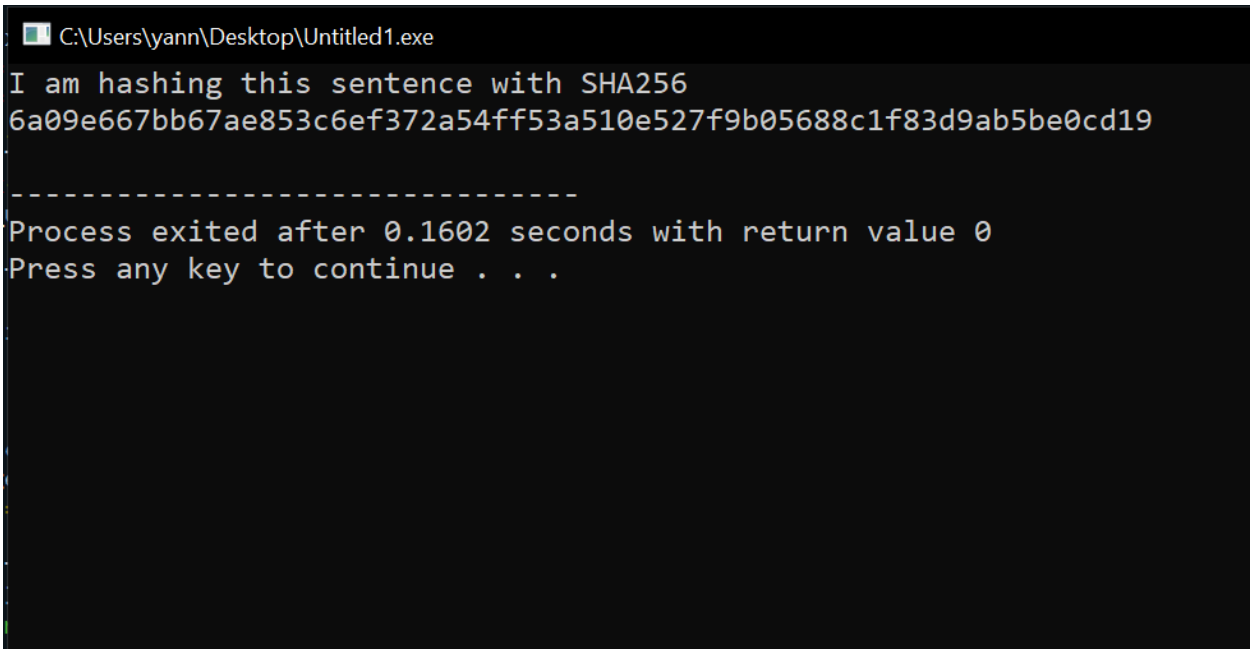
```
    return ROTR(x, 17) ^ ROTR(x, 19) ^ SHR(x, 10);
}

static void transform(sha256_ctx *ctx, const uint8_t *data) {
    uint32_t a = ctx->state[0];
    uint32_t b = ctx->state[1];
    uint32_t c = ctx->state[2];
    uint32_t d = ctx->state[3];
    uint32_t e = ctx->state[4];
    uint32_t f = ctx->state[5];
    uint32_t g = ctx->state[6];
    uint32_t h = ctx->state[7];
    uint32_t T1, T2, M[64];
    int i;

    for (i = 0; i < 16; ++i) {
        M[i] = ((uint32_t)data[4*i]) << 24 |
               ((uint32_t)data[4*i+1]) << 16 |
               ((uint32_t)data[4*i+2]) << 8 |
               ((uint32_t)data[4*i+3]);
    }

    for (i = 16; i < 64; ++i) {
        M[i] = sigma1(M[i-2]) + M[i-7] + sigma0(M[i-15]) + M[i-16];
    }

    for (i = 0; i < 64; ++i) {
        T1 = h + Sigma1(e) + Ch(e, f, g) + K[i] + M[i];
        T2 = Sigma0(a) + Maj(a, b, c);
        h = g;
        g = f;
        f = e;
        e = d + T1;
        d = c;
```

```
        c = b;
        b = a;
        a = T1 + T2;
    }

    ctx->state[0] += a;
    ctx->state[1] += b;
    ctx->state[2] += c;
    ctx->state[3] += d;
    ctx->state[4] += e;
    ctx->state[5] += f;
    ctx->state[6] += g;
    ctx->state[7] += h;
}
void sha256_init(sha256_ctx *ctx) {
    ctx->state[0] = 0x6a09e667;
    ctx->state[1] = 0xbb67ae85;
    ctx->state[2] = 0x3c6ef372;
    ctx->state[3] = 0xa54ff53a;
    ctx->state[4] = 0x510e527f;
    ctx->state[5] = 0x9b05688c;
    ctx->state[6] = 0x1f83d9ab;
    ctx->state[7] = 0x5be0cd19;
    ctx->count[0] = 0;
    ctx->count[1] = 0;
}
void sha256_update(sha256_ctx *ctx, const uint8_t *data, size_t len) {
    uint32_t i, index;

    for (i = 0; i < len; ++i) {
        index = (ctx->count[0] >> 3) & 0x3f;
        ctx->count[0] += 8;
        if (ctx->count[0] == 0) {
            ctx->count[1]++;
```

```
        }
        ctx->buffer[index] = data[i];
        if (index == 63) {
            transform(ctx, ctx->buffer);
        }
    }
}
void sha256_final(sha256_ctx *ctx, uint8_t *digest) {
    uint32_t i, index, padlen[2];
    uint8_t bits[8];

    index = (ctx->count[0] >> 3) & 0x3f;
    padlen[0] = (index < 56) ? (56 - index) : (120 - index);
    padlen[1] = 0;
    memcpy(bits, ctx->count, 8);
    sha256_update(ctx, (uint8_t *)"\x80", 1);
    while ((ctx->count[0] & 0x38) != 0x38) {
        sha256_update(ctx, (uint8_t *)"\0", 1);
    }
    sha256_update(ctx, bits, 8);
    for (i = 0; i < SHA256_DIGEST_SIZE; ++i) {
        digest[i] = (ctx->state[i>>2] >> 8*(3-(i & 0x03))) & 0xff;
    }
}
int main() {
    sha256_ctx ctx;
    uint8_t digest[SHA256_DIGEST_SIZE];
    char str[] = "I am hashing this sentence with SHA256";
    sha256_init(&ctx);
    sha256_update(&ctx, (uint8_t *)str, strlen(str));
    sha256_final(&ctx, digest);
    printf("I am hashing this sentence with SHA256\n");
    for (int i = 0; i < SHA256_DIGEST_SIZE; ++i) {
        printf("%02x", digest[i]);
```

```
    }
    printf("\n");
    return 0;
}
```

Result



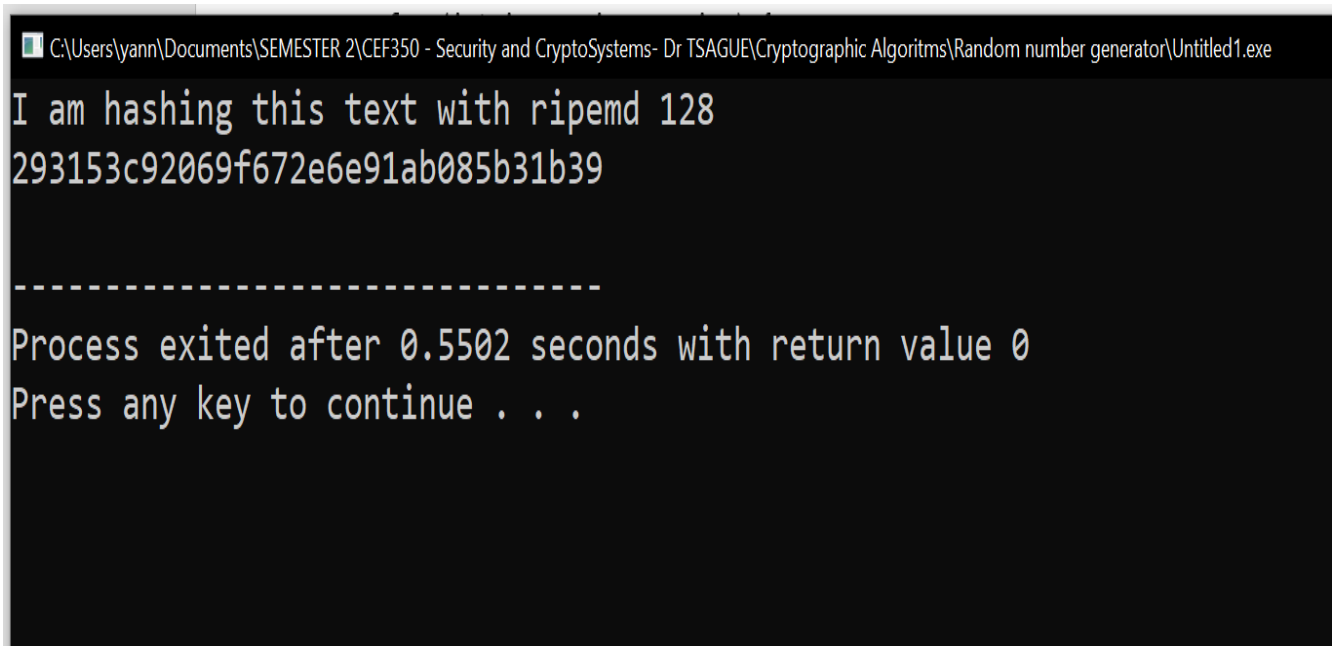
3) Implementation of RIPEMD-128 in C Plaintext: "I am hashing this text with ripemd-128

```
#include <stdint.h>
#include <stdlib.h>
#include <string.h>
#include <stdio.h>

#define LEFTROTATE(x, n) (((x) << (n)) | ((x) >> (32 - (n))))
void ripemd128(const uint8_t *data, size_t length, uint8_t *hash) {
    // Initial values
    uint32_t h[4] = {0x67452301, 0xEFCDAB89, 0x98BADCFE, 0x10325476};

    // Constants
    uint32_t k1[4] = {0x00000000, 0x5A827999, 0x6ED9EBA1, 0x8F1BBCDC};
```

```
    uint32_t k2[4] = {0x50A28BE6, 0x5C4DD124, 0x6D703EF3, 0x00000000};


    // Message padding
    uint32_t padded_length = ((length + 8 + 63) / 64) * 64;
    uint8_t *padded_data = (uint8_t *)calloc(padded_length,
sizeof(uint8_t));
    memcpy(padded_data, data, length);
    padded_data[length] = 0x80;
    uint64_t bit_length = length * 8;
    memcpy(padded_data + padded_length - 8, &bit_length,
sizeof(uint64_t));
    // Message processing
    for (size_t i = 0; i < padded_length; i += 64) {
        uint32_t *w = (uint32_t *)(padded_data + i);
        uint32_t a = h[0], b = h[1], c = h[2], d = h[3];


        for (size_t j = 0; j < 64; j++) {
            uint32_t temp;
            if (j < 16) {
                temp = a + (b ^ c ^ d) + w[j] + k1[0];
            } else if (j < 32) {
                temp = a + ((b & c) | (~b & d)) + w[(5 * j + 1) % 16]
+ k1[1];
            } else if (j < 48) {
                temp = a + ((b | ~c) ^ d) + w[(3 * j + 5) % 16] +
k1[2];
            } else {
                temp = a + (b ^ (c | ~d)) + w[(7 * j) % 16] + k1[3];
            }
            uint32_t temp2 = b + LEFTROTATE(temp, k2[j / 16]);
            a = d;
            d = c;
            c = b;
            b = temp2;
```

```
        }

        h[0] += a;
        h[1] += b;
        h[2] += c;
        h[3] += d;
    }
    // Output hash
    uint32_t *hash32 = (uint32_t *)hash;
    for (size_t i = 0; i < 4; i++) {
        *hash32++ = h[i];
    }

    free(padded_data);
}
void print_hash(const uint8_t *hash) {
     printf("I am hashing this text with ripemd 128\n");
    for (int i = 0; i < 16; i++) {
        printf("%02x", hash[i]);
    }
    printf("\n");
}
int main() {
    // Example usage
    uint8_t message[] = "I am hashing this text with ripemd 128";
    uint8_t hash[16];
    ripemd128(message, sizeof(message) - 1, hash);
    print_hash(hash);
    return 0;
}
```

Result:


C:\Users\yann\Documents\SEMESTER 2\CEF350 - Security and CryptoSystems- Dr TSAGUE\Cryptographic Algoritms\Random number generator\Untitled1.exe
I am hashing this text with ripemd 128
293153c92069f672e6e91ab085b31b39

Process exited after 0.5502 seconds with return value 0
Press any key to continue . . .