**ΕΡΓΑΣΤΗΡΙΑΚΗ ΑΣΚΗΣΗ 9 (ΜΙΚΡΟΠΡΟΓΡΑΜΜΑΤΙΣΜΟΣ 4)**

**29.04.2024**

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Ομάδα Α4

|  |  |
| --- | --- |
| Accumulator | 0001 |
| Program Counter | **1000** |
| Βοηθητικός Καταχωρητής Χ | **0000** |
| BR | **1010** |
| SP | **1001** |

**Ερώτημα 1.**

**Να γραφούν μικροπρογράμματα για την υλοποίηση των ακόλουθων εντολών.**

**LΟΑDSP #Υ** : Αρχικοποίηση του stack pointer με την τιμή Κ, όπου Κ ένας διψήφιος δεκαεξαδικός αριθμός.

PC+1->PC,MAR

MDR+0->SP

PC+1->PC,MAR

NEXT(PC)

**PUSH $K** : Τοποθέτησε στην κορυφή του σωρού τα περιεχόμενα της θέσης μνήμης με διεύθυνση Κ.

PC+1 ->PC , MAR

//////// CHECK ////////

PC+1->PC,MAR

BR-SP ->NOP,MSTATUSCLK

PC+1->PC,MAR

NEXT(PC)

//////// JUMP JNN //////////

PC+1->PC,MAR

MDR+X->NOP,MAR

MDR+0->PC

PC+1->PC,MAR

NEXT(PC)

SP-1->SP

MDR+0->MAR

MDR+0->SP

PC+1->PC, MAR

NEXT(PC)

//////// HALT ////////

PC+0->PC

NEXT(PC)

**POP $K** : Αποθήκευσε στη θέση μνήμης με διεύθυνση Κ το περιεχόμενο της κορυφής της στοίβας

PC+1->PC,MAR

BR-SP ->NOP,MSTATUSCLK

PC+1->PC,MAR

NEXT(PC)

//////// JUMP JNN //////////

PC+1->PC,MAR

MDR+X->NOP,MAR

MDR+0->PC

PC+1->PC,MAR

NEXT(PC)

//////// JUMP JNZ //////////

PC+1->PC,MAR

MDR+X->NOP,MAR

MDR+0->PC

PC+1->PC,MAR

NEXT(PC)

MDR+0->NOP,MAR

SP+0->NOP,MWR

SP+1->SP

PC+1->PC,MAR

NEXT(PC)

//////// HALT ////////

PC+0->PC

NEXT(PC)

**ADD** : Πρόσθεση των περιεχομένων των δύο πρώτων θέσεων της στοίβας και επιστροφή του αποτελέσματος στην κορυφή της στοίβας

PC+1->PC,MAR ////PROTO POP////

MDR+0->NOP,MAR

SP+0->NOP,MWR

PC+1->PC,MAR

NEXT(PC)

PC+1->PC,MAR //// DEYTERO POP////

MDR+0->NOP,MAR

SP+0->NOP,MWR

PC+1->PC,MAR

NEXT(PC)

PC+1->PC ////PROSTHESI////

K+Y->K

PC + 1 -> PC , MAR ////PUSH TO APOTELESMA STO STACK////

SP-1->SP

MDR + 0 -> MAR

MDR + 0 -> SP

PC + 1 -> PC,MAR

NEXT(PC)

**SUB** : Αφαίρεση του περιεχομένου της θέσης της στοίβας που βρίσκεται κάτω από την κορυφή από το περιεχόμενο της κορυφής της και αποθήκευση του αποτελέσματος στην κορυφή της στοίβας

PC+1->PC,MAR ////PROTO POP////

MDR+0->NOP,MAR

SP+0->NOP,MWR

PC+1->PC,MAR

NEXT(PC)

PC+1->PC,MAR //// DEYTERO POP////

MDR+0->NOP,MAR

SP+0->NOP,MWR

PC+1->PC,MAR

NEXT(PC)

PC+1->PC ////afairesi////

K-Y->K

PC + 1 -> PC , MAR ////PUSH TO APOTELESMA STO STACK////

SP-1->SP

MDR + 0 -> MAR

MDR + 0 -> SP

PC + 1 -> PC,MAR

NEXT(PC)

**HALT** : Τέλος εκτέλεσης του προγράμματος.

PC+0->PC

NEXT(PC)

**Οι 40αδες των μικροεντολών**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BOOTSTRAP** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| SW+0->PC,MAR | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | 1000 | xx | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | m00 |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m01 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **LOADSP #K** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m02 |
| MDR+0->SP | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | 1001 | xx | x | x | 1 | 0 | x | 1 | 1 | 1 | 1 | 1 | m03 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m04 |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m05 |

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| **PUSH $K** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m06 |
| BR-SP->NOP,MSTATUSCLK | xxxxx | 000 | 000 | 100 | 000 | 001 | 1010 | xxxx | xx | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | m07 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m08 |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 011 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m09 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m0a |
| MDR+X->NOP,MAR | xxxxx | 000 | 000 | 100 | 000 | 001 | 0001 | xxxx | xx | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | m0b |
| MDR+0->PC | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | 1000 | xx | x | x | 1 | 0 | x | 1 | 1 | 1 | 1 | 1 | m0c |
| NEXT(PC)(JUMP IF NEGATIVE) | xxxxx | 000 | 010 | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m0d |
| SP-1->SP | xxxxx | 000 | 000 | 100 | 000 | 001 | 1001 | 1001 | 01 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | m0e |
| MDR+0->MAR | xxxxx | 000 | 000 | 100 | 000 | 001 | xxxx | xxxx | xx | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | m0f |
| MDR+0->SP | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | 1001 | xx | x | x | 1 | 0 | x | 1 | 1 | 1 | 1 | 1 | m10 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m11 |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 011 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m12 |
| PC+0->PC | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 00 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m13 |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 011 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m14 |

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| **POP $K** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m15 |
| BR-SP->NOP,MSTATUSCLK | xxxxx | 000 | 000 | 100 | 000 | 001 | 0000 | xxxx | xx | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | m16 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | 0001 | xx | x | x | 1 | 0 | x | 1 | 1 | 1 | 1 | 1 | m17 |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m18 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m19 |
| MDR+X->NOP,MAR | xxxxx | 000 | 000 | 100 | 000 | 001 | 0001 | xxxx | xx | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | m1a |
| MDR+0->PC | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | 1000 | xx | x | x | 1 | 0 | x | 1 | 1 | 1 | 1 | 1 | m1b |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m1c |
| NEXT(PC) JUMP IF NEGATIVE | xxxxx | 000 | 010 | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m1d |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m1e |
| MDR+X->NOP,MAR | xxxxx | 000 | 000 | 100 | 000 | 001 | 0001 | xxxx | xx | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | m1f |
| MDR+0->PC | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | 1000 | xx | x | x | 1 | 0 | x | 1 | 1 | 1 | 1 | 1 | m20 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m21 |
| NEXT(PC) JUMP IF ZERO | xxxxx | 000 | 011 | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m22 |
| MDR+0->NOP,MAR | xxxxx | 000 | 000 | 100 | 000 | 001 | xxxx | xxxx | xx | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | m23 |
| SP+0->NOP,MWR | xxxxx | 000 | 000 | 100 | 000 | 001 | 1001 | xxxx | xx | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | m24 |
| SP+1->SP | xxxxx | 000 | 000 | 100 | 000 | 001 | 1001 | 1001 | 01 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | m25 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m26 |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m27 |
| PC+0->PC | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 00 | x | x | 1 | 0 | x | 1 | 1 | 1 | 1 | 0 | m28 |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m29 |

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| **ADD** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m2a |
| MDR+0->NOP,MAR | xxxxx | 000 | 000 | 100 | 000 | 001 | 0000 | xxxx | xx | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | m2b |
| SP+0->NOP,MWR | xxxxx | 000 | 000 | 111 | 000 | 011 | xxxx | 0001 | xx | x | x | 0 | 0 | x | 1 | 1 | 1 | 1 | 1 | m2c |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m2d |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m2e |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m2f |
| MDR+0->NOP,MAR | xxxxx | 000 | 000 | 100 | 000 | 001 | 0000 | xxxx | xx | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | m30 |
| SP+0->NOP,MWR | xxxxx | 000 | 000 | 100 | 000 | 001 | 1001 | xxxx | xx | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | m31 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m32 |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m33 |
| PC+1->PC | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 0 | x | 1 | 1 | 1 | 1 | 0 | m34 |
| K+Y->K | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | xxxx | xx | x | x | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | m35 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m36 |
| SP-1->SP | xxxxx | 000 | 000 | 100 | 000 | 001 | 1001 | 1001 | 01 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | m37 |
| MDR+0->MAR | xxxxx | 000 | xxx | 111 | 000 | 011 | 0000 | xxxx | xx | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 1 | m38 |
| MDR+0->SP | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | 1001 | xx | x | x | 1 | 0 | x | 1 | 1 | 1 | 1 | 1 | m39 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m3a |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m3b |

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| **SUB** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m3c |
| MDR+0->NOP,MAR | xxxxx | 000 | 000 | 100 | 000 | 001 | 0000 | xxxx | xx | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | m3d |
| SP+0->NOP,MWR | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | 0001 | xx | x | x | 0 | 0 | x | 1 | 1 | 1 | 1 | 1 | m3e |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m3f |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m40 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m41 |
| MDR+0->NOP,MAR | xxxxx | 000 | 000 | 100 | 000 | 001 | 0000 | xxxx | xx | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | m42 |
| SP+0->NOP,MWR | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | 0001 | xx | x | x | 0 | 0 | x | 1 | 1 | 1 | 1 | 1 | m43 |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m44 |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m45 |
| PC+1->PC | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 0 | x | 1 | 1 | 1 | 1 | 0 | m46 |
| K-Y->K | xxxxx | 000 | 000 | 100 | 000 | 001 | xxxx | xxxx | xx | x | x | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | m47 |
| PC+1 ->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m48 |
| SP-1->SP | xxxxx | 000 | 000 | 100 | 000 | 001 | 1001 | 1001 | 01 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | m49 |
| MDR+0->MAR | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | xxxx | xx | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 1 | m4a |
| MDR+0->SP | xxxxx | 000 | xxx | 111 | 000 | 011 | xxxx | 1001 | xx | x | x | 1 | 0 | x | 1 | 1 | 1 | 1 | 1 | m4b |
| PC+1->PC,MAR | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 01 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m4c |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m4d |

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| **HALT** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC+0->PC | xxxxx | 000 | xxx | 101 | 000 | 011 | 1000 | 1000 | 00 | x | x | 1 | 1 | x | 1 | 1 | 1 | 1 | 0 | m4e |
| NEXT(PC) | xxxxx | 000 | xxx | xxx | xxx | 001 | xxxx | xxxx | xx | x | x | 1 | x | x | 0 | x | 1 | x | x | m4f |

**Ερώτημα 2.**

**Να γραφεί πρόγραμμα για τον υπολογισμό της έκφρασης: W = X – Y + Z, όπου τα W, X, Y και Z είναι θέσεις της κύριας μνήμης. Οι τιμές των W, X, Y και Z καθώς και ο καταχωρητής που θα χρησιμοποιηθεί ως SP, και οι δέκα διαδοχικοί καταχωρητές Ri, Ri+1, Ri+2, .. που θα χρησιμοποιηθούν για την υλοποίηση της στοίβας θα σας δοθούν κατά την διάρκεια του εργαστηρίου.**

LDBR #09

LDSP#OA

PUSH #01

PUSH #02

ADD

PUSH #03

SUB

POP

|  |  |
| --- | --- |
| **Mapper**  m00 02  m01 06  m02 0a  m03 1b  m04 2c  m05 3e  m06 50  m07 65 | **Main memory**  m00 00 // opcode εντολής LOADBR  m01 0e // έντελο εντολής LOADBR  m02 01 // opcode εντολής LOADSP  m03 0f// έντελο εντολής LOADSP  m04 02 // opcode εντολής PUSH  m05 10 // έντελο εντολής PUSH  m06 03 // opcode εντολής PUSH  m07 11 // έντελο εντολής PUSH  m08 04 // opcode εντολής ADD  m09 05 // opcode εντολής PUSH  m0a 12 // έντελο εντολής PUSH  m0b 06 // opcode εντολής SUB  m0c 07 // opcode εντολής POP  m0d 13 // έντελο εντολής POP  // περιοχή δεδομένων//  m0e 09  m0f 0a  m10 01  m11 02  m12 03  m13 04 |