

Sample Exam H		Blatt Nr.:	1 von 12
Studiengang:	Softwaretechnik SWB Technische Informatik TIB Ingenieurpädagogik IEP	Semester:	IT4
Prüfungsfach:	Computerarchitektur	Fachnummer:	1054003
Hilfsmittel:	Vorlesungs- und Labormanuskript, Fachliteratur, Taschenrechner Lecture manuscript, books, pocket calculator	Dauer:	90 min
		Dozent::	Zimmermann

Insert your name here:

Total: 100 Points

Given name (Vorname):	Last name (Nachname):	Student ID (Matrikelnummer):
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Please use the free space on these sheets for your solution. Solutions may be in English or German. If space is not sufficient, please use the backside or additional sheets.

Bitte tragen Sie Ihre Lösungen in Deutsch oder Englisch in die Aufgabenblätter ein. Wenn der vorgesehene Platz nicht ausreicht, verwenden Sie bitte die Rückseite bzw. Zusatzblätter. Kennzeichnen Sie, auf welche Fragen sich die Zusatzblätter beziehen.

Viel Erfolg - Good luck!

Problem 1: Miscellaneous (Σ 25 points)

1.1

(5 points)

Which problems/bugs does the following C function have?

```
int * enterPinNumber (void)
{
    char pin[8] = "12345678";
    int pinNum = 0;
    printf("Enter your PIN: ");
    gets(pin);                //Enter PIN from keyboard as string
    pinNum = atoi(pin);       //Convert string to number
    return &pinNum;
}
```

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1.2

(4 points)

Describe the structure of a "Stack Frame" used by HCS12's C compiler when calling subroutines:

1.3

(10 points)

A student writes the following C program. The program shall toggle the LEDs on the Dragon12 board approximately once every 5 seconds via an ECT timer interrupt service routine.

The code compiles and runs, but the LEDs do not blink as expected. Correct **all** bugs and add instructions (if required), to make the program work as specified.

```
#include <mc9s12dp256.h>

#define COUNT 10

void timerISR(void)
{
    static int i = 0;

    if (++i >= 500)
    {
        PORTB = ~ PORTB;
        i = 0;
    }

    TC0 = TC0 + COUNT;
}

void main(void)
{
    DDRB = 0xFF; // Configure LED ports
    DDRJ = DDRJ | 0x02;
    PORTB = 0x00;
```

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		Dozent::	Zimmermann

```

PTJ    = PTJ & 0xFC;

TSCR1 = 0x80;           // Configure timer channel 0
TSCR2 = 0x07;

TIOS   = 0x01;

TCTL1 = 0x00;
TCTL2 = 0x00;

TC0 = TCNT + COUNT;

    for (;;)
}

```

1.4 (6 points)

What is the contents of variables *s1, s2, ..., s6*, when the following C code has been executed:

```
char a = 0x7E, b = 0x81, c=0x7F, s1,s2,s3,s4,s5,s6;
```

```

s1 = !a;
s2 = a | b;
s3 = a && b;
s4 = a ^ c;
s5 = ~a;
s6 = a > b ? 1 : 0;

```

s1 =
s2 =
s3 =
s4 =
s5 =
s6 =

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Problem 2: Addressing Modes (Σ 25 points)

2.1

(5 points)

Specify the addressing mode for all operands of the following HCS12 instructions.

One (or more) instructions may contain bugs. Mark the instruction(s) and explain the problem.

Instruction	1st operand	2nd operand
LDD #var1	Implicit register address for D	
LDD 6, -Y	Implicit register address for D	
STD #var3	Implicit register address for D	
LDD \$C000	Implicit register address for D	
MOVB 0,Y,var3		

2.2

A HCS12 program defines some global variables and constants:

```
.const:    SECTION
           ORG      $D010

c1:        DC.W      $0102, $0304, $0506, $0708
c2:        DC.B      $09, $10, $11, $12, $13, $14, $15, $16
c3:        DC.L      $76543210, $FEDCBA98

.data:     SECTION
           ORG      $2080
p:         DS.W      1
v:         DS.W      1
```

For each row in the following table specify the contents of CPU registers D, X and Y and of variables p and v, after the instructions in the left field of the row have been executed. Fields, where values do not change, may be left empty. Mark unknown values as “???” if necessary.

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Note: All values in Hex

(20 points)

HCS12 Instructions	D	X	Y	p	v
Initial values	0	0	0	0	0
LDD c1 LDX c2 LDY c3 MOVW #\$2456, v MOVW #v, p					
PSHX PSHD PSHY PULB PULA PULX LDY 2, SP+					
LDX #c1 LDY #c2 LDD 2, X					
LDAA 3, +X LDAB 1, Y-					
LDX #p LDD [0, X]					
LDD #\$7080 TFR A, X TFR B, Y BMI L0 LDD c3 L0: NOP					
LDD #\$2080 LDX \$D010 LDY c3+2					
MOVW #v, p LDD #\$ABCD STD p+2					

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Problem 3: Code Analysis (Σ 35 points)

The following C program performs a mathematical operation with two vectors:

```
char vectorA[8] = { 1, 2, 3, 4, 5, 6, 7, 8 };
char vectorB[8] = { 8, 7, 6, 5, 4, 3, 2, 1 };
int result;

int function(char *a, char *b, int n);

void main(void)
{
    . . .
    result = function(vectorA, vectorB, 3);
    . . .
}
```

function() is a HCS12 assembler subroutine:

```
function:      STD     6, -SP           ; Line 1
               LDD     #0              ; Line 2
               STD     4, SP           ; Line 3
               STD     2, SP           ; Line 4
               BRA     m2              ; Line 5

m1:           LDD     10, SP           ; Line 6
               ADDD    2, SP           ; Line 7
               TFR     D, X            ; Line 8
               LDAB    0, X            ; Line 9
               SEX     B, D            ; Line 10
               PSHD                    ; Line 11

               LDD     10, SP           ; Line 12
               ADDD    4, SP           ; Line 13
               TFR     D, X            ; Line 14
               LDAB    0, X            ; Line 15
               SEX     B, Y            ; Line 16
               PULD                    ; Line 17

               EMUL                    ; Line 18
               ADDD    4, SP           ; Line 19
               STD     4, SP           ; Line 20

               LDX     2, SP           ; Line 21
               INX                    ; Line 22
               STX     2, SP           ; Line 23

m2:           LDD     2, SP           ; Line 24
               CPD     0, SP           ; Line 25
               BLT     m1              ; Line 26

               LDD     4, SP           ; Line 27
               LEAS    6, SP           ; Line 28
               RTS                    ; Line 29
```

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3.1

Into which HCS12 assembler instructions does the C compiler translate the subroutine call

`result = function(vectorA, vectorB, 3)`

(6 points)

3.2

Specify the state of the stack, when the CPU reaches line 5. Use the table on the next page.

3.3

What is the purpose of the following lines of code?

(6 points)

Lines 1...4:

Line 27:

Line 28:

3.4

How often does the program execute lines 24...25, when the function is called as in 3.1?

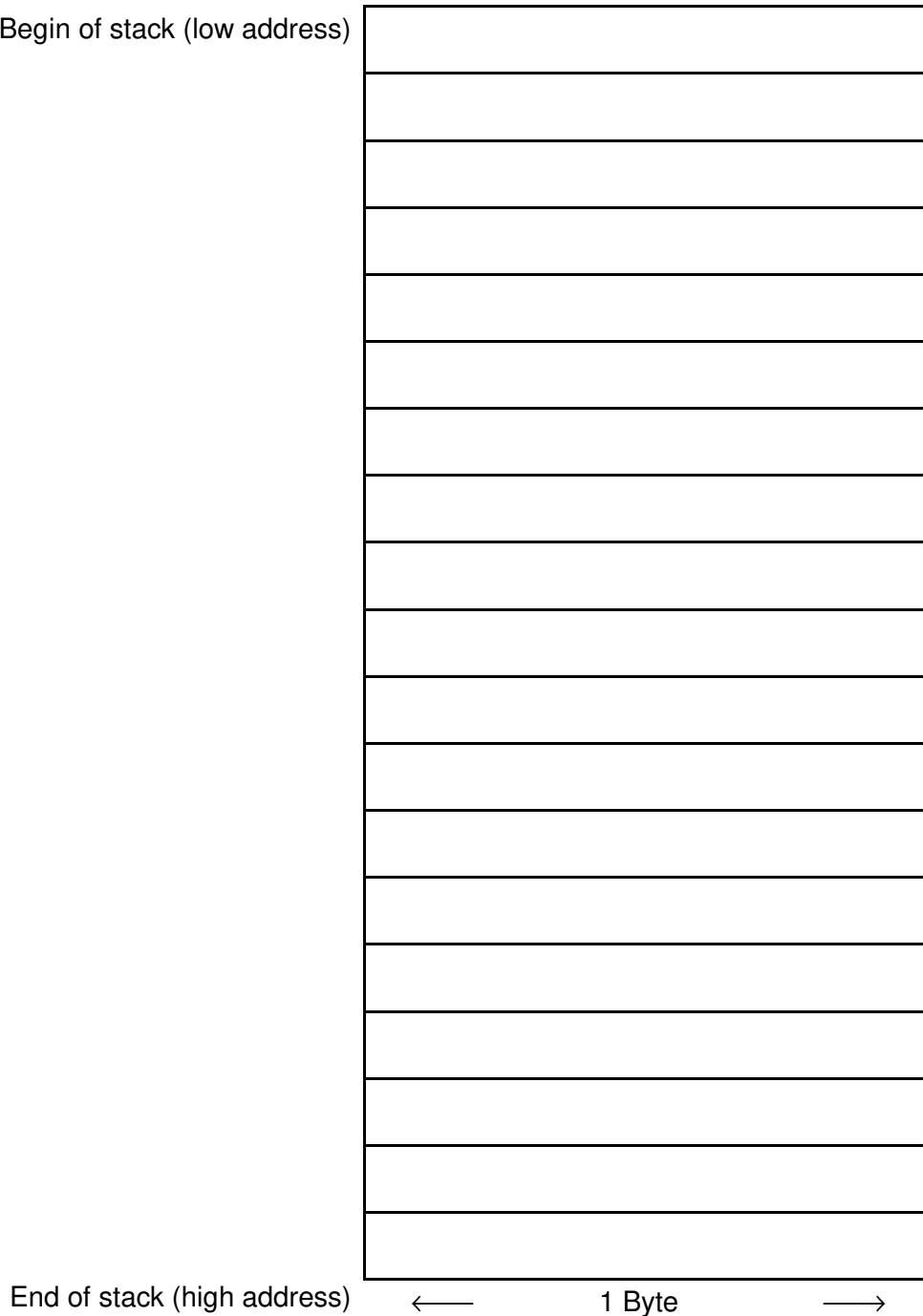
(2 points)

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Stack status for question 3.2:

Begin of stack (low address)

(8 points)



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		Dozent: :	Zimmermann

3.5

Lines 21...26 implement a well-known C/C++ programming construct, which is used to control program flow. Which one?

(2 points)

3.6

Which value is in register D, when the program reaches line 11 for the first time?

D = (2 points)

Which value is in register Y, when the program reaches line 17 for the first time?

Y = (2 points)

Which value is in register D, when the program reaches line 20 for the first time?

D = (2 points)

Which value does the function return and what is the purpose of this function?

(5 points)

Return value:

Function purpose:

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Problem 4: String to Integer Number Conversion (Σ 15 points)

You shall write a subroutine

```
unsigned char asciiToNum(char *string)
```

which converts a string into a number. The ASCII zero terminated string contains two characters, which are ASCII-coded decimal digits. The subroutine shall convert this string into the respective unsigned 8 bit number, e.g. `string = "37" → num = 37 = 0x25`.

If the string contains non-numeric characters, i.e. other characters than '0','1',...,'9', the function shall return 0 = 0x00.

The subroutine shall be written in HCS12 assembler or C (without using any standard library functions) in such a way, that it can be called from a C program.

ASCII table:

<i>ASCII character</i>	<i>ASCII code in hex</i>
Non-numeric characters	0x00 ... 0x2F
'0'	0x30
'1'	0x31
'2'	0x32
...	...
'9'	0x39
Non-numeric characters	0x3A ... 0xFF

4.1

Describe your subroutine design with a program flow chart:

(7 points)

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4.2

Write the subroutine in HCS12 assembler or in C without any C standard library functions. The subroutine shall be placed into a separate module (=file). Don't forget to add comments to your code!

(4 points for a solution in C OR 8 points for a solution in HCS12 assembler)

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