

**UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING**

**APS 105 — Computer Fundamentals
Midterm Examination
October 15, 2014
7:45 p.m. – 9:30 p.m.
(105 minutes)**

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Exam Type A: This is a “closed book” examination; no aids are permitted.
Calculator ‘Type’ 4: No calculators or other electronic devices are allowed.

All questions are to be answered on the examination paper. If the space provided for a question is insufficient, you may use the last page to complete your answer. If you use the last page, please direct the marker to that page and indicate clearly on that page which question(s) you are answering there.

You must use the C programming language to answer programming questions. You are not required write `#include` directives in your solutions. You may use any math function that you have learned, as necessary.

The examination has 16 pages, including this one.

Circle the day of your lab - (**1 mark will be deducted** if you don’t correctly indicate your lab day):

PRA0101	PRA0102	PRA0103	PRA0104
Friday	Wednesday	Monday	Thursday
1-3pm	12-2pm	12-2pm	12-2pm

First Name: _____ Last Name: _____

Student Number: _____

MARKS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
/2	/2	/2	/2	/2	/2	/3	/3	/2	/6	/6	/6	/6	/6	/50

Question 1 [2 Marks]

What will be printed when the following C program is executed?

```
int main(void) {
    int first = 1, second = 10;
    int *pointerToFirst, *pointerToSecond;

    pointerToFirst = &first;
    pointerToSecond = &second;

    *pointerToFirst = *pointerToSecond - *pointerToFirst;
    *pointerToSecond = *pointerToSecond - *pointerToFirst;
    *pointerToFirst = *pointerToSecond + *pointerToFirst;

    printf("%d, %d\n", first, second);
}
```

Solution:

10, 1

Question 2 [2 Marks]

In the following C program, how many times will the asterisk "*" be printed?

```
int main(void) {
    int i, j, k;

    for (i = 0; i < 2; i++)
        for (j = 0; j < 3; j++)
            for (k = j; k > 0; k--)
                if (i < j)
                    printf("*");
    return 0;
}
```

Solution:

The asterisk will be printed 5 times.

Question 3 [2 Marks]

Write a single C statement that will compute the value of `r` according to the following expression, and assign the value to `r`.

$$r = \frac{x^n + 6 \times x^4}{\sin(y) + \cos^{-1}(z)}$$

You can assume that all the variables in the expression are already declared as `double` types, and that the math library (described by the header file `math.h`) is available, and that the value of `y` and `z` is in radians.

```
r = (pow(x, n) + 6 * pow(x, 4.0)) / (sin(y) + acos(z));
```

Question 4 [2 Marks]

Suppose that `x` is a variable of type `int`, and has a value of 5, `y` is a `char` variable with value `'T'` and `z` is a `double` variable with value `9.2`. Evaluate the following expressions:

Solution:

Expression	Answer
<code>pow(2.0, x - 2)</code>	<code>8.0</code>
<code>(char) (y + x)</code>	<code>Y</code>
<code>(int) (z / x)</code>	<code>1</code>
<code>(x != 0) && (x < z)</code>	<code>true</code>

Question 5 [2 Marks]

What does the following program print?

```
int main(void) {
    int i = 10;

    while (i > 5) {
        printf("%d\n", i * i);

        if (i % 2 != 0)
            printf("***\n");

        i--;
    }
    return 0;
}
```

Solution:

```
100
81
***
64
49
***
36
```

Question 6 [2 Marks]

Write a single C statement that declares an `int` type variable named `randomNum` and initializes it to a random number between 0 and 105 inclusive, where the random number is divisible by 5.

Solution:

```
int randomNum = (rand() % 22) * 5;
```

Question 7 [3 Marks]

What is the output of the following program?

```
int main(void) {
    int a = 1, b = 2, c = 7, d = 4, e = 5;

    for (a = 1; a <= 4; a++)
        b = b - 10 + a;
```

```
c = c / 2;

printf("a: %d b: %d c: %d ", a, b, c);

while (d >= 7)
    d = d + 100;

printf("d: %d ", d);

do {
    e = e % 2;
} while (e >= 4);

printf("e: %d\n", e);

return 0;
}
```

Solution:

a: 5 b: -28 c: 3 d: 4 e: 1

Question 8 [3 Marks]

The following C program is supposed to ask the user for an input integer n and to compute which numbers from 1 to n are divisible by 3, and to output just those numbers, one per line. There are four errors in this program, which are either syntax or logical errors.

```
1  #include <stdio.h>
2
3  int main(void)
4      int i, n, div3;
5
6      printf("Enter number: ");
7      scanf("%d", n);
8
9      for (i = 1; i <= n; n++) {
10         div3 = i % 3;
11
12         if (div3 == 0)
13             printf("%d", i);
14     }
15
16     return 0;
17 }
```

For each error, state, in the following table, the line number that has the error, and give the corrected statement.

Solution:

Line Number	Corrected Line
3	int main(void) {
7	scanf("%d", &n);
9	for (i = 1; i <= n; i++) {
13	printf("%d\n", i);

Question 9 [2 Marks]

There have been five plenary lectures so far in this course, and there is one question from each below. You should give a written answer from **two of these five questions**. The answer should be one or two sentences. If you answer more than two questions, you must indicate which two you wish to be graded; if you do not indicate which, then the first two in order will be graded.

Plenary Lecture 1 – Creative Application for Mobile Devices. What does it mean when we say that smartphones allow an application to *scale*? Give an example.

Solution: Once an application works, it can be deployed to everyone in the world who has compatible smartphones – for example, if an application for diagnosing a skin disease can work, it can be deployed to everyone in the world with a compatible camera.

Plenary Lecture 2 – Software at Google Scale. How did Google make clever use of its computer servers when they were not being used?

Solution: When one part of the world was more likely to be sleeping, and therefore making less use of the local servers, those would be used to help the part of the world that was awake, and needing more compute power?

Plenary Lecture 3 – From Smartphones to the Cloud. What does an object contain?

Solution: Variables and Functions, also known as methods.

Plenary Lecture 4 – Software Companies – Pheedloop and Konnectivity. In one sentence each, describe what service is provided by the companies Konnectivity and Pheedloop.

Solution: Konnectivity allows people in a geographic area, at a conference, to meet people who would be of interest to them, after describing their own profile. Pheedloop allows speakers to obtain fast feedback from their audience.

Plenary Lecture 5 – An EE's Journey to the Software Side. Name one of the things (systems) that Professor Betz talked about using software to optimize (i.e. make better). In addition, say, in one sentence, *what* was being optimized.

Solution: Three possible answers: Antenna for US Navy, optimizing the radiation or efficiency of antenna. MRI - optimizing the design of the MRI magnets, or the shielding of the system. Design of a computer chip - optimizing the sizing of transistors (or anything close to that).

Question 10 [6 Marks]

In Canada, different tax rates are used depending on the taxpayer's marital status and income. The table below gives the tax rate computations for a single person, using the values for the 2013 federal tax return.

If the taxable income is over	But not over	The tax is	Of the amount over
\$0	\$43,561	15%	\$0
\$43,561	\$87,123	6534.15 + 22%	\$43,561
\$87,123	\$135,054	16118.79 + 26%	\$87,123
\$135,054		28580.85 + 29%	\$135,054

Write a C program that asks the user to enter the taxable income, and then prints out the federal tax owing on that income, to two decimal places.

Your program should match the output of these example runs:

Example Run 1:

```
Enter your taxable income: 21346.00
Your federal tax is $3201.90
```

Example Run 2:

```
Enter your taxable income: 34500.00
Your federal tax is $5175.00
```

Example Run 3:

```
Enter your taxable income: 53000.00
Your federal tax is $8610.73
```

Solution:

```
#include <stdio.h>
int main(void) {

    const double LEVEL1 = 0.0, LEVEL2 = 43561.0,
                  LEVEL3 = 87123.0, LEVEL4 = 135054.0;
    const double RATE1 = 0.15, RATE2 = 0.22, RATE3 = 0.26, RATE4 = 0.29;
    const double BASE1 = 0.0, BASE2 = 6534.15,
                  BASE3 = 16118.79, BASE4 = 28580.85;
    double income, tax;

    printf("Enter your taxable income: ");
    scanf("%lf", &income);

    if(income <= LEVEL2)
```

```

        tax=income*RATE1;

else if (income <= LEVEL3)

        tax=BASE2 + (income-LEVEL2)*RATE2;

else if (income<=LEVEL4)

        tax=BASE3 + (income-LEVEL3)*RATE3;

else

        tax=BASE4 + (income-LEVEL4)*RATE4;

printf("Your federal tax is $%.2lf\n", tax);
return (0);
}

```

Question 11 [6 Marks]

Please write a C program that **repeatedly** prompts the user to enter two integer numbers (num1 and num2). For each pair of numbers, the program computes the remainder of the integer division of num1 by num2, but **the modulus (%) operator must not be used**. The remainder for each pair is to be printed. You can assume that neither of the inputs are zeros. The program should terminate when at least one of the inputs is a negative number.

Again, you may only use the basic arithmetic operators in this program: +, -, *, and /. **You may not use the % operator.**

The output of your program should match the example run shown below:

```
Please enter two integer numbers: 10 3
10 % 3 = 1
```

```
Please enter two integer numbers: 25 5
25 % 5 = 0
```

```
Please enter two integer numbers: 2 3
2 % 3 = 2
```

```
Please enter two integer numbers: 10 -5
Goodbye.
```

Solution:

```
int main(void) {
    int num1, num2, divide, multiply, remainder;

    printf("Please enter two integer numbers: ");
    scanf("%d%d", &num1, &num2);

    while(num1 > 1 && num2 > 1) {
        divide    = num1    / num2;
        multiply   = divide  * num2;
        remainder = num1    - multiply;

        printf("%d %% %d = %d\n\n", num1, num2, remainder);

        printf("Please enter two integer numbers: ");
        scanf("%d%d", &num1, &num2);
    }
    printf("Goodbye.");
    return 0;
}
```

Question 12 [6 Marks]

Write a C program that prompts the user to enter three lower-case letter and then prints them out in alphabetical order. (You can assume that the three letters are all lower case.)

The program's input and output sequence should look like these examples, each time it is run:

Example Run 1:

```
Enter three lower-case letters: cvb
Output in alphabetical order: bcv
```

Example Run 2:

```
Enter three lower-case letters: zxy
Output in alphabetical order: xyz
```

Example Run 3:

```
Enter three lower-case letters: abc
Output in alphabetical order: abc
```

Example Run 4:

```
Enter three lower-case letters: ddb
Output in alphabetical order: bdd
```

Solution:

```
int main(void) {
    char a,b,c;

    printf("Enter three lower-case letters: ");
    scanf("%c%c%c",&a,&b,&c);

    printf("Output in alphabetical order: ");

    if (a <= b && a <= c) {
        printf("%c",a);

        if (b<=c) printf("%c%c",b,c);
        else printf("%c%c",c,b);
    }

    else if (b <=c && b <= a) {
        printf("%c",b);

        if (a<=c) printf("%c%c",a,c);
        else printf("%c%c",c,a);
    }
}
```

```
}

else {
    printf("%c",c);

    if (a<=b) printf("%c%c",a,b);
    else printf("%c%c",b,a);
}

return (EXIT_SUCCESS);
}
```

Question 13 [6 Marks]

In this question, you are to complete the code for a function and its calling in a main program. The function is called `sumAndProductOfMultiples`; it takes integers `multiple1` and `multiple2`, and a maximum bound `max` as input, and computes both the sum and the product of all the positive integers less than `max` that are multiples of either `multiple1` or `multiple2`.

For example, if `multiple1 = 3`, `multiple2 = 5`, and `max = 10`, the positive integers less than 10 that are multiples of either 3 or 5 are 3, 5, 6, 9. Their sum is 23, and their product is 810. The function must return the sum and product values via pointer parameters `sumPtr` and `productPtr`, as implied in the skeleton code below.

In the code skeleton below, you are given most of the main function, **but** you must give the call to the `sumAndProductOfMultiples` function. After that you are given just the declaration line of the function, and you must write the remainder of the function.

Solution:

```
void sumAndProductOfMultiples(int multiple1, int multiple2, int max, int *sumPtr, int *productPtr) {

int main(void)
{
    int multi1 = 3, multi2 = 5, max = 10;
    int sum, product;

    // add your call to sumAndProductOfMultiples here:

    sumAndProductOfMultiples(multi1, multi2, max, &sum, &product);

    printf("m1 = %d, m2 = %d, max = %d, sum = %d, product = %d\n",
           multi1, multi2, max, sum, product);
    return 0;
}

void sumAndProductOfMultiples(int multiple1, int multiple2, int max, int *sumPtr, int *productPtr) {
{
    *sumPtr = 0, *productPtr = 1;
    int i;
    for (i = 1; i < max; i++) {
        if (i % multiple1 == 0 || i % multiple2 == 0) {
            *sumPtr += i;
            *productPtr *= i;
        }
    }
}
}
```

Question 14 [6 Marks]

Write a complete C program that first prompts the user for a number of rows (with the assumption that the user enters a valid number between 0 and 26 inclusive), and then prints a pattern of letters that appears exactly like the following examples:

When the number of rows is 3 it should print:

```
ABC
BCA
CAB
```

When the number of rows is 10 it should print::

```
ABCDEFGHIJ
BCDEFGHIJA
CDEFGHIJAB
DEFGHIJABC
EFGHIJABCD
FGHIJABCDE
GHIJABCDEF
HIJABCDEFGF
IJABCDEFGH
JABCDEFGHI
```

If a user enters 0 as the number of rows, nothing will be printed.

Solution:

```
int main(void) {
    int numberOfRows;

    printf("Please enter the number of rows: ");
    scanf("%d", &numberOfRows);

    int row, col;
    for (row = 1; row <= numberOfRows; row++) {
        for (col = 1; col <= numberOfRows; col++) {
            printf("%c", 'A' + ((row + col - 2) % numberOfRows));
        }
        printf("\n");
    }
    return 0;
}
```

This page has been left blank intentionally. You may use it for answers to any questions.