UNIVERSITY OF GHANA

BACHELOR OF SCIENCE IN ENGINEERING
FIRST SEMESTER EXAMINATIONS: 2015/2016

DEPARTMENT OF COMPUTER ENGINEERING
CPEN 101: ENGINEERING COMPUTATIONAL TOOLS (2 Credits)

INSTRUCTION: *Answer all Questions in Section A, two (2) Questions from Section B, and two (2) Questions from Section C.*

TIME ALLOWED: *TWO (2) HOURS*

SECTION A (40 Marks)

Answer all questions in this section

1.

a. Briefly explain what an engineering computational tool is and why it is considered important. List four (4) mathematical computational tools that could be used to solve engineering and scientific problems. [6 marks]

b. List and briefly describe two (2) major engineering achievements since the introduction of computers and computational tools. [4 marks]

c. Explain the difference between hardware system and software system. Draw a diagram of the computer hardware architecture of your computer and discuss how the processor interacts with the memory to execute instructions. [5 marks]

d. Explain the difference between operating system (OS) and application software. Illustrate your answer using a simple diagram of the software architecture and its interaction with the various domains. [5 marks]

e. Draw the layered structure diagram of the computer language hierarchy and explain the function in each hierarchy. Give two (2) examples of a low-level language and two (2) examples of a high-level language. [5 marks]

f. What is the difference between a compiler and an interpreter? Explain why we

need the two systems and give one (1) advantage and one (1) disadvantage of each type. [5 marks]

g. Engineering problem can be broadly classified into five (5) main areas. Briefly describe any two (2) and give one (1) example of each type. [5 marks]

h. Briefly describe the steps you will follow to solve a typical engineering problem in your field of study. State the problem to be solved. [5 marks]

SECTION B: EXCEL SPREADSHEET (30 Marks)

Answer any two (2) questions from this section

2. A system of linear equations $AX = B$ is defined as follows:

$$x_1 - x_2 = 0$$

$$x_1 - x_3 = 0$$

$$x_1 - x_4 = 0$$

$$x_1 + x_2 + x_3 + x_4 = 1$$

(a) Describe how you will use the excel spreadsheet to solve the equation for X. Use the cell range of B2:E5 for your matrix A, H2:H5 for matrix B, B8:E11 for your inverse matrix A^{-1}, and the range G8:G11 for matrix X. [7 marks]

(b) Determine the following spreadsheet functions given the following cell values: B4 = 20, C4 = 15, D4 = 5, and E4 = 2. [8 marks]

i. =IF(B4<C4, IF(C4<D4,"GOOD",C4*D4), B4*D4)

ii. =IF(B4<C4, IF(C4<D4,C4*D4,"BAD"), B4*D4)

iii. =IF(B4<C4, IF(C4>D4,C4*D4,"bad"), "bad")

iv. =IF(B4<C4, IF(C4<D4,C4*D4,"bad"),SUM(B4,D4:E4))

3. (a) Explain the following spreadsheet terms: [4 marks]

i. Excel workbook

ii. *Visual basic application (VBA)*

(b) Table 1 shows the results (courses taken and the grades obtained) of a student in a particular academic year.

i. Describe how you will find the contents of cells F2:F15.

ii. Assuming you have contents in F2:F15, what excel expression will you enter in cell F17 to compute the CGPA of the student for

the academic year? [3 marks]

(ii) What function will you put in cell F18 to *count* the number of courses the students had taken more than once? [2 marks]

(iii) What function will you put in cell F19 to determine the number of courses the students scored A? [2 marks]

(iv) What will be the content of cell F20 if the following function *"=IF(C8 >2, IF(E13<4, C42*E4, C8*E8), C2*E2)"* is entered in that cell? [2 marks]

(v) What will be the content of cell G20 if the following function *"=IF(C8 <2, IF(E13<4, C42*E4, C8*E8), C2*E2)"* is entered in that cell? [2 marks]

Table 1 – Student GPA calculation

I19

	A	B	C	D	E	F	G	H	I	J
1		CODE	CREDIT	GRADE	GRADE POINT	CPA				
2		CPEN101	2	F	0					
3		FAEN201	4	B	3					
4		CPEN201	3	A	4					
5		CPEN203	3	A	4					
6		CPEN205	2	D	1					
7		CPEN101	2	A	4					
8		CPEN207	3	C+	2.5					
9		FAEN102	4	F	0					
10		FAEN202	4	D+	1.5					
11		FAEN206	3	A	4					
12		CPEN202	2	A	4					
13		CPEN204	3	B	3					
14		FAEN102	4	A	4					
15		CPEN206	3	C+	2.5					
16										
17										
18										
19										
20										
21										

4. (a) Suppose we want to generate random numbers between 10 and 100 to fill the cell range B1:B10. Describe the excel function and how you will use the function achieve this. [2 marks]

(b) Suppose the data in Table 2 below shows the population of students in the Computer Engineering Department from 2004 to 2015.

(i) What excel expression will you put in cells D15 and D16 to compute the total *min* and *max* number of students? [2 marks]

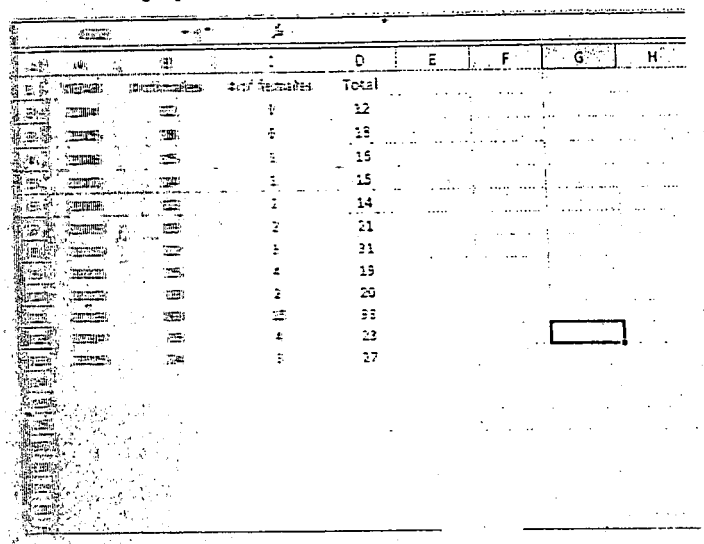
(ii) What excel functions will you put in cell D17 to compute the *average* number of students that entered the Department from 2004 to 2015? What is this value? [3 marks]

(iii) What expression will you put in D18 to *count* the number of years in which female students were admitted in the Department from 2004 to 2015? [2 marks]

(iv) What expression will you put in cell D19 to *count* the total number of students above 21? What is this value? [3 marks]

(v) What excel expression will you put in cell D20 to find the total number of students between 50 and 100 from 2004 to 2015? What is the value? [3 marks]

Table 2 – Student population from 2004 – 2015



			D	E	F	G	H
		and females	Total				
		7	12				
		6	18				
		1	15				
		1	15				
		2	14				
		2	21				
		3	31				
		4	19				
		2	20				
			33				
		4	23				
		3	27				

SECTION C – MATLAB (30 Marks)

Answer any (2) questions from this section

1. (a) Write a MATLAB script to convert user input temperature values measured in Fahrenheit (F) to degree Celsius (C) and also from degree Celsius (C) to Fahrenheit. Use C = (5/9)*[F-32]. [7 marks]

(b) Suppose you have savings account at the bank with interest that has accrued and can be modelled by the expression:

$$x(n) = x(n-1) + \frac{r}{12}x(n-1)$$

where $x(n)$ is the amount in the account at the end of the n-th month, $x(n)$ is the amount you deposited in the n-th month, and r is the annual interest rate. If the

bank interest rate r is 15%, write a Matlab function to compute y(n) for $n = 48$ when y(0) is 300, and $x(n)$ is 50 for $n \geq 1$. [8 marks]

2. (a) Suppose the voltage signal in the socket of your room is given by the function $y = Asin(2\pi ft + 40^0)$, where A and f are the amplitude and frequency, write a Matlab code to generate the signal y over the t = -10:0.01:10, for arbitrary user values of A and f. [5 marks]

(b) A ball is released from a height of 10m to the ground. The ball bounces to 80% of its height with each bounce. The bouncing process of the ball can be modeled as the geometric sum as defined below. Find the initial value and the ratio and write a Matlab code for a user to find how high a ball bounces on any bounce, example the 10^{th} bounce. [6 marks]

$$S_n = \sum_{k=0}^{n-1} ar^k = a\frac{(1-r^n)}{(1-r)}$$

(c) Suppose the function describing the motion of a space shuttle is given as:

$$3x^4 + 4x^3 - 2x = 300.$$

Find the roots of the function in Matlab. How will you evaluate the function at $x = 6$ at the Matlab command prompt. [4 marks]

3. (a) Suppose you opened an account at a bank with an initial sum y(0) of GHc250. Assume you plan to deposit monthly amount $x(n)$ of GHc50. If the bank annual interest rate (r) is 18%, write a short script in Matlab to compute how long in months (n) it will take you to save a sum of GHc1,000,000 in the account. Your script should allow users the flexibility to change the amounts and interest rates. Assume the savings at the end of the n-th is given by the expression: [8 mark]

$$y(n) = (1 + r/12)*y(n-1) + x(n)$$

(b) A system of linear equations $AX = B$ is defined as follows:

$$5x_1 + 2x_2 + 8x_3 = 46$$
$$4x_1 - x_2 = 12$$
$$6x_1 + 7x_2 + 4x_3 = 50$$

(i) Describe the steps you will follow working from the command prompt in Matlab to solve equation for the solution. [4 marks]

(ii) Write an expression in Matlab for the transpose of the matrix A and put the content of the transpose in D. Find the contents of $D(2,1)$, $D(2,3)$, and $D(2,1)*D(1,3)$. [3 marks]