UNIVERSITY OF GHANA, LEGON

BSC. ENGINEERING FIRST SEMESTER EXAMINATIONS: 2015/2016

DEPARTMENT OF COMPUTER ENGINEERING

CPEN 309: PROGRAMMING LANGUAGES FUNDAMENTALS (3 CREDITS)

INSTRUCTION: ***ANSWER ALL QUESTIONS.***

TIME ALLOWED: ***TWO AND A HALF (2½) HOURS***

SECTION A

Answer all Questions in Section A.

1.

a. Briefly describe a *programming language*. [4 marks]

b. Briefly explain four parts that constitute the layered structure of a *language*. [8 marks]

c. List six key "forces" that have contributed to the development of *programming languages*. [6 marks]

e. Briefly explain one *programming language* concept that has been developed from each of the following "special domains" : [6 marks]

- **i.** *Simulation.*
- **ii.** *Theorem-proving.*
- **iii.** *Windows and graphical user interface (GUI).*

2.

a. State, with a reason, one *programming language* that you would recommend to address each of the following needs of some institutions in Ghana: [12 marks]

- **i.** The development of a new operating system for the Institute of Applied Sciences of the College of Basic and Applied Sciences of the University of Ghana.
- **ii.** Artificial intelligence based surveillance systems for the Ghana Armed Forces.
- **iii.** Scientific or high performance computing platform for the Ghana Atomic Energy Commission.
- **iv.** Distributed systems to support the monitoring of mobile communications for the National Communications Authority.
- **v.** Systems programming framework (requiring low-level access to processor) for the Ghana Standards Board.
- **vi.** A Web based application to support online application of passport for the Passport Office.

b. Briefly describe the contribution of each of the following programming languages towards the evolution of *programming language paradigms*: [10 marks]

i. *C.*
ii. *C++.*
iii. *Java.*
iv. *Python.*
v. *Ruby.*

SECTION B

Answer all questions in Section B.

3.

a. Assume that ten years ago, the Volta River Authority (VRA) required a C programme to control the operation of its turbines. A module of this programme utilised a variant of Ackermann function defined as:

$$A(m,n) = \begin{cases} 2n & \text{if } m = 0 \\ 0 & \text{if } m \geq 1 \text{ and } n = 0 \\ 2 & \text{if } m \geq 1 \text{ and } n = 1 \\ A(m-1, A(m, n-1)) & \text{if } m \geq 1 \text{ and } n \geq 2 \end{cases}$$

Write a *C programme* to implement a recursive function *turbineAcker* to compute the values of the Ackermann function. [12 marks]

b. In the year 2016, VRA plans to replace the Ackermann function in 3.a. with a factorial function on a *Ruby* compatible programming environment. Create a recursive function and name it as *turbineFacto* in a Ruby programme. *turbineFacto* accepts as parameter a positive integer N and returns the factorial of the positive integer. [12 marks]

4. Transportation engineers coordinate bus traffic in major cities in Ghana. Consider ten different stops on one bus line (route). Assume that each stop has a name and an integer typed identification number. Write a programme in *Python* that implements a queue to simulate the identification number of the ten bus stops. [15 marks]

5. Products that have limited shelf life are put onto shelves in a supermarket in a manner similar to that of the stack data structure. New products arriving are simply put in front of older products. Customers remove the newer products until the older ones become exposed. Write a Java class that mimics this behaviour for five different products. [15 marks]