



**NATIONAL OPEN UNIVERSITY OF NIGERIA**  
**Plot 91, Cadastral Zone, Nnamdi Azikwe Expressway, Jabi, Abuja.**

**FACULTY OF SCIENCES**  
**DEPARTMENT OF MATHEMATICS**  
**October Examination 2019**

**Course Code: MTH 303**

**Course Title: Vectors and Tensors Analysis**

**Credit Unit: 3**

**Time Allowed: 3 Hours**

**Total: 70 Marks**

**Instruction: Answer Question Number One and Any Other Four Questions**

1. (a) When is the vector function  $A(u)$  said to be continuous at a point  $u_0$  ? **(2 marks)**  
(b) Define the following; (i) the derivative of the vector function  $A(u)$  **(3 marks)**  
(ii) The vector operator  $\nabla$  called "del" **(2 marks)**  
(iii) Grad  $\phi$ ; if  $\phi(x, y, z)$  has continuous first partial derivative in a particular region **(3 marks)**  
(c) Given a vector function  $\underline{A}(x, y, z)$ , define the following;  
(i) The divergence of a vector function  $\underline{A}$  **(3 marks)**  
(ii) The curl of a vector function  $\underline{A}$  **(3 marks)**  
(d) In Tensor form of gradient, if  $\phi$  is a scalar of invariant, define the following; (i) The gradient of  $\phi$  **(3 marks)**  
(ii) The Laplacian of  $\phi$  **(3 marks)**
2. (a) If  $\phi(x, y, z) = xyz^2$  find  $\nabla\phi$  **(4 marks)**  
(b) If  $\phi(x, y, z) = 3x^2y - y^3z^2$  find  $\nabla\phi$  **(4 marks)**  
(c) Obtain the divergence of the vector function  
 $\underline{A} = 2xzi + yzj - xy^2k$  at the point  $(1, -1, 1)$  **(4 marks)**
3. (a) If  $\phi = x^2yz$  is a scalar function and  $\underline{A} = 2xzi + yzj - xy^2k$   
Find  $\nabla \cdot (\phi A)$  at the point  $(1, -1, 1)$  **(5 marks)**  
(b) Find the curl of  $\underline{A}$  if  $\underline{A} = 3x^2yi + yz^2j - xzk$  **(4 marks)**

- (c) If  $\phi = x^2y^2$  and  $A = 2xzi + yzj - xy^2k$ . Obtain the value of  $\phi A$  **(3 marks)**
4. (a) State Green's Theorem **(3 marks)**
- (b) Verify the Green's Theorem in the plane for  $\oint_C (xy + y^2) dx + x^2 dy$  where  $C$  is a closed curve of the region bounded by  $y = x$  and  $y = x^2$  **(9 marks)**
5. (a) State Stoke's Theorem **(3 marks)**
- (b) Use Stoke's Theorem to determine  $\iint_S (\nabla \times A) \cdot \hat{n} ds$  where  $A = (y - z + 2)i + (yz + 4)j - xzk$ . And  $S$  is the surface of the closed cube  $x = 0, y = 0, z = 0, x = 2, y = 2, z = 2$  in the  $xy -$ plane **(9 marks)**
6. (a) State the Divergence Theorem **(3 marks)**
- (b) State the difference between a scalar quantity and a vector quantity **(2 marks)**
- (c) If  $A_r^{pq}$  and  $B_r^{pq}$  are tensors, Prove that their sum and difference are tensor **(7 marks)**