



JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY
SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES
UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION
SCIENCE WITH IT
2ND YEAR 1ST SEMESTER 2016/2017 ACADEMIC YEAR
MAIN CAMPUS

COURSE CODE: SPH 203

COURSE TITLE: MATHEMATICAL METHODS FOR PHYSICS 1

EXAM VENUE: LAB 1

STREAM: (BED Sc.)

DATE: 28/04/16

EXAM SESSION: 2.00 – 4.00PM

TIME: 2 HOURS

Instructions:

- 1. Answer question 1 (compulsory) and ANY other 2 questions.**
- 2. Candidates are advised not to write on the question paper.**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room.**

1.

(a) From the first principle of differentiation obtain the derivative of the function $f(x) = (4x^2 - 12x^2 + 6)$ (3 mks)

(b) Given $f(t) = at^2 + bt + c$ show that $f'(t) = 2at + b$ (4mks)

(c) Evaluate the following integrals

(i) $\int 2x\sqrt{1+x^2} dx$ (3mks)

(ii) $\int_{-1}^2 xe^{6x} dx$ (3 mks)

(d) Determine if the following sets of vectors are linearly independent

(i) $v_1 = \begin{pmatrix} 3 \\ 1 \end{pmatrix}$, $v_2 = \begin{pmatrix} 6 \\ 2 \end{pmatrix}$ (2 mks)

(ii) $v_1 = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$, $v_2 = \begin{pmatrix} 6 \\ 2 \end{pmatrix}$ (2 mks)

(e) A particle of mass 2 moves in a force field depending on time t given by

$$F = 24t^2\hat{i} + (36t - 16)\hat{j} - 12t\hat{k}$$

Assuming that at $t = 0$ the particle is located at $r_o = 3\hat{i} - \hat{j} + 4\hat{k}$ and has velocity $v_o = 6\hat{i} + 15\hat{j} - 8\hat{k}$, find

(i) The velocity (3 mks)

(ii) The position at any time t (3mks)

(f) Verify that the following equation is an identity

$$1 + \sec x \sin x \tan x = \sec^2 x \quad (4 \text{ mks})$$

(g) Find the angle between the vectors $A = \hat{i} + 2\hat{j} + 3\hat{k}$ and $B = 2\hat{i} + 3\hat{j} + 4\hat{k}$ (3mks)

QUESTION TWO

(a) (i) Find from the first principle the first derivative of $f(x) = (x+3)^2$ and compare your results with that obtained using chain rule (5 mks)

(ii) Given $f(t) = 2t^2 + 5t - 3 = s$

- (I) Find displacement from $t = 0$ to $t = 2s$ (2 mks)
- (II) Find the instantaneous velocity $v = \frac{ds}{dt} = f'(t)$ (3mks)
- (III) Find v for $t = 2s$ (2mks)
- (b) Evaluate the following integral $\int x\sqrt{x+1}dx$
- (i) Using integration by parts (3 mks)
- (ii) Using a standard calculus 1 substitution. Comment on the two answers obtained in (i) and (ii) (5 mks)

QUESTION THREE

- (a) (i) Find the volume V of the parallelepiped with sides $\vec{A} = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{B} = 4\hat{i} + 5\hat{j} + 6\hat{k}$ and $\vec{C} = 7\hat{i} + 8\hat{j} + 10\hat{k}$ (6 mks)
- (ii) Construct reciprocal vectors of $\vec{A} = 2\hat{i}$, $\vec{B} = \hat{j} + \hat{k}$, $\vec{C} = \hat{i} + \hat{k}$ (6 mks)
- (b) (i) Show that if $\vec{A} = \vec{B} + \lambda\vec{C}$, for some scalar λ , then $\vec{A} \times \vec{C} = \vec{B} \times \vec{C}$ (4 mks)
- (ii) Find the area A of the parallelogram with sides $\vec{A} = \hat{i} + 2\hat{j} + 3\hat{k}$ and $\vec{B} = 4\hat{i} + 5\hat{j} + 6\hat{k}$ (4 mks)

QUESTION FOUR

- (a) Initially a pendulum swings through an arc of 18 inches. On each successive swing the length of the arc is 0.98 of the previous length .
- (i) What is the length of arc after 10 swings ? (2 mks)
- (ii) On which swing is the length of arc first less than 12 inches ? (4 m)
- (iii) After 15 swings, what total length will the pendulum have swung ? (3 mks)
- (iv) When it will stop , what total length will the pendulum have swung ? (3 mks)
- (b) (i) Use L'Hopital's rule to evaluate

$$\lim_{x \rightarrow 0} \frac{\sin x}{2x} \quad (4 \text{ mks})$$

(ii) Find $\lim_{x \rightarrow \infty} \frac{x^5 + x^4 + x^3 + x^2 + x + 1}{2x^5 + x^4 + x^3 + x^2 + x + 1}$ (4 mks)

QUESTION FIVE

(a) Solve the hyperbolic equation

$$\cosh x - 5 \sinh x - 5 = 0 \quad (7 \text{ mks})$$

(b) (i) Verify the relation

$$\frac{d}{dx} \cosh x = \sinh x \quad (5 \text{ mks})$$

(ii) Evaluate $(d/dx) \sinh^{-1} x$ using the logarithmic form of the inverse (8 mks)

$$\lim_{x \rightarrow 0} \frac{\sin x}{2x}$$