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KIRIRI WOMENS' UNIVERSITY OF SCIENCE AND TECHNOLOGY
UNIVERSITY EXAMINATION, 2023/2024 ACADEMIC YEAR
FIRST YEAR, SECOND SEMESTER EXAMINATION
FOR THE DEGREE OF BACHELOR OF SCIENCE
(MATHEMATICS AND COMPUTER SCIENCE)

Date: 13th December, 2023
Time: 8.30am – 10.30am

KMA 201 - CALCULUS 1

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE (COMPULSORY) AND ANY OTHER TWO QUESTIONS

QUESTION ONE (30 MARKS)

a) Evaluate the following integrals;

i) $\int \frac{3x^2 + \cos x}{(x^3 + \sin x)^{10}} dx$ (3 marks)

ii) $\int x^3 \sqrt{x^4 - 1} dx$ (2 marks)

iii) $\int \sin^3 8x \cos 8x dx$ (2 marks)

iv) $\int x^2 \cos x dx$ (3 marks)

b) Find the curve whose slope at the point (x, y) is $2x + 1$ if the curve is required to pass through the point $(1, -1)$. (3 marks)

c) Define R as the region bounded above by the graph of $f(x) = 2x - x^2$ and below by the x -axis over the interval $[0, 2]$. Find the volume of the solid of revolution formed by revolving R around the y -axis. (4 marks)

d) Find the average value of $f(x) = 6 - 2x$ over the interval $[0, 3]$. (3 marks)

e) James and Kathy are racing on roller skates. They race along a long, straight track, and whoever has gone the farthest after 5 sec wins a prize. If James can skate at a velocity of $f(t) = 5 + 2t$ ft/sec and Kathy can skate at a velocity of $g(t) = 10 + \cos \frac{\pi}{2} t$ ft/sec, who is going to win the race? (4 Marks)

f) Evaluate the following definite integrals

i) $\int_0^1 x^2 (1 + 2x^3)^5 dx$ (3 marks)

ii) $\int_0^1 e^{4x^2+3} x dx$ (3 marks)

QUESTION TWO (20 MARKS)

a) Evaluate the following integrals:

i) $\int x \sqrt{2x-1} \, dx$ (4 marks)

ii) $\int \frac{1}{x(\ln x)^3} \, dx$ (3 marks)

iii) $\int x \cos x \, dx$ (4 marks)

iv) $\int e^x \cos x \, dx$ (3 marks)

v) $\int \cos^5 x \, dx$ (3 marks)

b) Suppose a population of fruit flies increases at a rate of $g(t) = 2e^{0.02t}$, in flies per day. If the initial population of fruit flies is 100 flies, how many flies are in the population after 10 days? (3 marks)

QUESTION THREE (20 MARKS)

a) Express the following functions in the form $P(x) + \frac{Q(x)}{R(x)}$

i) $f(x) = \frac{x^4+x}{x^2-3x+2}$ (3 Marks)

ii) $f(x) = \frac{3x^2-2x-7}{x^2-x-2}$ (3 marks)

b) Find the integral of $\int \frac{1}{x^3-2x^2+x} \, dx$ using the method of partial fractions.

(6 marks)

c) If the motor on a motorboat is started at $t = 0$ and the boat consumes gasoline at the rate of $5 - t^3$ gal/hr, how much gasoline is used in the first 2 hours? (4 marks)

d) The parabola $y = x^2$ and the line $y = 3x + 4$ enclose an area. Use integration methods to find the size of the area enclosed. (6 marks)

QUESTION FOUR (20 MARKS)

a) Evaluate the following integrals:

i) $\int \frac{\sin t}{\cos^3 t} \, dt$ (3 marks)

ii) $\int \frac{x \, dx}{\sqrt{x-1}}$ (3 marks)

b) Evaluate the following definite integrals:

i) $\int_0^{\frac{\pi}{4}} \tan x \sec^2 x \, dx$ (4 marks)

ii) $\int_0^{\frac{\pi}{2}} (x+1) \sin x \, dx$ (3 marks)

iii) $\int_0^1 x e^{-x} \, dx$ (3 marks)

- c) Find $\int_0^6 y dx$ using Simpsons Rule given the following data

x	0	1	2	3	4	5	6
y	8	12	14	11	9	3	1

(4 marks)

QUESTION FIVE (20 MARKS)

- a) Find the integral of the following using trigonometric substitution

i) $\int \frac{dx}{x^2\sqrt{16-x^2}}$ (7 marks)

ii) $\int \frac{1}{x^2\sqrt{x^2+1}} dx$ (7 marks)

- b) Use the slicing method to find the volume of the solid of revolution bounded by the graphs of $f(x) = x^2 - 4x + 5$, $x = 1$, and $x = 4$, and rotated about the x -axis.

(6 marks)