Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	MATHEMATICS FOR ENGINEERING TECHNOLOGY I
COURSE CODE	:	BNJ12203 / BNP12203 / BNR17803 / BNT12203
PROGRAMME CODE	:	BNA / BNB / BNC / BND / BNE / BNF / BNG / BNL / BNM / BNN / BNT
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**.
		3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 Evaluate the following limits

$$\lim_{x\to 2}\frac{x^3-8}{x^2-4}.$$

(5 marks)

Q2 Use L'Hopital's rule to find the limits of

$$\lim_{x\to\pi}\frac{\ln(\cos 2x)}{(\pi-x)^2}$$

(6 marks)

Q3 Determine the value of c such that

$$f(x)=\begin{cases} cx+1 & x\le 3, \\ cx^2-1 & x>3 \end{cases}$$

is continuous for any value of x

(6 marks)

Q4 If $y=\sin\left(e^x-1\right)$, show that

$$\frac{d^2y}{dx^2}-\frac{dy}{dx}+ye^{2x}=0$$

(6 marks)

Q5 Find $\frac{dy}{dx}$ where x and y are related by the following equation

$$(x+y)^2=ax^2+by^2$$

(5 marks)

Q6 A curve is given by a parametric equations

$$x=t-\frac{1}{t},\ y=t+\frac{1}{t} \text{ with } t\neq 0$$

Find $\frac{dy}{dx}$ by using parametric differentiation

(4 marks)

Q7 Evaluate the following integral

$$\int_0^{\frac{\pi}{2}} \sin^2\theta\left(\cos^3\theta - 1\right)d\theta$$

(11 marks)

Q8 By using the substitution $t = \tan\frac{1}{2}x$, evaluate the following integral

$$\int \frac{5}{4\cos x + 3\sin x}dx$$

(11 marks)

Q9 Evaluate the integration of irrational function

$$\int \frac{dx}{x^2\sqrt{4-x^2}}$$

(8 marks)

Q10 Using the Maclaurin series for the function e^x, write down the first four terms of the Maclaurin series for $e^{-\frac{x^2}{2}}$

(11 marks)

Q11 Determine the interval and radius of convergence for following power series

$$\sum_{n=1}^{\infty} \frac{6^n}{n}(4x-1)^{n-1}$$

(15 marks)

Q12 The length of a rectangle is five times its width. The width increases at rate of $2cms^{-1}$. When the width is 5cm, what is the rate of increase of the rectangle area?

(6 marks)

Q13 Sitting beside a lake, you see perturbed wave form which is circle. If the radius of the circle increases at a rate of 15cm per second, calculate the rate increase of the area of perturbation when radius is 5cm

(6 marks)

- END OF QUESTIONS –

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Formulae

Indefinite Integrals

$$\int x^n dx = \frac{x^{n+1}}{n+1} + C, \quad n \neq -1$$

$$\int \frac{1}{x} dx = \ln|x| + C$$

$$\int \cos x \, dx = \sin x + C$$

$$\int \sin x \, dx = -\cos x + C$$

$$\int \sec^2 x \, dx = \tan x + C$$

$$\int \csc^2 x \, dx = -\cot x + C$$

$$\int \sec x \tan x \, dx = \sec x + C$$

$$\int \csc x \cot x \, dx = -\csc x + C$$

$$\int e^x dx = e^x + C$$

$$\int \cosh x \, dx = \sinh x + C$$

$$\int \sinh x \, dx = \cosh x + C$$

$$\int \operatorname{sech}^2 x \, dx = \tanh x + C$$

$$\int \operatorname{csch}^2 x \, dx = -\coth x + C$$

$$\int \operatorname{sech} x \tanh x \, dx = -\operatorname{sech} x + C$$

$$\int \operatorname{csch} x \coth x \, dx = -\operatorname{csch} x + C$$

Integration of Inverse Functions

$$\int \frac{1}{\sqrt{1-x^2}} dx = \sin^{-1} x + C, \ |x| < 1$$

$$\int \frac{-1}{\sqrt{1-x^2}} dx = \cos^{-1} x + C, \ |x| < 1$$

$$\int \frac{1}{1+x^2} dx = \tan^{-1} x + C$$

$$\int \frac{-1}{1+x^2} dx = \cot^{-1} x + C$$

$$\int \frac{1}{|x|\sqrt{x^2-1}} dx = \sec^{-1} x + C, \ |x| > 1$$

$$\int \frac{-1}{|x|\sqrt{x^2-1}} dx = \csc^{-1} x + C, \ |x| > 1$$

$$\int \frac{1}{\sqrt{x^2+1}} dx = \sinh^{-1} x + C$$

$$\int \frac{1}{\sqrt{x^2-1}} dx = \cosh^{-1} x + C, \ |x| > 1$$

$$\int \frac{-1}{|x|\sqrt{1-x^2}} dx = \operatorname{sech}^{-1} |x| + C, \ 0 < x < 1$$

$$\int \frac{-1}{|x|\sqrt{1+x^2}} dx = \operatorname{csch}^{-1} |x| + C, \ x \neq 0$$

$$\int \frac{1}{1-x^2} dx = \begin{cases} \tanh^{-1} x + C, & |x| < 1 \\ \coth^{-1} x + C, & |x| > 1 \end{cases}$$

TAYLOR AND MACLAURIN SERIES

$$f(x) = f(a) + f'(a)(x-a) + \frac{f''(a)}{2!}(x-a)^2 + \frac{f'''(a)}{3!}(x-a)^3 + \cdots$$

$$f(x) = f(0) + f'(0)x + \frac{f''(0)}{2!}x^2 + \frac{f'''(0)}{3!}x^3 + \cdots$$

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TRIGONOMETRIC SUBSTITUTION

Expression	*Trigonometry*	*Hyperbolic*
$\sqrt{x^2+k^2}$	$x = k\tan\theta$	$x = k\sinh\theta$
$\sqrt{x^2-k^2}$	$x = k\sec\theta$	$x = k\cosh\theta$
$\sqrt{k^2-x^2}$	$x = k\sin\theta$	$x = k\tanh\theta$

TRIGONOMETRIC SUBSTITUTION

$t = \tan\frac{1}{2}x$		$t = \tan x$	
$\sin x = \frac{2t}{1+t^2}$	$\cos x = \frac{1-t^2}{1+t^2}$	$\sin 2x = \frac{2t}{1+t^2}$	$\cos 2x = \frac{1-t^2}{1+t^2}$
$\tan x = \frac{2t}{1-t^2}$	$dx = \frac{2dt}{1+t^2}$	$\tan 2x = \frac{2t}{1-t^2}$	$dx = \frac{dt}{1+t^2}$

IDENTITIES OF TRIGONOMETRY AND HYPERBOLIC

Trigonometric Functions	*Hyperbolic Functions*
$\cos^2 x + \sin^2 x = 1$	$\sinh x = \frac{e^x - e^{-x}}{2}$
$\sin 2x = 2\sin x\cos x$	$\cosh x = \frac{e^x + e^{-x}}{2}$
$\cos 2x = \cos^2 x - \sin^2 x$	$\cosh^2 x - \sinh^2 x = 1$
$= 2\cos^2 x - 1$	$\sinh 2x = 2\sinh x\cosh x$
$= 1 - 2\sin^2 x$	$\cosh 2x = \cosh^2 x + \sinh^2 x$
$1 + \tan^2 x = \sec^2 x$	$= 2\cosh^2 x - 1$
$1 + \cot^2 x = \csc^2 x$	$= 1 + 2\sinh^2 x$
$\tan 2x = \frac{2\tan x}{1-\tan^2 x}$	$1 - \tanh^2 x = \operatorname{sech}^2 x$
$\tan(x \pm y) = \frac{\tan x \pm \tan y}{1 \mp \tan x\tan y}$	$\coth^2 x - 1 = \operatorname{csch}^2 x$
$\sin(x \pm y) = \sin x\cos y \pm \sin y\cos x$	$\tanh 2x = \frac{2\tanh x}{1+\tanh^2 x}$
$\cos(x \pm y) = \cos x\cos y \mp \sin x\sin y$	$\tanh(x \pm y) = \frac{\tanh x \pm \tanh y}{1 \pm \tanh x\tanh y}$
$2\sin ax\cos bx = \sin(a+b)x + \sin(a-b)x$	$\cosh(x \pm y) = \cosh x\cosh y \pm \sinh x\sinh y$
$2\sin ax\sin bx = \cos(a-b)x - \cos(a+b)x$	