Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(TAKE HOME)
SEMESTER II
SESSION 2019/2020

COURSE NAME	:	ENGINEERING MATHEMATICS I
COURSE CODE	:	BEE 11303
PROGRAMME CODE	:	BEJ / BEV
EXAMINATION DATE	:	JULY 2020
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS **OPEN BOOK EXAMINATION**

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

Q1 (a) If $f'(x)=\frac{a}{3}\sin 4x+\frac{b}{8}\cos 2x$ and $f'(0)=\frac{1}{6}$, $f(0)=5$ and $f(\frac{\pi}{4})=3$, find a, b, integration constant C and $f(x)$.

(7 marks)

(b) Use tabular method to evaluate $\int x^2\left(\frac{1}{2}\cos 5x\right)dx$.

(3 marks)

(c) Based on your understanding on power of sines and cosines, show that $\frac{1}{2}(\sec x\tan x+\ln|\tan x+\sec x|)$ is the solution for $\int \sec^3 x\,dx$ by applying integration by parts. Use $\int \sec x\,dx=\ln|\sec x+\tan x|+C$ whenever applies.

(4 marks)

(d) If $I=\int x^2 e^{x^3}\cos x^3\,dx$, apply combination techniques of substitution and by parts to obtain $2I=\frac{1}{3}e^{x^3}(\sin x^3+\cos x^3)+C$.

(6 marks)

Q2 (a) Calculate $\int \frac{\sin^3 x}{\sqrt{\cos x}}dx$.

(3 marks)

(b) Evaluate $\int 16\cos^2 x\sin^4 x\,dx$

You are required to use the following trigonometry formula and identities to solve the problem:

Trigonometry Formulas & Identities
$\cos 2x=2\cos^2 x-1$
$\cos 2x=1-2\sin^2 x$
$\cos^2 x+\sin^2 x=1$

(8 marks)

(c) Evaluate $\int \frac{\text{sech}^2 x}{2\tanh x+\tanh^3 x}dx$ by using the combination of substitution and partial fraction techniques.

(6 marks)

(d) The summing integrator circuit is shown in **Figure Q2 (d)**. If $v_1 = 10\cos 2t$ mV and $v_2 = 0.5t$ mV, find v_0. Assume that the voltage across the capacitor is initially zero.

Given $v_0 = -\frac{1}{R_1 C}\int v_1\, dt - \frac{1}{R_2 C}\int v_2\, dt$, $R_1 = 3\ \text{M}\Omega$, $R_2 = 100\ \text{k}\Omega$, $C = 2\ \mu\text{F}$

(3 marks)

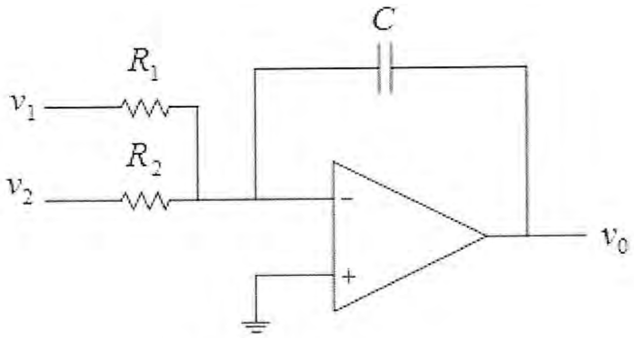

Figure Q2 (d)

– END OF QUESTIONS –

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Formulae

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

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

IDENTITIES OF TRIGONOMETRY AND HYPERBOLIC

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

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Formulae

Indefinite Integrals	Integration of Inverse Functions
$\int x^n dx = \frac{x^{n+1}}{n+1} + C, \quad n \neq -1$	$\int \frac{1}{\sqrt{a^2 - x^2}} dx = \sin^{-1}\left(\frac{x}{a}\right) + C$
$\int \frac{1}{x} dx = \ln\lvert x\rvert + C$	$\int \frac{-1}{\sqrt{a^2 - x^2}} dx = \cos^{-1}\left(\frac{x}{a}\right) + C$
$\int \cos x \, dx = \sin x + C$	$\int \frac{1}{a^2 + x^2} dx = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right) + C$
$\int \sin x \, dx = -\cos x + C$	$\int \frac{1}{a^2 + x^2} dx = \frac{1}{a}\cot^{-1}\left(\frac{x}{a}\right) + C$
$\int \sec^2 x \, dx = \tan x + C$	$\int \frac{1}{\lvert x\rvert\sqrt{x^2 - a^2}} dx = \frac{1}{a}\sec^{-1}\left(\frac{x}{a}\right) + C$
$\int \csc^2 x \, dx = -\cot x + C$	$\int \frac{-1}{\lvert x\rvert\sqrt{x^2 - a^2}} dx = \frac{1}{a}\csc^{-1}\left(\frac{x}{a}\right) + C$
$\int \sec x \tan x \, dx = \sec x + C$	$\int \frac{1}{\sqrt{x^2 + a^2}} dx = \sinh^{-1}\left(\frac{x}{a}\right) + C$
$\int \csc x \cot x \, dx = -\csc x + C$	$\int \frac{1}{\sqrt{x^2 - a^2}} dx = \cosh^{-1}\left(\frac{x}{a}\right) + C$
$\int e^x dx = e^x + C$	$\int \frac{-1}{\lvert x\rvert\sqrt{a^2 - x^2}} dx = \frac{1}{a}\text{sech}^{-1}\left\lvert\frac{x}{a}\right\rvert + C$
$\int \cosh x \, dx = \sinh x + C$	$\int \frac{-1}{\lvert x\rvert\sqrt{a^2 + x^2}} dx = \frac{1}{a}\text{csch}^{-1}\left\lvert\frac{x}{a}\right\rvert + C$
$\int \sinh x \, dx = \cosh x + C$	$\int \frac{1}{a^2 - x^2} dx = \begin{cases} \frac{1}{a}\tanh^{-1}\left(\frac{x}{a}\right) + C, & \lvert x\rvert < a \\ \frac{1}{a}\coth^{-1}\left(\frac{x}{a}\right) + C, & \lvert x\rvert > a \end{cases}$
$\int \text{sech}^2 x \, dx = \tanh x + C$	
$\int \text{csch}^2 x \, dx = -\coth x + C$	
$\int \text{sech}\, x \tanh x \, dx = -\text{sech}\, x + C$	
$\int \text{csch}\, x \coth x \, dx = -\text{csch}\, x + C$	