UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	ENGINEERING MATHEMATICS I
COURSE CODE	:	BEE 11303
PROGRAMME CODE	:	BEJ/BEV
EXAMINATION DATE	:	DECEMBER 2019/JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Find the following integrals.

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

(4 marks)

(ii) $\int x^2 e^x dx$

(4 marks)

(b) Solve the integral $\int e^{\sqrt{x}} dx$ by making a u-substitution and then integrating by parts.

(8 marks)

(c) Evaluate the integral $\int_0^{\pi/8} \sin^5(2x) \cdot \cos(2x) dx$.

(9 marks)

Q2 (a) Solve the integration of the following functions.

(i) $\int 3x^2 \sqrt{x-1}\, dx$ by using tabular method.

(5 marks)

(ii) $\int \sin(3x) \cdot \sin(x) dx$ by using tabular method.

(5 marks)

(b) Solve the integration of $\int \frac{dt}{t^3 - 2t}$ using partial fraction method.

(6 marks)

(c) Evaluate $\int \sin^5(x) \cdot \cos^8(x) dx$.

(6 marks)

(d) An electronic integration circuit performs the mathematical operation of integration with respect to time. The output voltage is defined as $V_{OUT}(t) = -\frac{1}{RC}\int V_{IN}(t)\, dt$ with the initial output voltage, $V_{OUT}(0)$ of zero. The input voltage, $V_{IN}(t) = \sin(2\pi \cdot 5000t)$ is applied to the op-amp integrator. The circuit parameters of amplifier are R=1 kΩ and C=10 nF. Calculate the output voltage, $V_{OUT}(t)$.

(3 marks)

Q3 (a) Find the inverse of the following functions and then differentiate the functions.

(i) $f(x)=\dfrac{1}{2x-4}$

(4 marks)

(ii) $f(x)=(3x-5)^3$

(4 marks)

(b) Find the derivative of the following functions.

(i) $y=\ln|x|\cdot\tan^{-1}(x)$

(3 marks)

(ii) $y=\sin^{-1}\left(\dfrac{\cos x}{1+\sin x}\right)$

(5 marks)

(iii) $y=\text{sech}^{-1}\left(\sqrt{1-x}\right)$

(4 marks)

(iv) $y=\dfrac{x^2}{\sinh^{-1}(2x)}$

(5 marks)

Q4 (a) Evaluate the following integrals which may result in inverse trigonometric function or inverse hyperbolic function.

(i) $\displaystyle\int\frac{1}{\sqrt{6-e^{-2x}}}\,dx$

(3 marks)

(ii) $\displaystyle\int\frac{x-4}{\sqrt{9-16x^2}}\,dx$

(4 marks)

(b) Calculate $\displaystyle\int\frac{\sqrt{x^2+3}}{x^2}\,dx$ by using hyperbolic substitution.

(6 marks)

(c) Find the following integrals by using trigonometric substitution.

(i) $\int \frac{1}{\sqrt{(x^2+5)^3}}\,dx$

(5 marks)

(ii) $\int \sqrt{2x-x^2}\,dx$

(7 marks)

– END OF QUESTIONS–

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FORMULAE

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

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Formulae

TRIGONOMETRIC/ HYPERBOLIC SUBSTITUTION

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

WEIERSTRASS SUBSTITUTION

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

IDENTITIES OF TRIGONOMETRY AND HYPERBOLIC

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