UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	ENGINEERING MATHEMATICS I
COURSE CODE	:	BEE 11303
PROGRAMME CODE	:	BEJ / BEV
EXAMINATION DATE	:	DECEMBER 2018 / JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) Evaluate the integration of the following functions:

~~(i) Using substitution method, find~~ $\cancel{\int (5x^4 - 1)e^{(x^5 - x)}dx}$

(2 marks)

~~(ii) Using tabular method, find~~ $\cancel{\int x^3 e^{2x} dx}$

(7 marks)

~~(iii) Find~~ $\cancel{\int x^3 \cos(x^2)dx}$ ~~by combination of substitution and integral by parts~~ methods.

(7 marks)

(b) Solve $\int \frac{x^4 + x^2 - 1}{x^3 + x} dx$ using a combination of long division and partial fraction.

(9 marks)

Q2 (a) Evaluate each of the following integrals.

~~(i)~~ $\cancel{\int (\sin x)^{\frac{1}{2}} \cos^3 x dx}$

(6 marks)

~~(ii)~~ $\cancel{\int \sin^3 x \cos^2 x dx}$

(6 marks)

~~(b) Using tabular method, calculate integration of function~~ $\cancel{\int e^{4x} \sinh 2x dx}$

(7 marks)

(c) A current of $5te^{3t}$ ampere flows through a 0.1 F capacitor. Determine the voltage $v(t)$ across the capacitor after 0.5 seconds given initial charged is –3 V.

(Hint: The voltage across the capacitor is given by $v(t_2) - v(t_1) = \frac{1}{C}\int_{t_1}^{t_2} i(t)dt$

(6 marks)

Q3 (a) For each function $f(x)$ below, find $(f^{-1})'(x)$

(i) $f(x)=\dfrac{3x}{1-3x}$

(4 marks)

(ii) $f(x)=(3x+4)^2$

(3 marks)

(b) Find the derivative of the following functions.

(i) $y=\cosh^{-1}(e^{2x})$

(5 marks)

(ii) $y=\dfrac{1+\sin^{-1}x}{2-3\sin^{-1}x}$

(6 marks)

(iii) $y=\ln(x^2+4)-\dfrac{1}{2}\tan^{-1}\left(\dfrac{x}{2}\right)$

(7 marks)

Q4 (a) Evaluate the following integrals by using inverse trigonometric function or inverse hyperbolic function.

(i) $\displaystyle\int\frac{3}{45+5x^2}dx$

(4 marks)

(ii) $\displaystyle\int\frac{2}{x^2+8x+17}dx$

(6 marks)

(iii) $\displaystyle\int\frac{\cos x}{\sqrt{1+\sin^2 x}}dx$

(5 marks)

(b) Calculate $\int \frac{dx}{\left(4+x^2\right)^{\frac{3}{2}}}$ by using trigonometric substitution.

(10 marks)

– 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

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

IDENTITIES OF TRIGONOMETRY AND HYPERBOLIC

Trigonometric Functions

$$\cos^2 x+\sin^2 x=1$$
$$\sin 2x=2\sin x\cos x$$
$$\cos 2x=\cos^2 x-\sin^2 x$$
$$=2\cos^2 x-1$$
$$=1-2\sin^2 x$$
$$1+\tan^2 x=\sec^2 x$$
$$1+\cot^2 x=\csc^2 x$$
$$\tan 2x=\frac{2\tan x}{1-\tan^2 x}$$
$$\tan(x\pm y)=\frac{\tan x\pm\tan y}{1\mp\tan x\tan y}$$
$$\sin(x\pm y)=\sin x\cos y\pm\sin y\cos x$$
$$\cos(x\pm y)=\cos x\cos y\mp\sin x\sin y$$
$$2\sin ax\cos bx=\sin(a+b)x+\sin(a-b)x$$
$$2\sin ax\sin bx=\cos(a-b)x-\cos(a+b)x$$
$$2\cos ax\cos bx=\cos(a-b)x+\cos(a+b)x$$

Hyperbolic Functions

$$\sinh x=\frac{e^x-e^{-x}}{2}$$
$$\cosh x=\frac{e^x+e^{-x}}{2}$$
$$\cosh^2 x-\sinh^2 x=1$$
$$\sinh 2x=2\sinh x\cosh x$$
$$\cosh 2x=\cosh^2 x+\sinh^2 x$$
$$=2\cosh^2 x-1$$
$$=1+2\sinh^2 x$$
$$1-\tanh^2 x=\operatorname{sech}^2 x$$
$$\coth^2 x-1=\operatorname{csch}^2 x$$
$$\tanh 2x=\frac{2\tanh x}{1+\tanh^2 x}$$
$$\tanh(x\pm y)=\frac{\tanh x\pm\tanh y}{1\pm\tanh x\tanh y}$$
$$\sinh(x\pm y)=\sinh x\cosh y\pm\sinh y\cosh x$$
$$\cosh(x\pm y)=\cosh x\cosh y\pm\sinh x\sinh y$$

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Formulae

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