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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	ENGINEERING MATHEMATICS I
COURSE CODE	:	BEE11303 / BWM10103
PROGRAMME	:	BEJ / BEV
EXAMINATION DATE	:	JUNE/JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

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Q1 (a) Evaluate each of the following functions using:

(i) Substitution method

$$\int x(x^2-3)^4\,dx$$

(4 marks)

(ii) Tabular method

$$\int e^{ax}\sin bx\,dx$$

(5 marks)

(iii) Integral by part

$$\int e^{x}\cos 2x\,dx$$

(8 marks)

(iv) Partial fraction

$$\int \frac{x^3+4x^2}{x^2+4x+3}\,dx$$

(6 marks)

Q2 (a) Solve each of the following integrals.

(i) $\int \frac{\sin^3\theta}{\cos^2\theta}\,d\theta$

(6 marks)

(ii) $\int \cosh^2 x\,dx$

(5 marks)

(b) Evaluate $\int \frac{\cos x}{\sin^3 x+\sin x}\,dx$ by combination of substitution and partial fraction methods.

(10 marks)

(c) RC integrator circuit is a series connected RC network that produces an output signal which corresponds to the mathematical process of integration as shown in **Figure Q2 (c)**.The output voltage, V_{OUT} of the RC integrator circuit is $V_{OUT}=\frac{1}{RC}\int_0^t V_{IN}(t)\,dt$.

Given the values of $R=1\ k\Omega$, $C=10\ \mu F$ and $V_{IN}=12V$. Assume that capacitor is initially charged to 3V. Calculate the voltage across the capacitor after 30ms.

(6 marks)

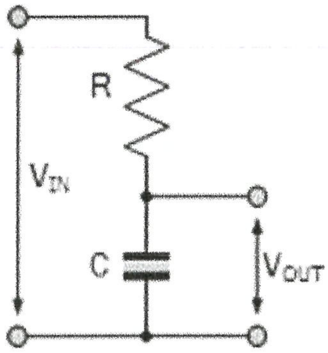

Figure Q2 (c)

Q3 (a) Determine $f^{-1}(x)$ and $(f^{-1})'(x)$ of the following functions.

(i) $f(x)=x^7-5$

(4 marks)

(ii) $f(x)=\dfrac{3x-4}{x+1}$

(4 marks)

(b) Find the derivative of the following functions.

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

(5 marks)

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

(6 marks)

(iii) $\cosh^{-1}x+x\tan^{-1}y=e^y$

(6 marks)

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

(i) $\int \frac{1}{\sqrt{1-49x^2}}\,dx$

(4 marks)

(ii) $\int \frac{x^2}{2+x^6}\,dx$

(4 marks)

(iii) $\int \frac{1}{\sqrt{9x^2-16}}\,dx$

(4 marks)

(b) Calculate $\int \frac{1}{\sqrt{x^2-16}}\,dx$ by using trigonometric substitution.

(7 marks)

(c) Calculate $\int \frac{1}{\sqrt{x^2+8x+5}}\,dx$ by using hyperbolic substitution.

(6 marks)

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Formulae

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

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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

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

IDENTITIES OF TRIGONOMETRY AND HYPERBOLIC

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