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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	ENGINEERING MATHEMATICS II
COURSE CODE	:	DAC 20103
PROGRAMME CODE	:	DAA
EXAMINATION DATE	:	JANUARY/ FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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THIS QUESTION PAPER CONSISTS OF **SEVEN** (7) PAGES

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Q1 (a) Find the general solution of the first order differential equation $\left(y^2+2y-3\right)dx=\left(2y+2\right)\left(x-5\right)dy$.

(5 marks)

(b) Find the solution of the homogeneous equation $\frac{dy}{dx}=\frac{4xy}{4x^2-6y^2}$ by substituting $y=vx$ and $\frac{dy}{dx}=v+x\frac{dv}{dx}$.

(7 marks)

(c) Solve the first order linear differential equation $x\frac{dy}{dx}=y+x^2\cos 2x$, given that $y(\pi)=1$.

(8 marks)

Q2 (a) A wet towel from a clothesline to dry loses moisture through evaporation at a rate proportional to its moisture content. If after 1 hour the towel has lost 20% of its original moisture content, find the time needed to lost 70% of the moisture.

(9 marks)

(b) Police arrive at the scene of a murder at 11 am. They immediately record the temperature of the deceased, which is 90 °F, and thoroughly inspect the area. By the time they finish the inspection, it is 1.30 am. The temperature of the deceased was recorded for the second time, which has dropped to 85 °F, and sent to the morgue. The temperature at the crime scene has remained steady at 82 °F. When was the person murdered? Assume that the temperature of the deceased at the time of death was 98.6 °F.

(11 marks)

Q3 (a) Solve the second order homogeneous differential equation of $12y''-36y'+24y=0$ with initial conditions $y(0)=-12$ and $y'(0)=-36$.

(6 marks)

(b) Using the method of variation of parameters, find the general solution of $y''+2y'+y=e^{-x}\ln x$.

(14 marks)

Q4 (a) Find the Laplace transform for $f(t) = e^{-3t} \sinh 5t - t\cos 3t$.

(7 marks)

(b) Find the inverse Laplace for the following equations:

(i) $F(s) = \dfrac{6}{5s^4} + \dfrac{3s-1}{s^2-16}$.

(4 marks)

(ii) $F(s) = \dfrac{3}{s^2+25} - \dfrac{4}{s+4}$.

(3 marks)

(iii) $F(s) = \dfrac{s+5}{s^2+8s+65}$.

(6 marks)

Q5 Solve the following initial value problems by using Laplace transform.

(a) $2y' + 3y = e^{4t}$; $y(0) = 5$.

(10 marks)

(b) $y'' - 3y' + 2y = 0$; $y = 6$ and $y' = -1$ when $t = 0$.

(10 marks)

-END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2020/2021 PROGRAMME CODE: DAA
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Formulae

Table 1: Laplace and Inverse Laplace Transforms

$L\{f(t)\}=\int_0^\infty f(t)e^{-st}dt=F(s)$	
$f(t)$	$F(s)$
k	$\frac{k}{s}$
$t^n, n=1,2,\ldots$	$\frac{n!}{s^{n+1}}$
e^{at}	$\frac{1}{s-a}$
$\sin at$	$\frac{a}{s^2+a^2}$
$\cos at$	$\frac{s}{s^2+a^2}$
$\sinh at$	$\frac{a}{s^2-a^2}$
$\cosh at$	$\frac{s}{s^2-a^2}$
First Shift Theorem	
$e^{at}f(t)$	$F(s-a)$
Multiply with t^n	
$t^n f(t), n=1,2,\ldots$	$(-1)^n \frac{d^nF(s)}{ds^n}$
Convolution Property:	
If $F(s)=G(s)H(s)$, then $L^{-1}G(s)=g(t)$ and $L^{-1}H(s)=h(t)$. $f(t)=L^{-1}F(s)=L^{-1}\left[G(s)H(s)\right]=\int_0^t g(\tau)h(t-\tau)d\tau$ or $\int_0^t h(\tau)g(t-\tau)d\tau$	
Initial Value Problem	
$L\{y(t)\}=Y(s)$	
$L\{y'(t)\}=sY(s)-y(0)$	
$L\{y''(t)\}=s^2Y(s)-sy(0)-y'(0)$	

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2020/2021 PROGRAMME CODE: DAA
COURSE NAME : ENGINEERING MATHEMATICS II COURSE CODE : DAC 20103

Table 2: Differentiation

$\frac{d}{dx}[c]=0$	$\frac{d}{dx}[\sin u]=\cos u\left(\frac{du}{dx}\right)$
$\frac{d}{dx}\left[x^n\right]=nx^{n-1}$	$\frac{d}{dx}[\cos u]=-\sin u\left(\frac{du}{dx}\right)$
$\frac{d}{dx}[cu]=c\frac{du}{dx}$	$\frac{d}{dx}[\ln\lvert u\rvert]=\frac{1}{u}\left(\frac{du}{dx}\right)$
$\frac{d}{dx}[u\pm v]=\frac{du}{dx}\pm\frac{dv}{dx}$	$\frac{d}{dx}\left[e^u\right]=e^u\left(\frac{du}{dx}\right)$
$\frac{d}{dx}[uv]=u\frac{dv}{dx}+v\frac{du}{dx}$	$\frac{d}{dx}\left[a^u\right]=a^u\ln a\left(\frac{du}{dx}\right)$
$\frac{d}{dx}\left[\frac{u}{v}\right]=\frac{v\frac{du}{dx}-u\frac{dv}{dx}}{v^2}$	$\frac{d}{dx}[\tan u]=\sec^2 u\left(\frac{du}{dx}\right)$
$\frac{d}{dx}[\log_a u]=\frac{1}{u}\log_b e\left(\frac{du}{dx}\right)$	$\frac{d}{dx}[\sec u]=\sec u\tan u\left(\frac{du}{dx}\right)$

Table 3: Integration

$\int x^n dx=\frac{x^{n+1}}{n+1}+C$	$\int\cos ax\,dx=\frac{1}{a}\sin ax+C$
$\int\frac{1}{x}dx=\ln\lvert x\rvert+C$	$\int\tan ax\,dx=\frac{1}{a}\ln\lvert\sec ax\rvert+C$
$\int\frac{1}{a+bx}dx=\frac{1}{b}\ln\lvert a+bx\rvert+C$	$\int u\,dv\,dx=uv-\int v\,du$
$\int\sin ax\,dx=-\frac{1}{a}\cos ax+C$	$\int e^{ax}dx=\frac{1}{a}e^{ax}+C$

FINAL EXAMINATION

SEMESTER / SESSION	: SEM I / 2020/2021	PROGRAMME CODE: DAA	
COURSE NAME	: ENGINEERING MATHEMATICS II	COURSE CODE	: DAC 20103

Table 4: Characteristic Equation and General Solution

Homogeneous Differential Equation: $ay'' + by' + cy = 0$ Characteristics Equation: $am^2 + bm + c = 0$ $m = \dfrac{-b + \sqrt{b^2 - 4ac}}{2a}$		
Case	Roots of Characteristics Equation	General Solution
1	Real and Distinct: $m_1 \neq m_2$	$y_h(x) = Ae^{m_1 x} + Be^{m_2 x}$
2	Real and Equal: $m_1 = m_2 = m$	$y_h(x) = (A + Bx)e^{mx}$
3	Complex Roots: $m = \alpha \pm i\beta$	$y_h(x) = e^{\alpha x}(A\cos\beta x + B\sin\beta x)$

Table 5: Variation of Parameters Method

Homogeneous solution, $y_h(x) = Ay_1 + By_2$
Wronskian function, $W = \begin{vmatrix} y_1 & y_2 \\ y_1' & y_2' \end{vmatrix} = y_1 y_2' - y_2 y_1'$
$u_1 = -\int \dfrac{y_2 f(x)}{aW} dx + A$ $u_2 = \int \dfrac{y_1 f(x)}{aW} dx + B$
General solution, $y(x) = u_1 y_1 + u_2 y_2$

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FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2020/2021 PROGRAMME CODE: DAA
COURSE NAME : ENGINEERING MATHEMATICS II COURSE CODE : DAC 20103

Table 6: Trigonometry Identities

$\sin^2 t + \cos^2 t = 1$
$\sin^2 t = \frac{1}{2}(1 - \cos 2t)$
$\cos^2 t = \frac{1}{2}(1 + \cos 2t)$

Table 7: Partial Fraction

$\frac{P(s)}{(s+b)(s-c)} = \frac{A}{s+b} + \frac{B}{s-c}$
$\frac{P(s)}{s(s-b)(s-c)} = \frac{A}{s} + \frac{B}{s-b} + \frac{C}{s-c}$
$\frac{P(s)}{(s+b)^2} = \frac{A}{s+b} + \frac{B}{(s+b)^2}$
$\frac{P(s)}{(s+b)(s^2+c)} = \frac{A}{(s+b)} + \frac{Bs+C}{(s^2+c)}$