UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF CHEMICAL AND BIO-ENGINEERING TECHNOLOGY

FINAL EXAMINATION
OCTOBER 2025 SEMESTER

COURSE CODE	:	CLB19303
COURSE TITLE	:	MATHEMATICS 2
PROGRAMME NAME	:	TECHNICAL FOUNDATION - BACHELOR
DATE	:	30 JANUARY 2026
TIME	:	9:00AM - 12:00PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of ONE sections.
4. Section A consist of five questions. Answer FOUR (4) questions only.
5. Please write your answer on the answer booklet provided.
6. Please answer all questions in English only.
7. Refer to the attached Formula/ Appendies. ☐ *Tick if applicable*

THERE ARE 7 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 100 marks)

Answer FOUR (4) questions.

Please use the answer booklet provided.

Question 1

Answer the question below.

(a) Solve the differential equation below using the separation of variables method.

$$\left(x^2+1\right) dy + 4xydx = xdx$$

(10 marks)

(b) Solve the following first order ordinary differential equation using an integrating factor method.

$$dy = \left(x^2 e^{3x} + 6y\right) dx$$

(15 marks)

Question 2

Answer the question below.

(a) During a certain chemical reaction, the concentration of butyl chloride (C_4H_9Cl) obeys the rate equation

$$\frac{d[C_4H_9Cl]}{dt} = -k[C_4H_9Cl],$$

where $k = 0.1223/sec$.

Calculate the time taken for this reaction to consume 90% of the initial butyl chloride using the separation of variables method.

(10 marks)

(b) A tank as illustrated in Figure 1 contains 40 gallons of a solution composed of 90% water and 10% alcohol. A second solution containing half water and half alcohol is added to the tank at the rate of 4 gallons/min. At the same time, the tank is being drained at the rate of 4 gallons/min. Let *y(t)* be the number of gallons of alcohol in the tank at any time *t*. The differential equation modeling of the mixture process is given by

$$\frac{dy}{dt} = 2 - 4\left(\frac{y}{40}\right), \quad y(0) = 4$$

Refer Below - Figure1 : Mixing problem with equal flow rates .

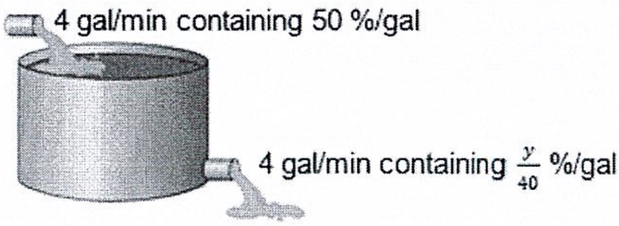

Figure 1: Mixing problem with equal flow rates

i. Compute the rate in and the rate out of the mixture.

(5 marks)

ii. Solve the differential equation as shown above and determine the amount of alcohol in the tank after 10 minutes.

(10 marks)

Question 3

Answer the question below:

(a) Show from the definition of Laplace transform that

$$L\{f(t)\} = \frac{1}{s^2}\left(1 - e^{-s}\right)$$

where

$$f(t) = \begin{cases} \text{t}, & 0 \leq t < 1 \\ 1, & t \geq 1 \end{cases}$$

Hint: Use

$$L\{f(t)\} = \int_0^\infty e^{-st} f(t)dt$$

(10 marks)

(b) Determine the following inverse Laplace transform using the partial fractions method.

$$L^{-1}\left[\frac{1}{(s+1)\left(s^2+1\right)}\right]$$

(15 marks)

Question 4

Answer the question below:

(a) In an RLC series circuit as shown in Figure 2, $R = 16\ \Omega$, $L = 1\ H$, $C = 0.01\ F$ and the voltage source is $E = 150\ V$.

Determine the current i(t) in the circuit using the undetermined coefficients if at the initial time i(0) = 0, i'(0) = 96 and q(0) = 0.1 C.

Hint: Note that

$$L\frac{di}{dt} + Ri + \frac{1}{C}q = E(t)$$

and

$$i = \frac{dq}{dt}.$$

Refer Below - Figure2 : An RLC series circuit .

(10 marks)

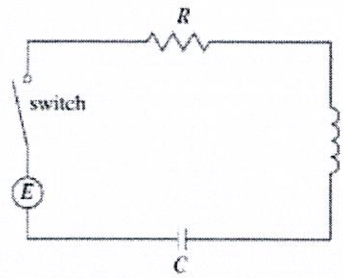

Figure 2: An RLC series circuit

(b) Verify your answer for the current i(t) in part (a) using Laplace Transforms. Simplify *I(s)* by using completing the square method.

(15 marks)

Question 5

Answer the question below.

(a) In an RLC series circuit as shown in Figure 2, $R = 130\ \Omega$, $L = 1\ H$, $C = 1.6 \times 10^{-3}$ F, and the voltage source is $E(t) = 100 \cos 10t$ V.

Determine the current $i(t)$ in the circuit using the undetermined coefficients if at the initial time $i(0) = 0$, and $q(0) = 0$ C.

Hint: Note that

$$L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + \frac{1}{C}q = E(t)$$

and

$$i = \frac{dq}{dt}$$

Refer Below - Figure3 : An RLC series circuit .

(10 marks)

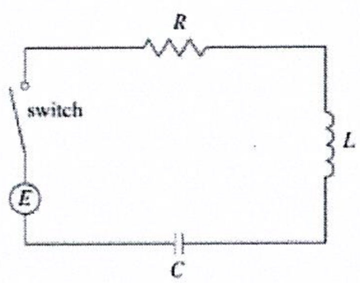

Figure 3: An RLC series circuit

(b) Verify your answer for the current $i(t)$ in part (a) using Laplace Transforms.

Hint: Use partial fractions to simplify $Q(s)$.

(15 marks)

END OF EXAMINATION PAPER

APPENDIX

DIFFERENTIATION RULES			
1.	$\frac{d}{dx}(k) = 0 \quad k = \text{constant}$	5.	$\frac{d}{dx}(\cos ax) = -a\sin ax$
2.	$\frac{d}{dx}(ax^n) = nax^{n-1}$	6.	$\frac{d}{dx}(\ln x) = \frac{1}{x}$
3.	$\frac{d}{dx}(e^{ax}) = ae^{ax}$	7.	Product Rule $\frac{dy}{dx} = u\frac{dv}{dx} + v\frac{du}{dx}$
4.	$\frac{d}{dx}(\sin ax) = a\cos ax$	8.	Quotient Rule $\frac{dy}{dx} = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$

INTEGRATION RULES			
1.	$\int x^n dx = \frac{x^{n+1}}{n+1} + c$	4.	$\int \sin ax\, dx = -\frac{\cos ax}{a} + c$
2.	$\int e^{ax} dx = \frac{e^{ax}}{a} + c$	5.	$\int \cos ax\, dx = \frac{\sin ax}{a} + c$
3.	$\int \frac{1}{x} dx = \ln x + c$	6.	Integration by parts $\int u dv = uv - \int v du$

FIRST ORDER LINEAR DIFFERENTIAL EQUATION		
1.	General Form of 1st order ODE nonhomogeneous	$\frac{dy}{dx} + P(x)y = Q(x)$
2.	Integrating Factor	$V(x) = e^{\int P(x)dx}$
3.	General Solution	$V(x)y = \int V(x)Q(x)dx$

SECOND ORDER LINEAR DIFFERENTIAL EQUATION			
1.	General Form of 2ndorder ODE nonhomogeneous	$a\frac{d^2y}{dt^2} + b\frac{dy}{dt} + cy = Q(t)$	
2.	Complementary Function, y_c	$y_c = c_1e^{\alpha t} + c_2e^{\beta t}$	2 distinct real roots
		$y_c = (c_1t + c_2)e^{\alpha t}$	2 equal (repeated) real roots
		$y_c = e^{\alpha t}(c_1\sin\beta t + c_2\cos\beta t)$	Complex roots
3.	Particular Function, y_p	$Q(t)$	y_p
		t^n at^n $at^n + bt^{n-1} + \ldots$	$A + Bt + Ct^2 + \ldots + kt^n$
		ae^{bt}	Ae^{bt}
		ate^{bt}	$Ae^{bt} + Bte^{bt}$

		$a\cos bt$ $a\sin bt$	$A\sin bt + B\cos bt$
		$at\cos bt$ $at\sin bt$	$A\sin bt + B\cos bt + Ct\cos bt + Et\sin bt$
4.	General Solution		$y = y_c + y_p$

TABLE OF LAPLACE TRANSFORMS

	$y(t) = \mathcal{L}^{-1}\{Y(s)\}$	$Y(s) = \mathcal{L}\{y(t)\}$		$y(t) = \mathcal{L}^{-1}\{Y(s)\}$	$Y(s) = \mathcal{L}\{y(t)\}$
1.	1	$\frac{1}{s}$	7.	e^{at}	$\frac{1}{s-a}$
2.	$t^n,\ n=1,2,3,\ldots$	$\frac{n!}{s^{n+1}}$	8.	$t^n e^{at},\ n=1,2,3,\ldots$	$\frac{n!}{(s-a)^{n+1}}$
3.	$\sin(at)$	$\frac{a}{s^2+a^2}$	9.	$\cos(at)$	$\frac{s}{s^2+a^2}$
4.	$t\sin(at)$	$\frac{2as}{(s^2+a^2)^2}$	10.	$t\cos(at)$	$\frac{s^2-a^2}{(s^2+a^2)^2}$
5.	$e^{at}\sin(bt)$	$\frac{b}{(s-a)^2+b^2}$	11.	$e^{at}\cos(bt)$	$\frac{s-a}{(s-a)^2+b^2}$
6.	$y'(t)$	$sY(s)-y(0)$	12.	$y''(t)$	$s^2Y(s)-sy(0)-y'(0)$