Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAM
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	ENGINEERING TECHNOLOGY MATHEMATICS 1
COURSE CODE	:	BDX 10102
PROGRAMME CODE	:	BDX
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	2 HOURS
INSTRUCTION	:	1. ANSWERS **FOUR** QUESTIONS **ONLY**
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSE BOOK**.
		3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 (a) Find $\frac{dy}{dx}$ of the following equations by using implicit differentiation.

(i) $\tan(xy) = 7$

(4 marks)

(ii) $5 - x^2 = sin(xy^2)$

(4 marks)

(b) An object is moving so that its speed after t minutes is $v(t) = 1 + 4t + 3t^2$ meters per minute. Identify the length that the object travel during the 3rd minute.

(4 marks)

(c) An airplane travels horizontally at a speed of 500 mi/h at an altitude of 3 miles above the ground. An observer sees the plane flying toward him at an angle of elevation of 60 degrees.

(i) Sketch a diagram of the given situation.

(3 marks)

(ii) Solve the given situation by finding the rate at which the angle of elevation is changing at this instant.

(10 marks)

Q2 (a) Given $y^3 + x^2y^5 - x^4 = 27$.

(i) Find $\frac{dy}{dx}$ using implicit differentiation.

(5 marks)

(ii) Find the slope of the tangent line to the curve at the point (0, 3).

(3 marks)

(b) Define the Maclaurin series for the function $f(x) = x^2e^{-x}$.

(4 marks)

(c) Define a Taylor series for the function $f(x) = e^x$ centered at $c = 3$.

(5 marks)

(d) Two airplanes are about to intersect at a single point. The first plane is travelling west at 400 mi/h and is currently 160 miles east from the convergence point. The second plane is travelling south at 750 mi/h and is currently 300 miles north from the convergence point. At what rate is the distance between the two planes changing?

(i) Sketch a diagram of the given situation.

(3 marks)

(ii) At what rate is the distance between the two planes changing? Write your answer in mi/h.

(5 marks)

Q3 (a) Solve the following differential equations.

(i) $y' = \frac{x'y'}{x^2-y^2}$

(4 marks)

(ii) $y' = \frac{2xe^{-y/x}+y}{x}$ at initial point of (1,0)

(10 marks)

(b) Find the function f whose tangent has slope $x^3 + \frac{2}{x^2} + 2$ for each value of x and whose graph passes through the point (1, 3).

(4 marks)

(c) It is estimated that t years from now the population of a certain lakeside community will be changing at the rate of $0.6t^2 + 0.2t + 0.5$ thousand people per year. Environmentalists have found that the level of pollution in the lake increases at the rate of approximately 5 units per 1000 people. Compute how much the pollution in the lake increases during the next 2 years.

(7 marks)

Q4 (a) Find the followings;

(i) $f[e^{2t}t^2]$

(4 marks)

(ii) $L[e^{3t}\cos 2t]$

(4 marks)

(iii) $f^{-1}[e^{-2t}s^2]$

(4 marks)

(b) A 1-kg mass stretches a spring 20 cm. the system is attached to a dashpot that imparts a damping force equal to 14 times with the instantaneous velocity of the mass. Write the equation of motion if the mass is released from equilibrium with an upward velocity of 3 m/s.

(4 marks)

(c) A metal bar with initial temperature 25°C is dropped into a container of boiling water (100°C). After 5 seconds, the temperature of the bar is 35°C.

(i) Find the temperature of the bar after 1 minute?

(5 marks)

(ii) Compute the duration needed for the temperature of the bar to be within 0.5 °C of the boiling water.

(4 marks)

Q5 (a) A mass of 1 slug stretches a spring 2 ft and comes to rest at equilibrium. The system is attached to an absorber that imparts a damping force equal to eight times the instantaneous velocity of the mass. Write the equation of motion if an external force equal to $f(t) = 8\sin(4t)$ is applied to the system beginning at time $t = 0$. Identify the transient solution and the steady-state solution.

(9 marks)

(b) Find the following;

(i) $L^{-1}\left[\frac{1}{s(s-3)}\right]$

(4 marks)

(ii) $L^{-1}\left[\frac{3s+6}{s^2+3s}\right]$

(4 marks)

(c) Use Laplace transform to solve the initial value problem.

$$y'' + 3y' + 2y = e^{-t}, \qquad y(0) = y'(0) = 0$$

(8 marks)

-END OF QUESTIONS –