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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021**

COURSE NAME : ENGINEERING
TECHNOLOGY MATHEMATICS 1

COURSE CODE : BDX 10102

PROGRAMME CODE : BDX

EXAMINATION DATE : JANUARY / FEBRUARY 2021

DURATION : 2 HOURS

INSTRUCTION : ANSWERS **FOUR** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF FOUR (4) PAGES.

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- Q1** (a) Find $\frac{dy}{dx}$ of the following equations by using implicit differentiation.
- (i) $\tan(xy) = 7$ (4 marks)
- (ii) $5 - x^2 = \sin(\pi y^2)$ (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)

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- (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) $\mathcal{L}[e^{2t}t^2]$ (4 marks)

(ii) $\mathcal{L}[e^{3t} \cos 2t]$ (4 marks)

(iii) $\mathcal{L}^{-1}[e^{-2t}s^2]$ (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) $\mathcal{L}^{-1} \left[\frac{1}{s(s-3)} \right]$

(4 marks)

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

(4 marks)

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

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

(8 marks)

-END OF QUESTIONS -

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