

Name: . . . . . Section: . . . . . Number: . . . . .

**Important Instructions**

- Write your name, ID # and Section # on the front cover of your answer booklet.
- You need to show your complete, mathematically correct and neatly written solution.
- You are NOT allowed to share calculators or any other material during the test.
- Cellular phones are NOT allowed to be used for any purpose during the test.
- You should NOT ask the invigilator questions about the exam.
- You need to solve questions **Q1** through **Q6**.

**Q1:** Show that the following limit does not exist (4 points)

$$\lim_{(x,y) \rightarrow (0,1)} \frac{xy - x}{x^2 + (y - 1)^2}.$$

**Q2:** Let  $z = \sin(x) \cos(y)$ , where  $x = (s - t)^2$  and  $y = s^2 - t^2$ . (4 points)

Use the chain rule to find  $\frac{\partial z}{\partial s}$ .

**Q3:** Find the absolute extrema of the function  $f(x, y) = x^2 + y^2 - 4xy$  on the region bounded by the curves of  $y = x + 1$ ,  $y = -3$  and  $x = 3$ . (6 points)

**Q4:** Given that (6 points)

$$F(x, y, z) = 200e^{-x^2 - 3y^2 - 9z^2}.$$

- (i) Find the rate of change at the point  $P(2, -1, 2)$  in the direction toward the point  $Q(3, -3, 3)$ .
- (ii) Find the direction in which  $F$  increases most rapidly at  $P$ .
- (iii) Find the maximum rate of increase of  $F$  at  $P$ .

**Q5:** Evaluate the integral (4 points)

$$\int_0^1 \int_x^1 e^{y^2} dy dx.$$

**Q6:** Find the volume of the solid bounded by  $z = 1 - y^2$ ,  $x + y = 1$  and the three coordinate planes (first octant). (6 points)