

Books, watches, notes or cell phones are **not** allowed. The **only** calculators allowed are the Sharp EL-531\*\*\*. You **must** show all your work, the correct answer is worth 1 mark the remaining marks are given for the work.

**Question 1.** (1 mark each) Complete each of the following sentences with **MUST**, **MIGHT**, or **CANNOT**.

- If a function is not defined at a point, then it \_\_\_\_\_ have a jump discontinuity at that point.
- If  $|f(x)|$  is continuous at  $a$ , then  $f(x)$  \_\_\_\_\_ also be continuous at  $a$ .
- If  $f(x)$  is continuous at  $a$ , then  $|f(x)|$  \_\_\_\_\_ also be continuous at  $a$ .

**Question 2.** (5 marks each) Evaluate the following limits:

a.  $\lim_{x \rightarrow 4} \frac{x^3 + 12x^2 + 32x}{4x^2 - 64}$

b.  $\lim_{x \rightarrow 0} f(x)$  where  $f(x) = \begin{cases} x \cos\left(\frac{1}{x}\right) & \text{if } x < 0 \\ -1 + \sec x & \text{if } x \geq 0 \end{cases}$

c.  $\lim_{x \rightarrow 0} \frac{\sqrt{4 + 4 \sin(2x^2)} - 2}{8x^2}$

d.  $\lim_{x \rightarrow -1^-} \left[ \frac{2}{|x+1|} \left( \frac{1}{3} - \frac{1}{x+4} \right) \right]$

e.  $\lim_{x \rightarrow \infty} \left( \sqrt{x^2 + ax} - \sqrt{x^2 + bx} \right)$

**Question 3.** (5 marks) Find the value(s) of  $x$  for which  $f(x)$  is not continuous where  $f(x) = \begin{cases} \frac{x^2-4}{x+2} & \text{if } x < -1 \\ 3x & \text{if } -1 \leq x \leq 2 \\ x^2 & \text{if } 2 < x \end{cases}$  Justify your answer by referring to the definition of continuity.

**Bonus Question.** (2 marks) State the  $\epsilon - \delta$  definition of a limit.