

**CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS**

**SCHEDULE I / ITEM 1  
MATHEMATICS**

**March 2009**

Although programmable calculators may be used, candidates must show all formulae used, the substitution of values into them, and any intermediate values to 2 more significant figures than warranted by the answer. Otherwise, full marks may not be awarded even though the answer is numerically correct.

**Note:** This examination consists of 10 questions on one page.

<u>Q. No</u>	<u>Time: 3 hours</u>	<u>Marks</u>	
		<u>Value</u>	<u>Earned</u>
1	a) Given a simple function $f(x)$ over the real line $\Upsilon$ , what does $f^{(2)}(x) = d^2f(x)/dx^2$ correspond to? Illustrate graphically $f^{(2)}(x) = 0$ , $f^{(2)}(x) < 0$ and $f^{(2)}(x) > 0$ .	5	
	b) For the same simple function $f(x)$ over the real line $\Upsilon$ , what does $f^{(3)}(x) = d^3f(x)/dx^3$ correspond to? Using the previous example, illustrate graphically where $f^{(3)}(x) = 0$ .	5	
2	a) Given the functions $f(x) = e^x$ and $g(x) = \log_e x$ , what are $f(g(x))$ and $g(f(x))$ ?	5	
	b) For the previous functions $f(x)$ and $g(x)$ , what is $g(x)$ called in terms of $f(x)$ ?	5	
3	a) What is the usual interpretation of the definite integral $\int_0^\pi \sin x \, dx$ over the finite interval $[0, \pi]$ ?	5	
	b) Approximate this integral using a simple quadrature over a partition of $[0, \pi]$ .	5	
4	a) Using Cartesian coordinates, set up the integral for the volume of the unit sphere at the origin of $\Upsilon^3$ .	5	
	b) Using (spherical) polar coordinates, set up the integral for the volume of the unit sphere at the origin of $\Upsilon^3$ .	5	
5	a) How can you justify the divergence in $\sum_{n=1}^{\infty} n^{-1} = 1 + 1/2 + 1/3 + \dots = \infty$ ?	5	
	b) Expand $(1 + x)^{-1}$ as a power series in $x$ . Does the series converge for $x = 1$ ?	5	
6	a) Given a function $f(x,y,z) = e^{xyz}$ in $\Upsilon^3$ , what is its total derivative $df(x, y, z)$ ?	5	
	b) For the same function $f(x,y,z) = e^{xyz}$ in $\Upsilon^3$ , what are its partial derivatives?	5	
7	a) Complex numbers are common when solving quadratic equations. Explain with examples.	5	
	b) What are the real and imaginary parts of $\sin z$ for a complex variable $z$ ?	5	
8	a) Given two vectors such as $\mathbf{u} = (1, 2, 3)^T$ and $\mathbf{v} = (4, 5, 6)^T$ , what is the angle between them?	5	
	b) How can the vectors $\mathbf{u}$ and $\mathbf{v}$ be easily checked for being orthogonal?	5	
9	a) Given a square matrix $A$ , what are its powers $A^2$ and $A^3$ ? Give simple examples.	5	
	b) For a rectangular matrix $B$ , can $B^2$ be defined? Illustrate with simple examples.	5	
10	a) For a square matrix $A$ , how are its eigen values defined? Illustrate with a simple example.	5	
	b) For a rectangular matrix $B$ , how are its singular values defined? Illustrate with a simple example.	5	
<b>Total Marks:</b>		100	