

CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

**SCHEDULE I / ITEM 1
MATHEMATICS**

October 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 for the answer. Otherwise, full marks may not be awarded even though the answer is numerically correct.

Note: This examination consists of 10 questions on two pages.

Marks

Q. No

Time: 3 hours

Value Earned

1. a)	What is the equation in Cartesian coordinates of an ellipse at the origin with semi-major axis a and semi-minor axis b?	5	
b)	Give a parametric form of the previous equation for an ellipse at the origin.	5	
2. a)	Set up and evaluate the integral for the area of one quadrant of a circle at the origin with radius r.	5	
b)	Set up and evaluate the integral for the length of the arc of one quadrant of a circle at the origin with radius r.	5	
3. a)	For the function $f(x,y,z) = e^x \sin(y) \cos(z)$, what is the total derivative df ?	5	
b)	For the same function $f(x,y,z) = e^x \sin(y) \cos(z)$, what is ∇f explicitly?	5	
4. a)	What are the real and imaginary parts of $\sin(z)$ for complex z ?	5	
b)	For a small complex matrix \mathbf{A} , when is it called Hermitian?	5	
5. a)	Given three equations: $3x + 2y + 1z = 9$, $2x - 5y + 3z = 15$, $1x + 3y + 12z = 18$ What are x , y and z by Gaussian elimination?	5	
b)	For the same equations, what are x , y and z by Cramer's rule?	5	
6. a)	What is the general solution $y(x)$ of the ordinary differential equation $y \, dx = x \, dy$?	5	
b)	What is the special solution $y(x)$ given that $y(1) = 0$?	5	
7. a)	What is the general solution $u(x, y)$ of the Laplace equation $\Delta u(x, y) \equiv \frac{\partial^2 u(x, y)}{\partial x^2} + \frac{\partial^2 u(x, y)}{\partial y^2} = 0$?	5	
b)	What is a trivial solution for the previous Laplace equation?	5	
8. a)	Given two vectors $\mathbf{u} = (1.1 \ 2.2 \ 3.3)^T$ and $\mathbf{v} = (4.4 \ 5.5 \ 6.6)^T$, what is their vector or cross product?	5	
b)	What is the angle between these two vectors \mathbf{u} and \mathbf{v} ?	5	
9. a)	Given a small matrix $\mathbf{A} = \begin{pmatrix} 2 & 1 \\ 1 & 2 \end{pmatrix}$, what are \mathbf{L} and \mathbf{U} for $\mathbf{A} = \mathbf{LU}$ with \mathbf{L} , lower triangular and \mathbf{U} upper triangular?	5	
b)	What is the usefulness of such an \mathbf{LU} decomposition of a matrix \mathbf{A} ?	5	

10. a)	The square of the length of a (column) vector $\mathbf{U} = (u_1 \ u_2 \ u_3)^T$ can be written as $\mathbf{U}^T\mathbf{U}$. Justify this statement.	5	
b)	What is the interpretation of the corresponding form $\mathbf{U}^T\mathbf{D}\mathbf{U}$ for some diagonal matrix $\mathbf{D} = \text{diag} (d_1 \ d_2 \ d_3)$ with positive d_1, d_2 and d_3 ?	5	
	Total Marks:	100	