CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C-1 MATHEMATICS

March 2022

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 2 pages.

Time: 3 hours

Q. No		Marks Value	Earned
1.	a) What is the inverse function of $f(x) = e^{\cos x+1}$ defined on $[0, \pi]$? b) Find the inverse matrix of $$C = \begin{bmatrix} -2 & 1 & 2 \\ -2 & -1 & -3 \\ 3 & 1 & 1 \end{bmatrix}$$	5 5	
2.	Find all interior angles for and the plane equation containing the triangle with points $$P = (-6, -2, -7), Q = (-2, 1, 6), R = (-8, 3, -5)$$ Use the cross product to find a normal vector to the plane.	10	
3.	The Laplacian operator ∇^2 is defined as follows, $$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2}$$ Find $\nabla^2 f$ for $$f(x, y, z) = \frac{1}{r}, r = \sqrt{x^2 + y^2 + z^2}$$	10	
4.	a) Calculate the distance along the great circle between Vancouver (49°15′N, 123°6′W) and Palma de Mallorca (39°34′N, 2°39′E). b) In a right spherical triangle with $C = \frac{\pi}{2}$, you know angles A and B. How do you find the side b? Provide the formula using Napier's Pentagram.	5 5	
5.	a) The ratio of the two sides of a rectangle is 5 : 12. Its diagonal is $52\,cm$. Calculate area and circumference. b) What is the initial velocity of a rock that is thrown vertically to a height of $100\,m$ before it returns to Earth? Use $g = 9.8m/s^2$ and note that $h''(t) = -g$ for the height $h(t)$.	5 5	

6.	a) Differentiate $f(x) = \sqrt{3x-7}$ using the definition of the derivative $$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$ b) Find the tangent line for the following curve at the given point. $$y = \sin(\sin x) \text{ at } (\pi, 0)$$	5 5	
7.	The currents running through an electrical system are given by the following system of equations. The three currents I_1, I_2, I_3 are measured in amps. Use Cramer's rule to provide I_2. Do not use other methods. $$\begin{array}{rcrcrcl} I_1 & + & 2I_2 & - & I_3 & = & 0.425 \\ 3I_1 & - & I_2 & + & 2I_3 & = & 2.225 \\ 5I_1 & + & I_2 & + & 2I_3 & = & 3.775 \end{array}$$	10	
8.	Find the vertex of the following parabola $$2y^2 - \frac{1}{2}x - 12y + 19 = 0$$	10	
9.	Find the solution set for the following system of linear equations. $$\begin{array}{rcrcrcl} 2x & + & 3y & - & 7z & = & 1 \\ x & + & 4y & + & 2z & = & 0 \end{array}$$	10	
10.	Find trace and determinant for the following Hermitian matrix. $$\begin{bmatrix} 3 & 4-i & -\pi i \\ 4+i & 7 & -3+2i \\ \pi i & -3-2i & -3 \end{bmatrix}$$ Give a precise answer using π.	10	
	Total Marks:	100	