

DAWSON COLLEGE
MATHEMATICS DEPARTMENT
Applied Mathematics (CIVIL ENGINEERING TECHNOLOGY)

201-912-DW
Fall 2021
Final Examination
December 14th, 2021
Time Limit: 3 hours

Name: _____

ID#: _____

Instructor: E. Richer, S. Soltuz

- This exam contains 16 pages (including this cover page) and 17 problems. Check to see if any pages are missing.
- Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page, and please indicate that you have done so.
- Give the work in full; – unless otherwise stated, reduce each answer to its simplest, exact form; – and write and arrange your exercise in a legible and orderly manner.
- You are only permitted to use the **Sharp EL-531X, XG or XT** calculator.
- This examination booklet must be returned intact.
- Good luck!

Question	Points	Score
1	6	
2	4	
3	5	
4	8	
5	8	
6	3	
7	4	
8	5	
9	5	
10	5	
11	5	
12	12	
13	5	
14	5	
15	6	
16	7	
17	7	
Total:	100	

1. (6 marks) Evaluate then convert the answer into the requested notation and unit. Remember to express your answer using the correct number of significant figures and make sure not to lose precision in your unit conversions.

(a) $300\bar{0}0$ in scientific notation

(b) 0.00267 m^3 to cm^3 , in engineering notation

(c) $(8.0 + (21.2)(5.12) - (3.7)(42))$ in engineering notation

(d) $(3.51 \times 10^4 + 2.216 \times 10^5)\text{m}^2$ to km^2 in scientific notation

2. (4 marks) Compute by long division

$$\frac{-2x^4 - 3x^2 + 4x + 1}{x - 1 + x^2}$$

3. (5 marks) Sketch the following function making sure to include at least 4 properly labelled points. The sketch should clearly indicate the intercepts and the vertex.

$$f(x) = x^2 - 5x + 6$$

4. Civil Engineering students notice that when they get extra sleep, their marks improve. They collect sample data (below) and find that for every additional hour of sleep (x) per week they see a certain percentage increase in their grade (y).

$$\begin{array}{l} x = 1 \quad 2 \quad 4 \\ y = 4 \quad 8 \quad 10 \end{array}$$

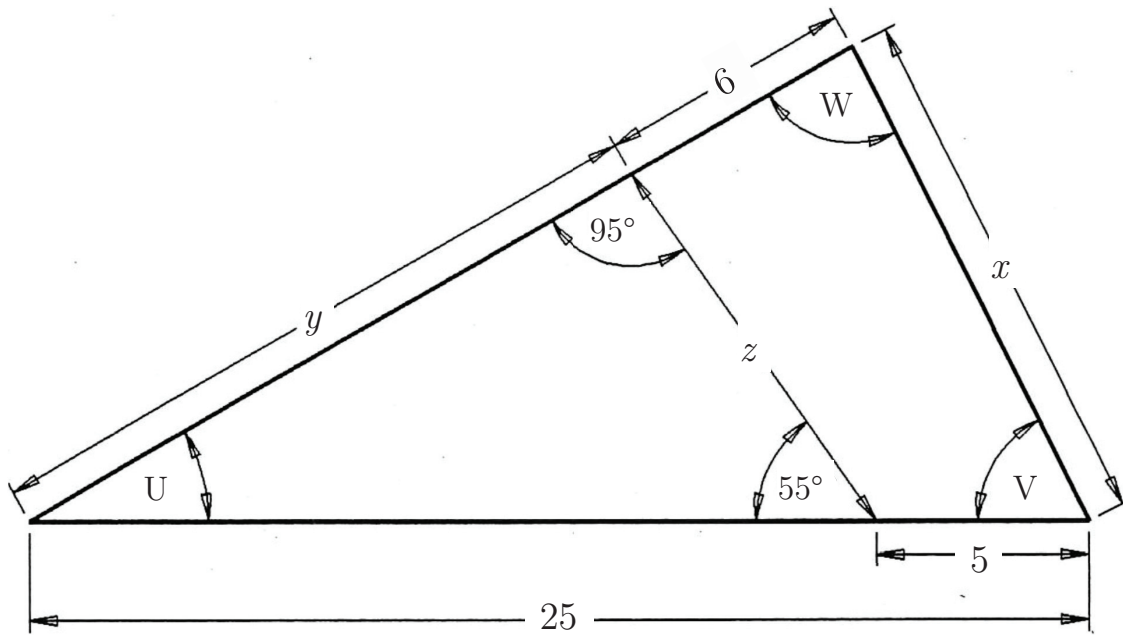
- (a) (5 marks) Find the least-squares regression line for the above data.
- (b) (3 marks) Use your answer in a) to estimate the number of hours of sleep required to have a 15% increase in grade.

You may use either of the two equivalent sets of formulas

$$m = \frac{\frac{\sum xy}{n} - \bar{x} \cdot \bar{y}}{\frac{\sum x^2}{n} - \bar{x}^2} \quad \text{or} \quad m = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}$$

$$b = \bar{y} - m \cdot \bar{x} \quad \text{or} \quad b = \frac{n(\sum x^2)(\sum y) - (\sum xy)(\sum x)}{n(\sum x^2) - (\sum x)^2}$$

5. (8 marks) Solve for all of the missing parameters x , y , z , U , V , W . Note that you are allowed to use any of the trigonometric formulas shown in class, you are not restricted to using only right angle triangles.



6. (3 marks) Find exact value of

$$4\sqrt{12} + \sqrt{108} - 2\sqrt{48}$$

7. (4 marks) Rationalize the denominator and simplify

$$\frac{25\sqrt{3} - 4\sqrt{2}}{7\sqrt{3} - 5\sqrt{2}}$$

8. (5 marks) Solve for x . Note that solutions found by trial and error will not be awarded any marks.

$$\sqrt{3x+1} - \sqrt{x-1} = 2$$

9. (5 marks) Solve for x . Note that solutions found by trial and error will not be awarded any marks.

$$\frac{x}{x-4} - \frac{7}{x+4} - \frac{56}{x^2-16} = 0$$

10. (5 marks) Solve the system of equations. Note that solutions found by trial and error will not be awarded any marks.

$$\left\{ \begin{array}{l} x + y + z = 0 \\ 2x - y + z = -1 \\ x + y - z = 4 \end{array} \right\}$$

11. (a) (3 marks) Find the inverse of

$$f(x) = \frac{x-3}{2x-1}$$

(b) (2 marks) Compute $f \circ f^{-1}$ making sure to show each of your steps.

12. In each of the following equations, solve for x . Note that solutions found by trial and error will not be awarded any marks.

(a) (6 marks)

$$2^{2-3x} = 5^{2x-5}$$

(b) (6 marks)

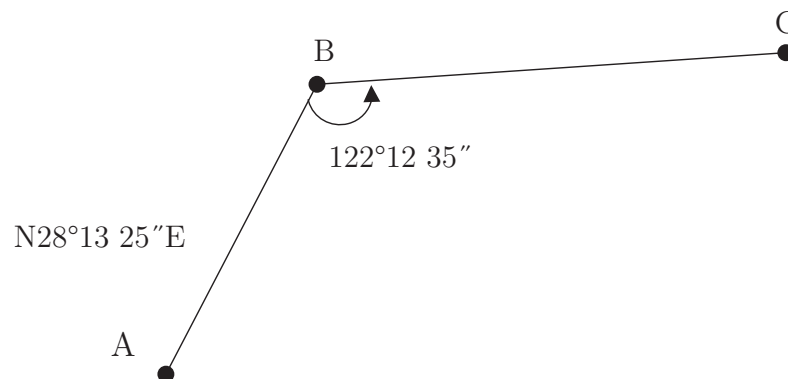
$$\log_2(x) + \log_2(x - 3) = 2$$

13. (5 marks) Answer **ONE** of the following questions. If you answer both questions, only the first will be marked.

Option A: Prove the following trigonometric identity.

$$\tan^2 \theta - \cot^2 \theta = \sec^2 \theta - \csc^2 \theta.$$

OR Option B: Complete the following table corresponding to the angle measurements listed in the figure below. Show your work using the figure below.



Line	Bearing (in D°M' S'')
AB	
BC	
CB	
BA	

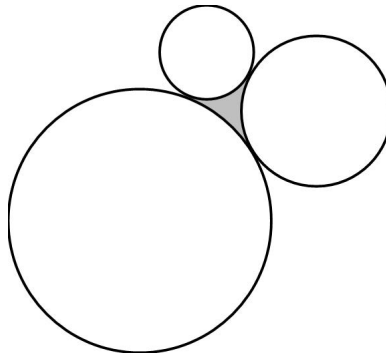
Note: the bearing measurement notation to be used is (NS-angle-EW)

14. (5 marks) Answer **ONE** of the following questions. If you answer both questions, only the first will be marked.

Option A: Find the exact value of

$$\cos \frac{5\pi}{4} + \tan \frac{4\pi}{3}$$

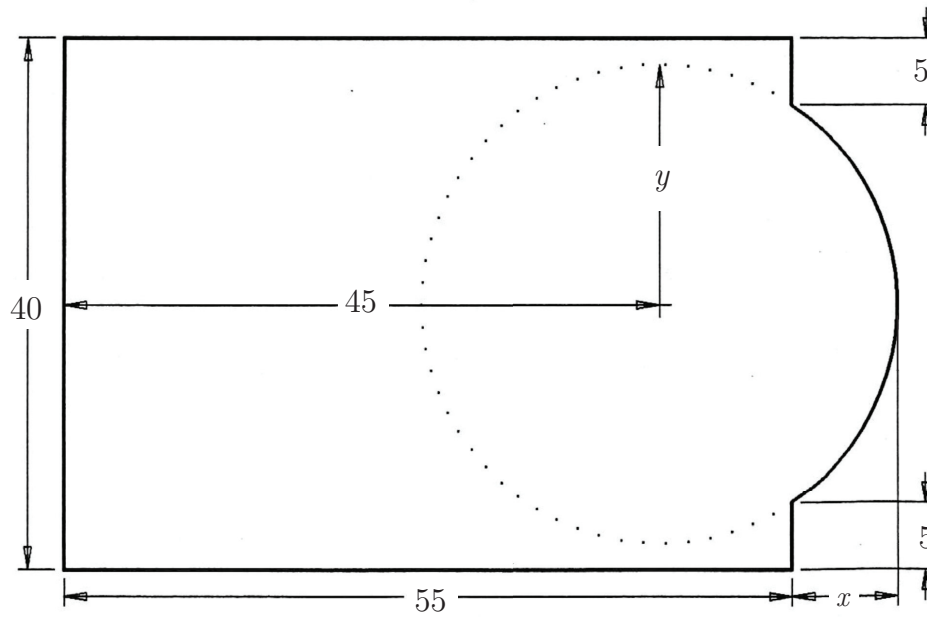
OR Option B: Three circles with radii 1.25cm, 2.5cm and 5 respectively are tangent to each other externally (see figure below). Compute the **shaded area** enclosed between the three circles.
Hint: *connect the centre of each of the circles*



15. (6 marks) Solve for θ giving all solutions contained in the interval $[0, 2\pi)$. Note that solutions found by trial and error will not be awarded any marks.

$$2 \sin \theta \cos \theta - \sqrt{3} \cos \theta = 0$$

16. (7 marks) Solve for x and y , then find the perimeter of the figure illustrated below.



17. (7 marks) Suppose a truck is parked on a bridge as illustrated in the figure below. The truck weighs 100N, acting through its center of gravity. The bridge weighs 20 N/m, which is uniformly distributed. Assuming the bridge is rigid, compute the reaction forces at the supports at the two ends of the bridge.

