Math Methods (Engn/Phys 225) – Winter 2021

First-day Info Sheet (aka Getting to know you)

1. Full Name:
2. My preferred First Name:
    i. First name pronunciation (if desired):
    ii. The pronoun(s) I go by (if any):

3. My career goals are:
4. Place(s) I grew up:
5. Something that I am good at or makes me feel proud of myself, or any fun fact about you:

6. I live (circle one) - on campus/off campus;
7. I have reliable access to Internet/sufficient bandwidth for Zoom (circle one): Yes/No
8. I work outside of school, including work study (if yes, how many hours/week)/

9. A word that described how I feel about this class at the moment:
10. Study strategies I use to work on problem sets:
11. Number of hours/week I believe I will be spending to study for this course:

12. I appreciate when my instructors:

13. I dislike when my instructors:

14. One current question I have about this class is:

15. One topic I would like to explore in this class is:

16. Please use this space to privately share anything you would like the instructor to know (perhaps something that could impact or help your learning experience in this class):

Preliminary Quiz
ENGN/PHYS 225—Winter 2021
Prof. Erickson

Foreword

The purpose of it is simply to help the instructor gauge the math background of the class. Doing so will help make optimal use of our relatively short 12 weeks together. This quiz will NOT be graded, but please do your very best to answer the following questions. Please show your work to the degree I can discern your thinking process/math mechanics. Do not worry if you don't know all of the answers right now. That's why you are in math methods, and by the end of our time together, you will probably look back and think some of these are child's play. Thank you in advance for helping the instructor get a read on your math preparation coming into 225!

1. Please indicate which of the following courses you have already completed:
   (a) Math 221: Multivariable caluclus
   (b) Math 222: Linear Algebra
   (c) Math 332: ODEs
   (d) Math 333: PDEs
   (e) CSCI 111 or 121: Fundamental of Programming/Scientific Computing
2. Please indicate which of the following courses (if any) that you are taking this winter term:
   (a) Engn 204: Dynamics
   (b) Engn 311: Fluid Mechanics
   (c) Phys 220: E&M
   (d) CSCI 111 or 121: Fundamental of Programming/Scientific Computing
3. Given $f(x, y, z) = xy^3 \sin(z)$, write an expression for the partial derivatives: $\frac{\partial f}{\partial x}$, $\frac{\partial f}{\partial y}$, and $\frac{\partial f}{\partial z}$.
4. Compute the magnitude of the imaginary number $2 + 3i$.
5. Draw the point $z = 5e^{i\frac{\pi}{4}} 2e^{i\frac{\pi}{2}}$ in the complex plane.
6. Given $v(t) = 5e^{i2\pi t}$, sketch the the real part of $v(t)$ vs. t.
7. Given $A = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} 4 \\ 5 \end{bmatrix}$, compute $C = AB$.
8. Compute the eigvenvalues and eigenvectors for matrix A given above (part 7).
9. Given a matrix $P = \begin{bmatrix} 2 & 0 \\ 0 & -5 \end{bmatrix}$ compute the inverse P^{-1}.
10. Given two vectors $\mathbf{F} = 1\hat{\mathbf{i}} + 0\hat{\mathbf{j}} + 3\hat{\mathbf{k}}$ and $\mathbf{r} = 0\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - 4\hat{\mathbf{k}}$, compute $\mathbf{M} = \mathbf{r} \times \mathbf{F}$.
11. The temperature in a room is described by the function $T(x, y) = xy - y^3$. Compute the temperature gradient ∇T at the position $(x, y) = (4, 2)$.

12. A vector field (could be fluid flowing or magnetic field lines) is given by $\mathbf{u}(x, y) = y\hat{\mathbf{i}} - x\hat{\mathbf{j}} + 0\hat{\mathbf{k}}$. Sketch this vector field in the xy plane and describe it ion layterms in one sentence.

13. For the same fluid vector field $\mathbf{u}(x, y)$, compute the divergence $\nabla \cdot \mathbf{u}$. (This represents how much net stuff—fluid or magnetic field—flows out of volume element)

14. Given the same vector field $\mathbf{u}$ from part 12, compute the curl $\boldsymbol{\omega} = \nabla \times \mathbf{u}$. (This is also known as the *vorticity* in fluid dynamics. The curl crucially comes into play in E&M too...Maxwell's equations!).

15. Given $\mathbf{u}(x, y)$ above, compute the path integral

$$\Gamma = \oint \mathbf{u} \cdot d\mathbf{s}$$

around a CCW path described by a square, centered at the origin, with side length 2, e.g. corners at $(\pm 1, \pm 1)$. (This quantity is known as the *circulation* of a vector field)

16. Solve $\frac{dn}{dt} = -kn$, given $k = 5$ and $n(0) = 7$. Sketch your final solution for $n(t)$ vs. t.

17. A mechanical system is described by the 2nd order ODE: $m\ddot{x} + kx = 0$. Given $m = 6$ kg and $k = 24$ N/m, and the initial condition $\dot{x}(0) = 0$ and $x(0) = 10$, write an expression for $x(t)$ and sketch your solution.

18. Now modify the mechanical system to include a first order derivative term: $m\ddot{x} + c\dot{x} + kx = 0$. Let $c = 10$ Ns/m. Given the same initial conditions as above, write an expression for $x(t)$ and carefully sketch your solution.