

Investigations in Engineering Self-Assessment

Center for Talented Youth

Spring, 2011

1 Introduction

The Investigations in Engineering (IENG) course is particularly challenging. It covers the material from a full college level class in just three short weeks. We provide this optional assessment for students to take to help them see if they are prepared to take the course. The pre-requisite for IENG is pre-calculus, so that will represent the majority of the topics covered in this test. We recommend that if a student isn't sure their knowledge is up to speed, they take this test and see how they do and use that to inform their decision to register for the IENG course. The main areas of pre-calculus that are covered are **functions** and **trigonometry**. Neither a textbook nor a graphing calculator should be necessary.

2 Functions

- 1) Find the midpoint and the length of the line segment joining the following two points: $(-1, -4)$ and $(3, 4)$.
- 2) Simplify: $(4 - 3i)^2$.
- 3) Find the coordinates of the maximum of this function: $-x^2 + 6x - 7$.
- 4) If 4 is a zero of $f(x) = x^2 + kx - 9$, find the value of k .
- 5) If $f(x) = x^2(x - 7)^2$, find $f(2 + 3i)$.

- 6) Find the remainder when $4x^3 - 2x + 5$ is divided by $x - 3$.
- 7) Factor and then sketch the graph of $f(x) = x^3 + 5x^2 - 2x - 24$.
- 8) Find a cubic equation with roots $2 - 3i$ and -3 .
- 9) Find the domain and range of

$$\frac{x - 2}{x^2 - x - 6}$$

- 10) If $f(x) = x^2 - 5$ and $g(x) = x^3 - 1$ find $f(g(x))$.
- 11) Solve $\ln x^5 = 12$.
- 12) Graph the function

$$f(x) = \frac{x^2 - 9}{x^2 - 16}$$

Show horizontal and vertical asymptotes as well as intercepts.

3 Trigonometry

- 1) Simplify $\cot(x + \pi)$
- 2) Given the function $f(x) = A \sin\left(\frac{2\pi}{p}(x - 2)\right)$, write the equation of the graph if it is shifted 4 units to the right, and 3 units up.

- 3) Simplify

$$\frac{\sin^4(\theta) - \cos^4(\theta)}{\sin^2(\theta) - \cos^2(\theta)}$$

- 4) If $\sin(\alpha) = 1/2$ and $0 < \alpha < \pi/2$, find $\sin(2\alpha)$.
- 5) Find the measure of the largest angle in a triangle with side lengths 3, 6, and 7.

6) Show that: $\sin x \cos x \tan x = 1 - \cos^2 x$.

7) Simplify: $\cos(x - \pi/2)$.

8) Simplify: $-6 \sin(\frac{a+b}{2}) \sin(\frac{a-b}{2})$

4 Miscellaneous

1) Evaluate

$$\lim_{x \rightarrow 2} \frac{x^2 - 4}{x - 2}$$

2) Find the sum of: $\frac{1}{3} + \frac{1}{6} + \frac{1}{12} + \frac{1}{24} + \dots$

3) Is the following function continuous? If not, where are the discontinuities?

$$f = \begin{cases} -x & x < 0 \\ x^2 & 0 \leq x < 2 \\ x^2 + 1 & x \geq 2 \end{cases}$$

4) Consider three concentric spheres of radii a, b, c , with $0 < a < b < c$. What fraction of the volume between the spheres of radii a and c is occupied by the volume between the spheres of radii a and b ?