Final Examination - Math 142, Frank Thorne (thorne@math.sc.edu)

Thursday, December 12, 2013

Instructions and Advice:

- There are fifteen questions, some of which are shorter than others.

- You are welcome to as much scratch paper as you need. Turn in everything you want graded, and throw away everything you do not want graded.

- **Draw pictures where appropriate.** If you have any doubt, then a picture is appropriate.

- Be clear, write neatly, explain what you are doing, and show your work. **This is especially important for earning partial credit** in case your work contains one or more mistakes. Be warned that **work I cannot understand will not receive any credit.**

- 150 minutes is a long time. Don't dilly-dally, but don't rush. **You are strongly advised to take the entire 150 minutes to complete the examination.** If you finish early, you have the opportunity to check your work.

- You are welcome and encouraged to refer to the list of convergence tests provided with the exam.

- Please work without books, notes, calculators, or any assistance from others.

- I will be at the front of the room; if you have any questions, feel free to ask me.

GOOD LUCK!

(1) Evaluate
$$\int \frac{(\ln x)^2}{x} dx.$$

(2) Evaluate
$$\int_0^1 (x^2 + 1)e^{-x} dx.$$

(3) Evaluate
$$\int_0^{2\sqrt{3}} \frac{x^3}{\sqrt{16 - x^2}} dx.$$

(4) Evaluate
$$\int_4^\infty e^{-y/2} dy.$$

(5) Find the area of the region bounded by the curves $x = y^2 - 2$, $y = 1$, $y = -1$, and $x = e^y$.

(6) Find the volume of the solid obtained by rotating the region bounded by the given curves around the specified line. Sketch the region, the solid, and a typical disk or washer.
$$y = 1 - x^2, \ y = 0, the \ x - axis$$

(7) Sketch the curve given by the parametric equations
$$x = 5\sin(t), y = t^2, -\pi \le t \le t.$$

(8) Indicate with an arrow the direction in which the curve is traced as t increases. Find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ for the curve given. For which values of t is the curve concave upward?
$$x = 4 + t^2, \ y = t^2 + t^3$$

(9) What is the formula for the slope of the tangent line to a curve defined by polar coordinates? (Explain.)

(10) Determine whether the series
$$\sum_{n=1}^\infty \frac{2}{n^2 + 4n + 3}$$
is convergent or divergent by expressing the partial sums as a telescoping sum. If it converges, find its sum.

(11) Use the integral test to determine whether the series is convergent or divergent.
$$\sum_{n=1}^\infty \frac{n^2}{e^n}.$$

If the series diverges, then draw a graph which represents both the series and the integral youre comparing it to.

If the series converges, give upper and lower bounds on the value of your series which are guaranteed to be accurate within 0.01. Draw a graph which represents your lower bound.

(12) Using the comparison test, or otherwise, determine whether the following series converges or diverges:
$$\sum_{n=1}^{\infty} \frac{1 + 4^n}{1 + 3^n}.$$

(13) What does it mean for a series to converge absolutely? Conditionally?

(14) Find the radius of convergence and interval of convergence of the series:
$$\sum_{n=1}^{\infty} \frac{(3x - 2)^n}{n3^n}$$

(15) Find the Taylor (Maclaurin) series of the function $f(x) = \sin(x)$, and determine its radius of convergence.