TO: Math Department Instructors
FROM: Aryn DeJulis, Director of Undergraduate Services
DATE: August 22, 2016
RE: T. Benny Rushing Mathematics Center

The Mathematics Center has something for all undergraduate math students. Please let your classes know about the services and facilities that will be of use to them. The Math Center offers the following:

**Mathematics Tutoring Center:**
The Mathematics Tutoring Center offers free, drop-in tutoring to students enrolled in the following math classes: 990, 1010, 1030, 1040, 1050, 1060, 1070, 1080, 1090, 1100, 1170, 1180, 1210, 1220, 1250, 1260, 1310, 1311, 1320, 1321, 2200, 2210, 2250, 2270, 2280, 3070, 3080, 3140, 3150, 3160. The tutoring center will open **Monday, August 29th**, and the hours are: 8:00 AM - 8:00 PM Monday - Thursday and 8:00 AM - 6:00 PM on Friday. The tutoring center is closed during semester breaks, weekends, and University holidays. Students (particularly those in discrete mathematics, statistics, complex variables, and partial differential equations) should check the schedule to see when a tutor who can help them will be in. The schedule will be posted on the web (www.math.utah.edu/ugrad/tutoring.html) and in the tutoring center. For students who need more attention than our tutoring center can offer, the ASUU Tutoring Center, 330 SSB, offers inexpensive private tutoring ($7 an hour). A list of private tutors is also available from the math department office or the desk in the tutoring center.

In addition to our drop in tutoring service, we offer group-tutoring sessions in an effort to serve more students more effectively. Please let your students know that if they are interested in this, they should stop by the tutoring center and let me know the times they are interested in participating in a group tutoring session. We must have 5 or more students from the same course committed to meet at the same time on a weekly basis before we will schedule a group tutoring session. These group-tutoring sessions can also be arranged through the instructor, just let me know that you are interested in having sessions run for your course.

**Drop-in Computer Lab:**
All students enrolled in a math class have access to the undergraduate computer lab in the Rushing Student Center. The lab will open **Monday, August 22nd**, and the hours are: 8:00 AM - 8:00 PM Monday - Thursday and 8:00 AM - 6:00 PM on Friday. The lab is closed during semester breaks, weekends, and University holidays. However, when the lab is closed students may access the math system from the physics department computer lab in 205 South Physics (they must first arrange card access at www.physics.utah.edu).

**Group Study Rooms:**
The Rushing Student Center has four group study rooms that may be reserved by math majors and by groups of students from math classes. Reservations are made through my office (155A in the math center).

**Study Area:**
Along the wall adjoining JWB 121 are study desks.

**Thanks for helping get the word out about what the Math Center has to offer!**
More on Volumes

Torus

\[ V = \pi (R+r)^2 \left( (R+r)^2 - (R-r)^2 \right) \]

- Suppose the radius of the red circle is \( r \). Let \( R \) be the radius of the circle formed by the centers of all circles like the one drawn in red.

- Guess the volume of the torus. Then show that your guess is correct.

- This is essentially problem 45 on page 447 of the textbook.

**Figure 1.** Torus.
\[ V = \int_{-r}^{r} 2\pi (R+s) 2\sqrt{s^2 - r^2} \, ds \]

\[ V = 2\pi \int_{0}^{r} \left( R + \sqrt{r^2 - s^2} \right)^2 - (R - \sqrt{r^2 - s^2})^2 \, ds \]
\[ V = 2 \pi \int_0^r \left( R^2 + 2R \sqrt{r^2 - s^2} + 2 \frac{r^2}{s} - \left( R^2 - 2R \sqrt{r^2 - s^2} + r^2 \frac{r^2}{s} \right) \right) ds \]

\[ = 2 \pi \int_0^r 4R \sqrt{r^2 - s^2} ds \]

\[ = 8 \pi R \int_0^r \sqrt{r^2 - s^2} ds \]

\[ = 8 \pi R \frac{\pi r^2}{4} = 2 \pi^2 r^2 R \]

\[ A = \frac{\pi r^2}{4} \]
Example:

1, page 451. Find the volume of the solid obtained by rotating about the $y$-axis the region bounded by $y = 2x^2 - x^3$ and $y = 0$.

Figure 2. Some Region.

Évariste Galois, October 25, 1811 – May 31, 1832: In general polynomial equations cannot be solved in terms of radicals if their degree exceeds 4. . . . Galois Theory.
\[ V = \int_0^2 2\pi x y \, dx \]
\[ = \int_0^2 2\pi x \left( 2x^2 - x^3 \right) \, dx \]
\[ = 2\pi \int_0^2 2x^3 - x^4 \, dx \]
\[ = 2\pi \left[ \frac{x^4}{2} - \frac{x^5}{5} \right]_0^2 \]
\[ = 2\pi \left( \frac{16}{2} - \frac{32}{5} \right) = \frac{16\pi}{5} \]
Example 2, page 452. Find the volume of the solid formed by rotating the region shown in Figure 3 around the $y$-axis.

$$V = \int_0^1 2\pi x (x - x^2) \, dx$$
\[
\begin{align*}
&= 2\pi \int_{0}^{1} x^2 - x^3 \, dx \\
&= 2\pi \left[ \frac{x^3}{3} - \frac{x^4}{4} \right]^{1}_{0} \\
&= 2\pi \left( \frac{1}{3} - \frac{1}{4} \right) = \frac{2\pi}{12} = \frac{\pi}{6} \\
&= \int_{0}^{1} (y - y^2) \, dy \\
&= \pi \left[ \frac{y^2}{2} - \frac{y^3}{3} \right]^{1}_{0} = \pi \left( \frac{1}{2} - \frac{1}{3} \right) = \frac{\pi}{6}
\end{align*}
\]