# Math 120

## PSet 7

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# Contents

# Chapter 1

## 1.1 PSet 7

**Question 1**

Calculate the given iterated integrals.

1. $\int_0^1 \int_0^1 x\sqrt{1+4y}\,dy\,dx$
2. $\int_0^1 \int_1^2 \frac{xe^x}{y}\,dy\,dx$

***Solution:***

1)

$$\int_0^1 \int_0^1 x\sqrt{1+4y}\,dy\,dx$$

$$\int_0^1 x\sqrt{1+4y}\,dy$$

$$1+4y = t \quad r = dt$$

$$x\int_0^1 \frac{1}{4}\sqrt{t}dt$$

$$\frac{1}{4}x\int_0^1 \sqrt{t}dt$$

$$\frac{1}{4}x\cdot\frac{2t\sqrt{t}}{3}\Big|_0^1$$

$$\frac{1}{4}x\cdot\frac{2(1+4y)\sqrt{1+4y}}{3}\Big|_0^1$$

$$\frac{x\sqrt{1+4y}(1+4y)}{6}\Big|_0^1$$

$$\frac{x\sqrt{1+4}(1+4)}{6} - \frac{x\sqrt{1}1}{6}$$

$$\frac{5x\sqrt{5}}{6} - \frac{x}{6}$$

$$\int_0^1 \frac{5x\sqrt{5}}{6} - \frac{x}{6}dx$$

$$\frac{1}{6}\int_0^1 5\sqrt{5}x - x\,dx$$

$$\frac{1}{6}\left(\int_0^1 5\sqrt{5}x\,dx - \int_o^1 x\,dx\right)$$

$$\int_0^1 5\sqrt{5}x\,dx \Rightarrow \frac{5\sqrt{5}x^2}{2}\Big|_0^1$$

$$\frac{5\sqrt{5}(1)^2}{2} - 0 = \frac{5\sqrt{5}}{2}$$

$$\int_0^1 x\,dx \Rightarrow \frac{x^2}{2}\Big|_0^1$$

$$\frac{1}{2} - 0 = \frac{1}{2}$$

$$\frac{1}{6}\left(\frac{5\sqrt{5}}{2} - \frac{1}{2}\right) = \frac{5\sqrt{5}-1}{12}$$

## Question 2

(a) Sketch the solid whose volume is given by the iterated integral

$$\int_0^1 \int_0^2 e^{-x^2-y^2}\,dy\,dx.$$

(b) Explain why

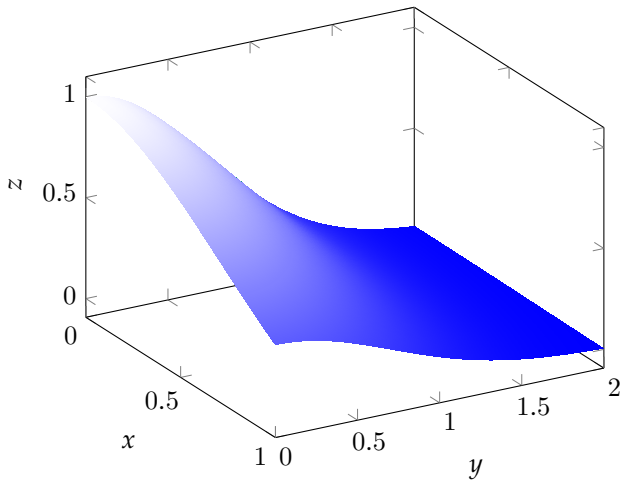
$$\int_0^1 \int_0^2 e^{-x^2-y^2}\,dy\,dx = \int_0^1 e^{-x^2}\,dx \cdot \int_0^2 e^{-y^2}\,dy.$$

(c) Use Desmos to compute

$$\int_0^1 \int_0^2 e^{-x^2-y^2}\,dy\,dx.$$

(Desmos will give a numerical approximation, but this is fine. In fact, there is no way to compute the antiderivatives necessary to get an exact answer.)

***Solution:***




## Question 3

(a) Find the average value of the function $f(x,y) = \sin x \cos y$ on the rectangle $R = [0,\pi]\times[-\pi/2,\pi/2]$.

(b) Use symmetry to find the average value of $f(x,y) = \frac{4\sin y}{e^{x^2}} - \frac{\cos x}{\ln y} + 3$ on the region $R = [2\pi,4\pi]\times$

$[2\pi, 6\pi]$. Please explain your answer carefully.

## Question 4

In each part, draw the region $D$, and evaluate the integral.

1. $\iint_D \frac{y}{x^5+1}\, dA$, where $D$ is the region $D = \{(x, y) \mid 0 \leqslant x \leqslant 1,\ 0 \leqslant y \leqslant x^2\}$.
2. $\iint_D x^3\, dA$, where $D = \{(x, y) \mid 1 \leqslant x \leqslant e,\ 0 \leqslant y \leqslant \ln x\}$.

## Question 5

Draw the region $D$. Set up the iterated integrals for both orders of integration. Then evaluate the double integral using the easier order and explain why it's easier.

$$\iint_D x^2 e^{-xy}\, dA \quad \text{where } D \text{ is bounded by } y = x,\ x = 4, \text{ and } y = 0.$$

## Question 6

(a) Find the volume of the solid in the first octant enclosed by the parabolic cylinder $y = 1 - x^2$ and the planes $z = 2 - y$ and $z = y$.

(b) Sketch the solid whose volume is given by the iterated integral

$$\int_0^1 \int_0^{1-x} (2 - y^2)\, dy\, dx.$$

## Question 7

Sketch the region of integration and change the order of integration.

1. $\int_0^1 \int_{4x}^4 f(x, y)\, dy\, dx$
2. $\int_0^3 \int_{\sqrt{9-y}}^3 f(x, y)\, dx\, dy$
3. $\int_0^4 \int_0^{\ln 2x} f(x, y)\, dy\, dx$

## Question 8

Evaluate the integral

$$\int_0^1 \int_x^1 \frac{e^x}{y}\, dy\, dx$$

by reversing the order of integration.

## Question 9

Evaluate the given integral by converting to polar coordinates. Be sure to draw the region of integration in each part.

1. $\iint_R (x + y)\, dA$, where $R$ is the region that lies to the left of the $y$-axis between the circles $x^2 + y^2 = 1$ and $x^2 + y^2 = 4$.

2. $\iint_R ye^x \, dA$, where $R$ is the region in the first quadrant enclosed by the circle $x^2 + y^2 = 25$.

## Question 10

Use polar coordinates to find the volume of the given solid.

(a) Inside the sphere $x^2 + y^2 + z^2 = 4$ and outside the cylinder $x^2 + y^2 = 1$.

(b) Bounded by the paraboloids $z = 3x^2 + 3y^2$ and $z = 4 - x^2 - y^2$.

## Question 11

Evaluate the iterated integral

$$\int_0^b \int_{-\sqrt{b^2-y^2}}^0 x^2 y \, dx \, dy$$

by converting to polar coordinates.

## Question 12

Let $D$ be the disk with center at the origin and radius $a$.

(a) Use your intuition: what do you expect is the average distance from points on the disk to the origin?

- less than $a/2$
- $a/2$
- between $a/2$ and $a$
- more than $a$

Give an intuitive explanation of your answer.

(b) What is the average distance from points in the disk to the origin?