Write legibly and neatly. Show all your work for full credit.

1. **(10 points)** Evaluate the double integral:

\[
\int_0^1 \int_{\frac{1}{y}}^1 \cos \left( \frac{x}{y} \right) \, dy \, dx
\]

**HINT:** There is no simple way to evaluate \( \int \cos(1/y) \, dy \). What method did we learn to help deal with double integrals like this?
2. **(5 points)** Write an expression for the $n$th term of the sequence:

\[
\begin{array}{cccc}
2 & 4 & 6 & 8 \\
\frac{3}{3} & \frac{9}{9} & \frac{27}{27} & \frac{81}{81} \\
\end{array}
\]
3. **(10 points)** For each of the following sequences, determine whether they converge or diverge. If they converge, what do they converge to?

(a) 
$$a_n = 2 + \frac{(-1)^n}{n}$$

(b) 
$$b_n = \frac{\sqrt{n}}{\sqrt{n + 1}}$$

(c) 
$$c_n = \frac{n!}{e^n}$$

(d) 
$$d_n = \sin^2 n$$

(e) 
$$e_n = \frac{n!}{(2n)!}$$