Math 180 **Name (Print):** _____

9/10/2016 **NetID:** _____

Time Limit: 20 Minutes

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1. (8 points) Evaluate

$$\frac{d}{dx}\left(\int_2^{\cos x} e^{t^2}\, dt\right)$$

$e^{(\cos x)^2}$

$y = \cos -x$

$y' = -\sin x$

$(-\sin x)\, e^{\cos^2 x}$

$2 + e^{t^2}\Big|_2^{\cos x}$

$2\cos x\, e^{\cos^2 x} - 4e^4$

$-\sin x\, e^{\cos^2 x} - e^4$

2. (8 points) Determine whether or not the following improper integral converges or diverges. Rewrite the integral as a limit, and evaluate the integral if it converges.

$\int_2^\infty \frac{dx}{x \ln x}$ integral test

f(x) is continuous

f(x) is positive

$f \geq 2$

$f'(x) = \frac{-\ln x}{(x \ln x)^2}$ = decreasing

$\lim_{b \to \infty} \int_2^b \frac{1}{x \ln x}\, dx$

↓

converges

$\frac{1}{x \ln x}$ = $\frac{hi\,di\,lo - lo\,di\,hi}{lo\,lo}$

product rule

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1. (8 points) Evaluate

$$\frac{d}{dx}\left(\int_2^{\cos x} e^{t^2}\, dt\right)$$

$$\int_2^{\cos x} e^{t^2} dt = e^{x^2} \cdot 2x = 2x e^{x^2} \Big|_2^{\cos x}$$

$$2(\cos x) e^{(\cos x)^2} - 2(2) e^4$$

$$2\cos x\, e^{\cos^2 x} - 4e^4$$

2. (8 points) Determine whether or not the following improper integral converges or diverges. Rewrite the integral as a limit, and evaluate the integral if it converges.

$$\int_2^\infty \frac{dx}{x \ln x}$$

$u = \ln x$

$du = \frac{1}{x}\, dx$

$$\int_{\ln 2}^{\ln a} \frac{1}{u}\, du$$

$$\lim_{a \to \infty} \int_2^a \frac{1}{\ln x}\, dx$$

$$\lim_{a \to \infty} \ln u \Big|_{\ln 2}^{\ln a}$$

$= \ln(\ln a) - \ln(\ln 2) = \infty$

diverges

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1. (8 points) Evaluate

$$\frac{d}{dx}\left(\int_2^{\cos x} e^{t^2}\, dt\right)$$

$= e^{\cos^2 x}(-\sin x)$

2. (8 points) Determine whether or not the following improper integral converges or diverges. Rewrite the integral as a limit, and evaluate the integral if it converges.

$$\int_2^\infty \frac{dx}{x \ln x}$$

$\frac{1}{x} < \frac{1}{x \ln x} < \frac{1}{\ln x}$ converges

$\lim_{x \to \infty} \frac{1}{x \ln x} = \frac{1}{\infty} = 0$

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1. (8 points) Evaluate

$$\frac{d}{dx}\left(\int_2^{\cos x} e^{t^2}\, dt\right)$$

$$f(x) = \int_2^0 e^{t^2}\,dt + \int_0^{\cos x} e^{t^2}\,dt$$

$$f(x) = -\int_0^2 e^{t^2}\,dt + \int_0^{\cos x} e^{t^2}\,dt$$

$$f'(x) = -e^4 + e^{\cos^2 x} + C$$

2. (8 points) Determine whether or not the following improper integral converges or diverges. Rewrite the integral as a limit, and evaluate the integral if it converges.

$$\int_2^\infty \frac{dx}{x \ln x}$$

$$= \lim_{b\to\infty} \int_2^b \frac{dx}{x \ln x} = \lim_{b\to\infty} \int_{\ln 2}^{\ln b} u\,du$$

$$\left(\begin{array}{l} u = \ln x \\ du = \frac{1}{x}\,dx \end{array}\right)$$

$$= \lim_{b\to\infty} \frac{u^2}{2}\Big|_{\ln 2}^{\ln b}$$

$$= \lim_{b\to\infty} \left(\frac{(\ln b)^2}{2} - \frac{(\ln 2)^2}{2} \right) = \frac{(\ln\infty)^2}{2} - \left(\frac{\ln 2}{2}\right)^2$$

$$= \infty - \frac{(\ln 2)^2}{2} = \infty \quad \text{diverges}$$

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1. (8 points) Evaluate

$$\frac{d}{dx}\left(\int_2^{\cos x} e^{t^2}\, dt\right)$$

according to the Fundamental Theorem of Calculus

$$f'\left(\int_2^{\cos x} e^{t^2} dt\right) = e^{(\cos x)^2} \cdot -\sin x$$

$$= -e^{\cos^2 x} \sin x$$

2. (8 points) Determine whether or not the following improper integral converges or diverges. Rewrite the integral as a limit, and evaluate the integral if it converges.

$$\int_2^\infty \frac{dx}{x \ln x}$$

$\lim_{b\to\infty} \int_2^b \frac{dx}{x \ln x}$

$u = \ln x$

$du = \frac{1}{x}\,dx$

$\lim_{b\to\infty} \int_2^b \frac{1}{u}\,du$

$\lim_{b\to\infty} \ln|u| \Big|_{\ln 2}^{\ln b} + C$

$\ln|\infty| - \ln|2|$

$\Rightarrow \ln\left|\frac{\infty}{2}\right|$

$\ln|\infty|$

goes to ∞

Diverges!

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1. (8 points) Evaluate

$$\frac{d}{dx}\left(\int_2^{\cos x} e^{t^2}\,dt\right)$$

$$f(x) = \int_x^{x} e^{t^2}\,dt$$

$$\Rightarrow = f(\cos x)$$

& $(f(\cos x))' = f'(\cos x)\cdot(-\sin x)$ chain Rule

$$= e^{(\cos x)^2}(-\sin x)$$

FTC

2. (8 points) Determine whether or not the following improper integral converges or diverges. Rewrite the integral as a limit, and evaluate the integral if it converges.

$\int_2^\infty \frac{dx}{x \ln x}$

$\frac{1}{x \ln x} > \frac{1}{x} \Rightarrow$ diverges

$\Rightarrow$ by comparison $\int_2^\infty \frac{dx}{x \ln x}$ diverges

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2. (8 points) Determine whether or not the following improper integral converges or diverges. Rewrite the integral as a limit, and evaluate the integral if it converges.

$$\int_2^\infty \frac{dx}{x \ln x}$$

$\hookleftarrow \sum_{n=2}^{\infty} \frac{1}{n \ln n}$ diverges

$\Rightarrow$ diverges by integral test

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1. (8 points) Evaluate

$\frac{d}{dx}\left(\int_2^{\cos x} e^{t^2}\, dt\right)$

$= e^{\cos^2 x}(-\sin x) - e^{x^2}\cdot(2t)$

$\cdot 0$

$= e^{\cos^2 x}(-\sin x)$

2. (8 points) Determine whether or not the following improper integral converges or diverges. Rewrite the integral as a limit, and evaluate the integral if it converges.

$\int_2^\infty \frac{dx}{x \ln x}$

$u = \ln x \qquad du = \frac{1}{x}\,dx$

$= \int_2^\infty \frac{du}{u} = \ln u \Big|_2^\infty = \ln \infty - \ln 2 = \infty$

diverges

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Sample 1

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1. (8 points) Evaluate

$\frac{d}{dx}\left(\int_2^{\cos x} e^{t^2}\, dt\right)$ $= e^{(\cos t^2)}(-\sin x)$

2. (8 points) Determine whether or not the following improper integral converges or diverges. Rewrite the integral as a limit, and evaluate the integral if it converges.

$$\int_2^\infty \frac{dx}{x \ln x}$$

$= \int \frac{d}{\ln x} =$ [illegible] $\frac{1}{x}\Big|_2^\infty = \frac{1}{\infty} - \frac{1}{2} = \frac{-1}{2}$ Converges

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1. (8 points) Evaluate

$$\frac{d}{dx}\left(\int_2^{\cos x} e^{t^2}\, dt\right) = \cos x\, e^{t^2}\, dt$$

2. (8 points) Determine whether or not the following improper integral converges or diverges. Rewrite the integral as a limit, and evaluate the integral if it converges.

$\int_2^\infty \frac{dx}{x \ln x}$

$= \frac{1}{x \ln x} \Big|_2^\infty = \frac{1}{\infty} - \frac{1}{2 \ln 2}$

Converges