Final Exam Review

Problem 1. If $\vec{a} = \langle 4, 3\rangle$ and $\vec{b} = \langle -2, 1\rangle$, find the unit vector $\hat{a}$ and the vector $(5\vec{a} - 2\vec{b})$.

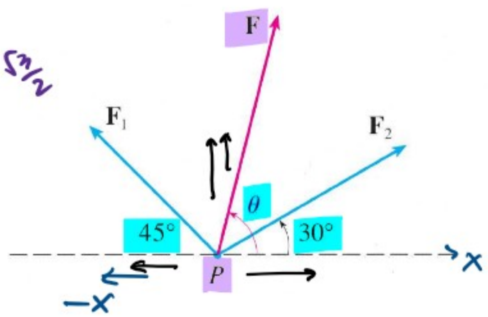
unit vector $\hat{a} = \dfrac{\bar{a}}{|\bar{a}|} = \dfrac{\langle 4,3\rangle}{\sqrt{16+9}} = \dfrac{\langle 4,3\rangle}{\sqrt{25}} = \left\langle \frac{4}{5}, \frac{3}{5} \right\rangle$

$$5\bar{a} - 2\bar{b} = 5\langle 4,3\rangle - 2\langle -2,1\rangle$$
$$= \langle 20, 15\rangle - \langle -4, 2\rangle$$
$$= \langle (20+4), (15-2)\rangle$$
$$= \langle 24, 13\rangle$$

Problem 2. Two forces $\vec{F}1$ and $\vec{F}2$, with magnitudes 10 lbs and 12 lbs respectively, act on an object P as shown in the diagram below. Find the direction and magnitude of the resultant force $\vec{F}$ acting on P.

$\sin 45 = \cos 45 = \frac{\sqrt{2}}{2}$

$\sin 30 = \frac{1}{2}$
$\cos 30 = \frac{\sqrt{3}}{2}$



$|F_1| = 10 \quad , \quad |F_2| = 12$

$$\bar{F}_1 = \langle 10(-\cos(45)), 10\sin(45)\rangle$$
$$= \langle -5\sqrt{2}, 5\sqrt{2}\rangle$$
$$\bar{F}_2 = \langle 12 \cdot \cos(30), 12\sin(30)\rangle$$
$$= \langle 6\sqrt{3}, 6\rangle$$

$$\bar{F} = \bar{F}_1 + \bar{F}_2 = \langle -5\sqrt{2}, 5\sqrt{2}\rangle + \langle 6\sqrt{3}, 6\rangle$$
$$= \langle (-5\sqrt{2} + 6\sqrt{3}), (5\sqrt{2}+6)\rangle$$
$$|\bar{F}| = \sqrt{(-5\sqrt{2}+6\sqrt{3})^2 + (5\sqrt{2}+6)^2}$$

direction: $\tan\theta = \dfrac{5\sqrt{2}+6}{-5\sqrt{2}+6\sqrt{3}} = \dfrac{F_y}{F_x}$

angle $\bar{F}$ makes with (+)ve x axis is $\theta = \arctan\left(\dfrac{5\sqrt{2}+6}{-5\sqrt{2}+6\sqrt{3}}\right)$

Scalar projection: $\text{comp}_{\bar{b}}\bar{a} = \dfrac{\bar{a}\cdot\bar{b}}{|\bar{b}|}$

$\vec{a} \to \vec{b}$

Problem 3. Find the vector projection of $\langle 4, 8\rangle$ onto $\langle 2, 1\rangle$.

$$\text{comp}_{\bar{b}}\bar{a} = \frac{\langle 4,8\rangle\langle 2,1\rangle}{|\langle 2,1\rangle|} = \frac{4(2)+8(1)}{\sqrt{4+1}} = \frac{16}{\sqrt{5}}$$

*

vector proj.: $\text{proj}_{\bar{b}}\bar{a} = (\text{comp}_{\bar{b}}\bar{a})\cdot\left(\dfrac{\bar{b}}{|\bar{b}|}\right)$ unit vector $\bar{b}$

$$= \left(\frac{16}{\sqrt{5}}\right)\left(\frac{\langle 2,1\rangle}{\sqrt{5}}\right) = \frac{16}{5}\langle 2,1\rangle$$

$$= \left\langle \frac{32}{5}, \frac{16}{5}\right\rangle$$

Problem 4. A parametric curve is given by $x = 2\sin\theta$, $y = 3\cos\theta$. Find its Cartesian equation.

$\sin\theta = \dfrac{x}{2}$ $\qquad$ $\cos\theta = \dfrac{y}{3}$ $\qquad$ eliminate parameter: θ

Trig Identity: $\sin^2\theta + \cos^2\theta = 1$

$$\left(\frac{x}{2}\right)^2 + \left(\frac{y}{3}\right)^2 = 1$$

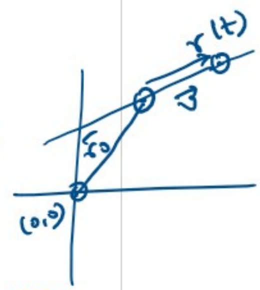
$$\frac{x^2}{4} + \frac{y^2}{9} = 1 \leftarrow \text{Eq}^{n} \text{ of an ellipse!}$$

$\bar{v}$

Problem 5. Find the vector equation of a line passing through the points $(1, 2)$ and $(-1, 4)$.

not unique!

$\bar{r}_0$



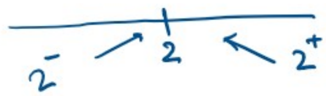
$$\bar{r}(t) = \bar{r}_0 + t\bar{v}$$

$t \to$ parameter

$$\bar{r}_0 = \langle 1, 2\rangle$$

$$\bar{v} = \underset{\text{(final)}}{\langle -1,4\rangle} - \underset{\text{(initial)}}{\langle 1,2\rangle} = \langle -2, 2\rangle$$

Vector Eq^{n}: $\bar{r}(t) = \langle 1,2\rangle + t\langle -2,2\rangle$



Problem 6. Evaluate the following limits:

a) $\lim_{x\to 2^-} \frac{x-1}{x^2(x+2)}$ $\sim \frac{2^- - 1}{(2^-)^2(2^- + 2)} = \frac{1}{(4)(4)} = \frac{1}{16}$ Ans.

f) $\lim_{x\to 2^-} \frac{x-1}{x^2(x-2)} \sim \frac{2^- - 1}{(2^-)^2(2^- - 2)} = \frac{1}{(4)(0^-)} = -\infty$

→ b) $\lim_{x\to -3} \frac{x^2-x-12}{x+3}$ $\sim \frac{(-3)^2 - (-3) - 12}{-3+3} = \frac{0}{0}$ ← indeterminate form

↳ $\frac{(x-4)\cancel{(x+3)}}{\cancel{(x+3)}} = \lim_{x\to(-3)} (x-4) = -3-4 = -7$ Ans.

limit at $-\infty$ ⇒ c) $\lim_{x\to -\infty} \frac{\sqrt{x^2+4x}}{4x+1}$ $= \lim_{x\to(-\infty)} \frac{\sqrt{x^2}}{4x} = \frac{|x|}{4x}$ $\quad |x| = \begin{cases} -x, & x<0 \\ +x, & x \geq 0 \end{cases}$

can choose largest terms!

$= \lim_{x\to(-\infty)} \frac{-\cancel{x}}{4\cancel{x}} = -\frac{1}{4}$ Ans. $\quad$ lim: $x \to (-\infty)$

d) $\lim_{x\to\infty} \frac{e^x - \cancel{e^{-3x}}^{\,0}}{e^{3x} + \cancel{e^{-3x}}^{\,0}}$ $= \lim_{x\to\infty} \frac{e^x}{e^{3x}} = \frac{\cancel{e^x}}{\cancel{e^x}\cdot e^x \cdot e^x} \sim \frac{1}{\infty} = 0$ Ans.

L'H will not work here!

$\lim_{x\to\infty} e^x \to \infty$

$\lim_{x\to\infty} e^{-x} = 0.$

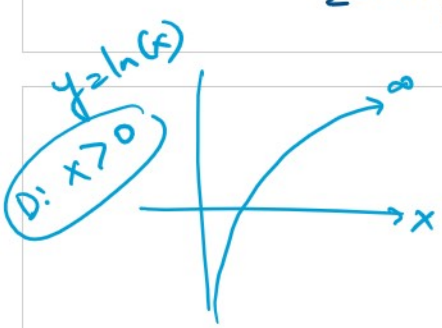
OR ↳ $\lim_{x\to\infty} e^{-2x} = 0$

e) $\lim_{x\to\infty} [\ln(3x^2) - \ln(6x^4 - 3x + 1)]$ $\sim (\infty - \infty)$ ← indeterminate form

→ use log laws! $\quad \ln a - \ln b = \ln\left(\frac{a}{b}\right)$

$$\lim_{x\to\infty} \ln\left(\frac{3x^2}{6x^4 - 3x + 1}\right) = \ln \lim_{x\to\infty}\left(\frac{3x^2}{6x^4-3x+1}\right) = \ln \lim_{x\to\infty}\left(\frac{3x^2}{6x^4}\right)$$

$$= \ln . \lim_{x\to\infty}\left(\frac{1}{2x^2}\right) = \ln(0^+) \to (-\infty)$$ Ans.



P.R → product rule

C.R → chain rule.

$u' \to f'(x)$

$-\infty$

$y' \to f'(x)$

Problem 7. Find the derivative or $\dfrac{dy}{dx}$ for the following:

a) $y = x^3(4x^5+5)^8$ P.R.

CR.

$$y' = (3x^2)(4x^5+5)^8 + (x^3)\,8(4x^5+5)^7 \cdot \underline{(20x^4)}$$

b) $f(x) = \sqrt{\cos(\sin^2 x)}$ CR

CR Power $\dfrac{d}{dx}(\sqrt{x}) = \dfrac{1}{2\sqrt{x}}$

CR

$$f'(x) = \frac{1}{2\sqrt{\cos(\sin^2(x))}}\left(-\sin(\sin^2 x)\right) \cdot 2\sin(x)\cdot\cos(x)$$

c) $y = \ln(xe^{-x})$ → P.R.

CR

$$y' = \frac{1}{xe^{-x}} \cdot \left(e^{-x} + x\cdot e^{-x}\cdot(-1)\right) = \frac{e^{-x} - xe^{-x}}{xe^{-x}} = \frac{1-x}{x}$$

P.R P.R

d) $e^y \sin x = x + xy$ ← Implicit differentiation

$$\left[\begin{array}{l} \dfrac{d}{dx}(x) = 1 \\ \dfrac{d}{dx}(y) = y' = \dfrac{dy}{dx} \end{array}\right.$$

$$e^y\cdot\cos(x) + \sin(x)\cdot e^y \cdot y' = 1 + y + xy'$$

$$y'(e^y\sin x - x) = 1 + y - e^y\cos x$$

$$\boxed{y' = \frac{1+y-e^y\cos x}{e^y\sin x - x}}$$ Ans.

Problem 8. Find the equation of the tangent line for the curve given by $x = 1-t^3$, $y = t^2-3t+1$ at $t = 2$.

pt: @ $t=2$, $x = 1-t^3 = -7$
$y = t^2-3t+1 = 4-6+1 = -1$ } $(-7,-1)$

$$m = \frac{dy/dt}{dx/dt} = \left.\frac{2t-3}{-3t^2}\right|_{t=2} = \frac{4-3}{-3(4)} = -\frac{1}{12}$$

Eq$^{\underline{n}}$: $y + 1 = \left(-\frac{1}{12}\right)(x+7)$

Problem 9. Differentiate $y = \dfrac{e^x(x^2+2)^3}{(x-1)^4(x^2-5)^2}$ ← use logs here

$$\ln y = \ln(\;\;\;\text{"}\;\;\;) = \ln(e^x) + \ln(x^2+2)^3 - \ln(x+1)^4 - \ln(x^2+5)^2$$

$$\ln y = \ln(\quad) = \ln(e^x) + \ln(x^2+2)^3 - \ln(x+1)^4 - \ln(x^2+5)^2$$

$$\ln y = x\cancel{\ln e}^{1} + 3\ln(x^2+2) - 4\ln(x+1) - 2\ln(x^2+5)$$

CR

$$\frac{1}{y}\cdot y' = 1 + \frac{3(2x)}{(x^2+2)} - \frac{4\cdot(1)}{(x+1)} - \frac{2(2x)}{(x^2+5)}$$

$$y' = \left(1 + \frac{6x}{x^2+2} - \frac{4}{x+1} - \frac{4x}{x^2+5}\right)\cdot\frac{e^x(x^2+2)^3}{(x+1)^4(x^2+5)^2}$$

Problem 10. Differentiate $y = (4x^2 - x + 1)^{\sin x}$ ~ $g(x)^{h(x)}$ ← have to use logs!

$$\ln y = \ln(4x^2-x+1)^{\sin x}$$

P.R

$$\ln y = \underbrace{(\sin x)}\,\underbrace{\ln(4x^2-x+1)}$$

← CR

$$\frac{1}{y}\cdot y' = \cos(x)\cdot\ln(4x^2-x+1) + \sin(x)\cdot\frac{(8x-1)}{4x^2-x+1}$$

$$y' = \left[\cos x\ln(4x^2-x+1) + \frac{(\sin x)(8x-1)}{4x^2-x+1}\right](4x^2-x+1)^{\sin x}$$

$y(0)$ $\times 3$ $t = \frac{1}{2}$ hr

Problem 11. A culture starts with 1000 bacteria and the population triples every half hour.

$y(\tfrac{1}{2}) = 3\,y(0) = 3000$

a) Find an expression for the number of bacteria after t hours.

$$y(t) = y(0) \cdot e^{kt}$$

$$3000 = 1000\, e^{\frac{1}{2}k} \quad \leftarrow \text{solve for } k$$

$$\ln 3 = \ln e^{k/2} = \frac{k}{2} \cancel{\ln e} = \frac{k}{2}$$

$$k = 2\ln 3$$

$$y(t) = 1000 \cdot e^{t \cdot 2\ln 3}$$

b) Find the number of bateria present in the sample after 20 minutes.

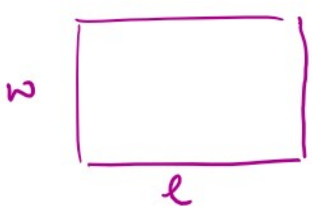
$$t = 20 \text{ min} = \frac{20}{60} = \frac{1}{3} \text{ hr}$$

$$y(\tfrac{1}{3}) = 1000 \cdot e^{\frac{1}{3} \cdot 2 \cdot \ln 3} = 1000\, e^{\frac{2}{3}\ln 3}$$

$$= 1000 \cdot \cancel{e}^{\cancel{\ln}\, 3^{2/3}} = (1000) \cdot 3^{2/3}$$

Problem 12. The length of a rectangle is decreasing at a rate of $1m/s$ while the area of the rectangle remains constant. How fast is the width of the rectangle increasing when its length is $10m$ and its width is $5m$?

$$\frac{dl}{dt} = -1 \ \text{m/s} \qquad Q: \left.\frac{dw}{dt}\right|_{\substack{l=10 \\ w=5}}$$



$$A = lw$$

$$\cancel{\frac{dA}{dt}}^{\,0} = \frac{dl}{dt} \cdot w + l \cdot \frac{dw}{dt}$$

$$\frac{dl}{dt} \cdot w = -\, l \cdot \frac{dw}{dt}$$

$$\frac{dw}{dt} = \frac{dl}{dt} \cdot \frac{w}{(-l)} = (-1) \cdot \frac{(5)}{-10} = \frac{1}{2} \text{ m/s}$$

Ans! width is increasing at a rate of $\frac{1}{2}$ m/s

$$f(3^-) = f(3^+) \qquad f'(3^-) = f'(3^+)$$

$f(3^-) = f(3^+)$ $\quad$ $f'(3^-) = f'(3^+)$

Problem 13. Find the values of a and c which would make $f(x)$ continuous and differentiable at $x = 3$.

$$f(x) = \begin{cases} ax^2 - 9x + c & \text{if } x < 3 \\ 2ax^2 + a^2x - 5 & \text{if } x \geq 3 \end{cases}$$

$$f(3) = \begin{cases} 9a - 27 + c \\ 18a + 3a^2 - 5 \end{cases}$$

$$f'(x) = \begin{cases} 2ax - 9, & x < 3 \\ 4ax + a^2, & x \geqslant 3 \end{cases}$$

$$f'(3) = \begin{cases} 6a - 9 \\ 12a + a^2 \end{cases}$$

$$9a - 27 + c = 18a + 3a^2 - 5$$
$$3a^2 + 9a + 22 = c$$
$$3(9) + 9(-3) + 22 = c$$
$$c = 22$$

$$6a - 9 = 12a + a^2$$
$$a^2 + 6a + 9 = 0.$$
$$(a+3)(a+3) = 0.$$
$$a = -3$$

Ans: $a = -3$
$c = 22$

$$\frac{d}{dx}(a^2x) = a^2 \cdot \frac{d}{dx}(x) = a^2$$

$1.97 \sim 2$

Problem 14. Use linear approximation to find an approximate value for $(1.97)^6$.

$$L(x) = f(a) + f'(a)(x - a)$$

$x = 1.97$ $\quad$ 2^6 $\quad$ $6(2^5)$ $\quad$ $(1.97 - 2)$

$f(x) = x^6$

$a = 2$

$f'(x) = 6x^5$

$$L(1.97) = 64 + (192)(-0.03)$$
$$= 64 - 5.76$$
$$= 58.24 \longrightarrow (1.97)^6$$

Extreme value theorem.

Problem 15. Find the absolute maxima and the absolute minima for $f(x) = 1 + 27x - x^3$ on the interval $[0, 4]$.

CN: $x = +3$

$f'(x) = 27 - 3x^2 = 0$.

$3x^2 = 27$ or $x^2 = 9$ or $x = \pm 3$

$f(3) = 1 + 27(3) - 3^3 = 55$ ← Absolute maximum

bounds. $\begin{cases} f(0) = 1 & \leftarrow \text{Absolute minima.} \\ f(4) = 1 + 27(4) - 4^3 = 45 \end{cases}$

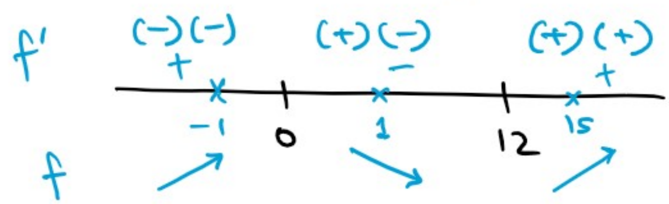
Problem 16. Find the intervals on which $f(x) = x^5 - 15x^4 + 6$ is decreasing and concave down.

$f'(x) = 0$ $f''(x) = 0$.

$\boxed{f'(x) = 5x^4 - 60x^3} = 0$

$5x^3(x - 12) = 0$

CNs: $x = 0$, $x = 12$



f(x) is decreasing on $(0, 12)$

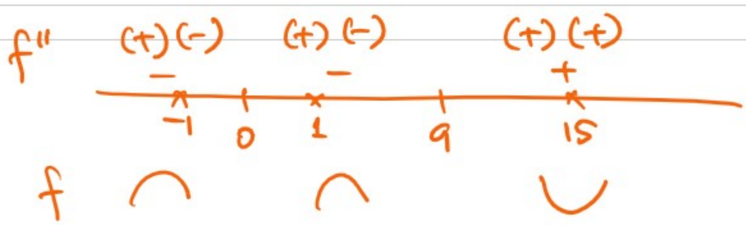
f(x) is decreasing + concave down on $(0, 9)$

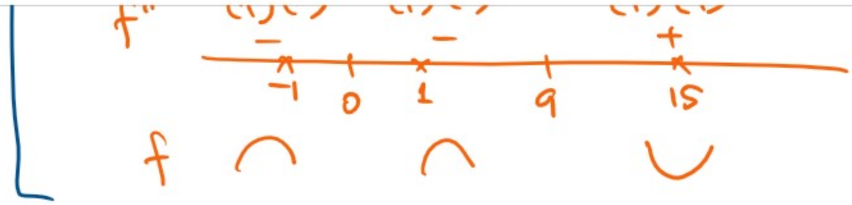
f(x) is concave down $(-\infty, 0) \cup (0, 9)$

$f''(x) = 20x^3 - 180x^2 = 0$

$20x^2(x - 9) = 0$.

IP: $x = 0, 9$





Problem 17. Find the following limits.

a) $\lim_{x\to 0} \dfrac{\sin x - x}{x^3} \sim \dfrac{0-0}{0} \sim \dfrac{0}{0}$

$$\xrightarrow{L'H} \frac{\cos x - 1}{3x^2} \sim \frac{1-1}{0} \xrightarrow{L'H} \frac{-\sin x}{6x} \sim \frac{0}{0} \xrightarrow{L'H} -\frac{\cos x}{6}$$

Ans. $\lim_{x\to 0} \Rightarrow -\dfrac{1}{6}$

b) $\lim_{x\to 0^+} x \ln x \sim 0(-\infty)$

$$\lim_{x\to 0^+} \frac{\ln x}{\left(\frac{1}{x}\right)} \sim -\frac{\infty}{\infty} \xrightarrow{L'H} \frac{\left(\frac{1}{x}\right)}{\left(-\frac{1}{x^2}\right)} = -\frac{x^2}{x} = -x$$

$\lim_{x\to 0^+} \Rightarrow 0$ Ans.

c) $\lim_{x\to 1} \left(\dfrac{1}{\ln x} - \dfrac{1}{x-1}\right) \sim \dfrac{1}{0} - \dfrac{1}{(1-1)} \sim \infty - \infty$

$$\lim_{x\to 1} \frac{x-1-\ln x}{(\ln x)(x-1)} \sim \frac{0}{0} \xrightarrow{L'H} \frac{\frac{x}{x}\left(1 - \frac{1}{x}\right)}{\frac{1}{x}(x-1) + \ln x \cdot \frac{x}{x}} = \frac{(x-1)/x}{(x-1+x\ln x)/x} \sim \frac{0}{0}$$

$$\xrightarrow{L'H} \frac{1}{1 + x\cdot\frac{1}{x} + \ln x} = \lim_{x\to 1} \frac{1}{2 + \cancel{\ln x}^{\,0}} = \frac{1}{2}$$ Ans.

$y =$ d) $\lim_{x\to\infty} x^{3/x}$

$\hookrightarrow \infty^0 \leftarrow$ use logs!

$$\ln y = \ln\left(\lim_{x\to\infty} x^{3/x}\right) = \lim_{x\to\infty}\left(\frac{3}{x}\cdot \ln x\right) \sim \frac{\infty}{\infty}$$

$$\frac{3\ln x}{x} \xrightarrow{L'H} \frac{3\left(\frac{1}{x}\right)}{1} = \lim_{x\to\infty} \frac{3}{x} = 0$$

$\ln y = 0 \Rightarrow y = e^0 = 1$ Ans.

Problem 18. Approximate the area under the curve $f(x) = x^2 + 1$ on the interval $[1, 7]$ using 3 rectangles of equal width and the left endpoints of each rectangle.

$n = 3$

width $\Delta x = \frac{b-a}{n} = \frac{7-1}{3} = 2$

1 3 5 7

$A = (\Delta x)(ht)$

$ht \to f(x_i)$

ht: $f(1) = 2$ $f(3) = 10$ $f(5) = 26$

$A = (2 \times 2) + (10 \times 2) + (26 \times 2)$

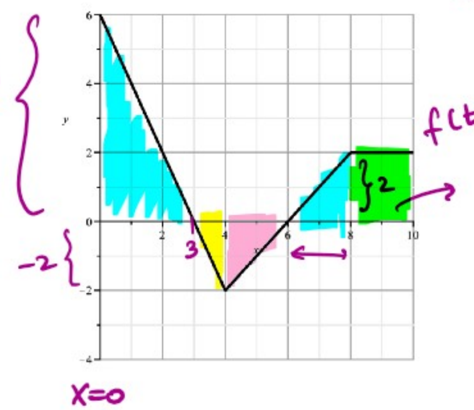
$= 4 + 20 + 52 = 76$ Ans.

net area

Problem 19. If $g(x) = \int_0^x f(t)\,dt$, where the graph of $f(t)$ is given below for $0 \le x \le 10$, evaluate $g(4)$ and $g(10)$. Where is $g(x)$ decreasing?

$[0, 10]$

$3 \le x \le 6$



$g(4) = \frac{1}{2}(3)(6) + \frac{1}{2}(1)(-2)$

$= 9 - 1$

$= 8$ Ans.

$g(10) = 9 - 1 + \frac{1}{2}(2)(-2) + \frac{1}{2}(2)(2) + (2)(2)$

$= 9 - 1 - 2 + 2 + 4$

$= 12$ Ans

FTC part 1.

$g'(x) = f(UB) \cdot \frac{d}{dx}(UB)$

Problem 20. Find $g'(x)$ if $g(x) = \int_{x^2}^{\sin x} \frac{\cos t}{t}\, dt$.

$f(t) = \frac{\cos(t)}{t}$

$$g'(x) = \frac{\cos(\sin x)}{\sin(x)} \cdot \frac{d}{dx}(\sin x) - \frac{\cos(x^2)}{x^2} \cdot \frac{d}{dx}(x^2)$$

$$g'(x) = \frac{\cos(x) \cdot \cos(\sin x)}{\sin(x)} - \frac{2\cancel{x} \cdot \cos(x^2)}{x^{\cancel{2}}}$$

Problem 21. Evaluate the following integrals:

a) $\int \frac{1 - \sqrt{x} + x}{x}\, dx$ $= \int \left(\frac{1}{x} + \frac{\sqrt{\cancel{x}}}{\cancel{x}}^{\,x^{-1/2}} + \frac{\cancel{x}}{\cancel{x}} \right) dx$

$= \ln|x| + 2x^{1/2} + x + C$

b) $\int \left(2x^3 - 6x + \frac{3}{x^2+1} \right) dx$

$= \frac{\cancel{2}x^4}{\cancel{4}_{2}} - \cancel{6}^{3}\frac{x^2}{\cancel{2}} + 3\arctan(x) + C$

Definite Integral no C reqd.

c) $\int_0^\pi \left(5e^x + \sin(2x)\right)\,dx$ $= \int_0^\pi 5e^x\,dx + \int_0^\pi \sin(2x)\,dx \rightarrow \int \sin(u)\,\frac{du}{2} \rightarrow \frac{-\cos(u)}{2}$

$5e^x \Big|_0^\pi$

$= 5(e^\pi - e^0)$

$= 5e^\pi - 5$

Ans: $5e^\pi - 5$

$u = 2x$

$\frac{du}{2} = \frac{2dx}{2}$

$-\frac{\cos(2x)}{2}\Big|_0^\pi$

$-\frac{1}{2}\underbrace{\left[\cancel{\cos}^{1}(2\pi) - \cancel{\cos}^{1}(0)\right]}_{0}$

d) $\int x^3\sqrt{1+x^2}\,dx$

$u = 1 + x^2$

$x^2 = u - 1$

$du = 2x\,dx$

$dx = \frac{du}{2x}$

$\int \cancel{x^3}^{x^2}\sqrt{u}\cdot\frac{du}{2\cancel{x}}$

$\frac{1}{2}\int (u-1)\sqrt{u}\cdot du = \frac{1}{2}\int (u\sqrt{u} - \sqrt{u})\,du$

$= \frac{1}{2}\left[\frac{u^{5/2}}{5/2} - \frac{u^{3/2}}{3/2}\right] + c$

$= \frac{u^{5/2}}{5} - \frac{u^{3/2}}{3} + C$

Ans.

$= \boxed{\frac{(1+x^2)^{5/2}}{5} - \frac{(1+x^2)^{3/2}}{3} + C}$

Definite

e) $\int_1^e \frac{\ln x}{x}\,dx$ $= \int_1^e \ln x \cdot \frac{1}{x}\cdot dx$

$u = \ln x$

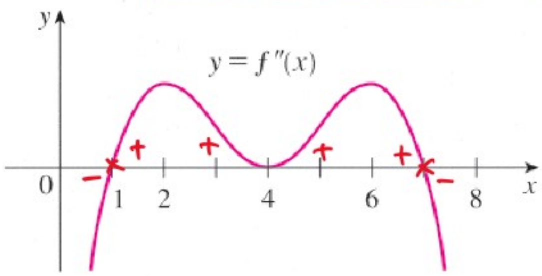
$du = \frac{1}{x}\,dx$

$= \int u\,du = \frac{u^2}{2}$

$= \frac{(\ln x)^2}{2}\Big|_{x=1}^{x=e} = \frac{1}{2}(\cancel{\ln e}^{1})^2 - \frac{1}{2}(\cancel{\ln(1)}^{0})^2 = \frac{1}{2}$ Ans.

→ tells us about concavity only.

Problem 22. The graph of the second derivative $f''(x)$ of a function $f(x)$ is shown.



a) On what intervals is f concave up?

$(1,4) \cup (4,7)$

b) On what intervals is f concave down?

$(-\infty,1) \cup (7,\infty)$

c) What are the inflection points of f?

$x = 1, 7$ only NOT $x=4$

d) Where does f have a local maxima? A local minima?

Dont have enough information to say anything about $f(x)$ maxima or minima from $f''(x)$!