section 4.4 pg 245 # 1, 3, 5, 11, 15, 19, 21, 23

① $f(x) = x^2 - 4x + 5$

$f'(x) = 2x - 4$

$2x - 4 = 0$

$x = 2$

$-$ $+$ at 2

minimum when $x = 2$.
global

③ $f(x) = x^3 - 3x^2 + 5$

$f'(x) = 3x^2 - 6x$

$3x^2 - 6x = 0$

$3x(x-2) = 0$

$x = 0, x = 2$

$+$ $-$ $+$ at 0, 2

local maximum when $x = 0$

local minimum when $x = 2$

⑤ $f(x) = x^3 - 3x^2 + 3x + 5$

$f'(x) = 3x^2 - 6x + 3$

$3x^2 - 6x + 3 = 0$

$3(x^2 - 2x + 1) = 0$

$3(x-1)^2 = 0$

$x = 1$

$+$ $+$ at 1

always increasing, so
when $x = 1$ it is neither
a minimum nor a maximum

⑪ $f(x) = x + \frac{9}{x}$

$f'(x) = 1 - \frac{9}{x^2}$

$1 - \frac{9}{x^2} = 0$

$1 = \frac{9}{x^2}$

$x^2 = 9$

$x = \pm 3$

$+$ $-$ $-$ $+$ at -3, 3

0 undefined

when $x = 3$, local minimum

when $x = -3$, local maximum

(15) $f(x) = (x+4)^2 e^{-x/5}$

$f'(x) = 2(x+4)e^{-x/5} - \dfrac{(x+4)^2 e^{-x/5}}{5}$

$2(x+4)e^{-x/5} - \frac{1}{5}(x+4)^2 e^{-x/5} = 0$

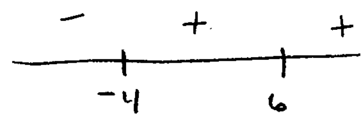
$e^{-x/5}(x+4)\left[2 - \frac{1}{5}(x+4)\right] = 0$

$(x+4)\left[2 - \frac{1}{5}x - \frac{4}{5}\right] = 0$

$x+4=0$ $\quad$ $\frac{6}{5} - \frac{1}{5}x = 0$

$x=-4$ $\quad$ $\frac{6}{5} = \frac{1}{5}x$

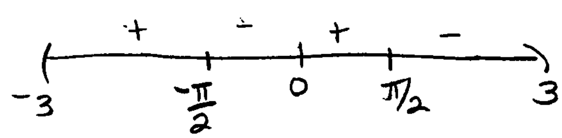
$6 = x$



$x=-4$ global minimum

$x=6$, neither min nor max

(19) $f(x) = \sin^3 x \quad (-3,3)$



$f'(x) = 3\sin^2 x \cos x$

$f'(x) = 0$ when

$\sin x = 0$ or $\cos x = 0$

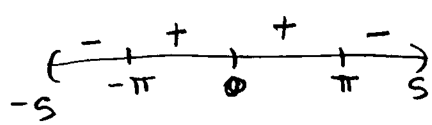
between -3 & 3, happens when $x=0$, $x=\pi/2$, $x=-\pi/2$

$x=-\pi/2$ local maximum

$x=0$ local minimum

$x=\pi/2$ local maximum

(21) $f(x) = \sin x - x\cos x \quad (-5,5)$



$f'(x) = \cos x - [\cos x - x\sin x]$

$= x\sin x$

$x\sin x = 0$

when $x = -\pi, 0, \pi$

in the interval $(-5,5)$

local minimum at $x=-\pi$

local maximum at $x=\pi$

$x=0$ is neither

(23) $f(x) = \dfrac{\ln x}{x^3}$ $(0,5)$

$f'(x) = \dfrac{1}{x} \cdot \dfrac{1}{x^3} - \dfrac{3}{x^4} \ln x$

$\dfrac{1}{x^4} - \dfrac{3}{x^4} \ln x = 0$

$\dfrac{1}{x^4}(1 - 3\ln x) = 0$

$1 - 3\ln x = 0$

$1 = 3\ln x$

$\ln x = 1/3$

$x \approx 1,4$

$+ \quad -$

$0 \quad 1,4 \quad 5$

$x = 1.4$ global maximum