Q1) $$\int_{1/50}^{2} \frac{e^{2/w}}{w^2}\,dw$$

let $t = e^{2/w}$

diff wrt $w$

$$\frac{dt}{dx} = -2e^{2/w}\frac{1}{w^2}$$

$$= \int_{1/50}^{2} \frac{t\,w^2\,dt}{-2w^2 e^{2/w}}$$

$$\frac{-1}{2}\int_{1/50}^{2} dt = \frac{-1}{2}\left[x\right]_{1/50}^{2}$$

$$= \frac{-1}{2}\left(2 - 0.02\right)$$

$$= \boxed{-0.99}$$

Q2) $$\int \frac{2t^3+1}{(t^4+2t)^3}\,dt$$

let $x = (t^4+2t)^3$

diff wrt $t$

$$\frac{dx}{dt} = 3(t^4+2t)^2(4t^3+2)$$

$$\int \frac{2t^3+1\;dx}{x(3)(t^4+2t)^2(4t^3+2)}$$

Multiply and divide by 2

$$\int \frac{4t^3+2\;dx}{(x)(6)(4t^3+2)(x)^{2/3}}$$

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$= \frac{1}{6} \int \frac{x^{-5/3} dx}{}$

$= \frac{1}{6} \left(\frac{-5}{3}\right) \frac{x^{-5/3+1}}{-5/3+1} + C = \frac{3}{6_2(-2)} x^{-2/3} + C$

$= \boxed{\frac{-1}{4} (t^4+2t)^{3(-2/3)} + C}$ $\quad = \frac{-1}{4} x^{-2/3} + C$

Q3) $f'(x) = x^4 + 3x - 9 \qquad f(x) = \int f'(x)\,dx$

$f(x) = \int (x^4 + 3x - 9)\,dx$

$= \frac{x^5}{5} + \frac{3x^2}{2} - 9x + C$

Q4) $f(x) = \begin{cases} 6 & \text{if } x > 1 \\ 3x^2 & \text{if } x \le 1 \end{cases}$

$\int_{-2}^{3} f(x)\,dx = \int_{-2}^{1} f(x)\,dx + \int_{1}^{3} f(x)\,dx$

$\int_{-2}^{1} 3x^2\,dx + \int_{1}^{3} 6\,dx$

$[x^3]_{-2}^{1} + [6x]_{1}^{3}$

$1+8 + 18-6 = 21$

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Q5) $\int 3(8y-1)\, e^{4y^2-y}\, dy$

$x = e^{4y^2-y}$

diff wrt

$\frac{dx}{dy} = (e^{4y^2-y})(8y-1)$

$\int \frac{3(8y-1)e^{4y^2-y}}{(e^{4y^2-y})(8y-1)}\, dx$

$3x + C$

$\boxed{3(e^{4y^2-y}) + C}$

Q6) $f''(x) = 15\sqrt{x} + 5x^3 + 6$

$f'(x) = \int 15\sqrt{x} + 5x^3 + 6\, dx$

$= \frac{15x^{3/2}}{3/2} + \frac{5x^4}{4} + 6x + k$

$f(x) = \int \frac{15x^{3/2}}{3/2} + \frac{5x^4}{4} + 6x + k\, dx$

$3/2 \times 5/2$

$f(x) = 4x^{5/2} + \frac{x^4}{4} + 3x^2 + kx + C$

$f(1) = -5/4 = 4 + \frac{1}{4} + 3 + k + C$

$k + C = -8.5$

$f(4) = 404 = 4(4)^{5/2} + \frac{(4)^4}{4} + 3(4)^2 + 4k + C$

$4k + C = 164$

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$$4k + c = 104$$
$$-12 + c = -8.5$$
$$3k = 172.5$$
$$k = 57.5$$
$$c = -66$$

$$\therefore f(x) = 4x^{5/2} + \frac{x^4}{4} + 3x^2 + 57.5x - 66$$

Q9)
$$\frac{dv}{dt} = 9.8 - 0.196v$$

$$\int \frac{dv}{9.8 - 0.196v} = \int dt$$

$$\log\left(\frac{9.8 - 0.196v}{\cancel{c}}\right) = -0.196t + c$$

Q12) Talor series for $f(x) = x^3 - 10x^2 + 6$ $\quad \underline{x=3}$

$f(x) = x^3 - 10x^2 + 6$ $\quad f(3) = -57$

$f'(x) = 3x^2 - 20x$ $\quad f'(3) = -33$

$f''(x) = 6x - 20$ $\quad f''(3) = -2$

$f'''(x) = 6$ $\quad f'''(3) = 6$

$$f(x) = f(3) + (x-3)f'(x) + \frac{(x-3)^2}{\lfloor 2} f''(3) + \frac{(x-3)^3}{\lfloor 3} f'''(3) \ldots$$

$$x^3 - 10x^2 + 6 = -57 + (x-3)-33 + \frac{(x-3)^2}{2}(-2) + \frac{6(x-3)^3}{\lfloor 3} \ldots$$

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Q13) Maclaurian series for $(1+x)^{n}$

$f'(x) = n(x+1)^{n-1}$ $\quad f'(x) = n(1+x)^{n-1}$

$f''(x) = (n)(n-1)$ $\quad f''(x) = (n)(n-1)(1+x)^{n-2}$

$f'''(x) = (n)(n-1)(n-2)(1+x)^{n-3}$

$$f(x) = f(0) + \frac{x^1}{\lfloor 1} f'(0) + \frac{x^2}{\lfloor 2} f''(0) + \frac{x^3}{\lfloor 3} f'''(0) -$$

$$(1+x)^{n} = 1 + n + (n-1)(n) + (n)(n-1)(n-2) \cdots$$

Q14) $f(x) = \sqrt{1+x}$

$f'(x) = \frac{1}{2}(1+x)^{-1/2}$ $\quad f'(0) = 1/2$

$f''(x) = \frac{-1}{4}(1+x)^{-3/2}$ $\quad f''(0) = -1/4$

$f'''(x) = \frac{-3}{8}(1+x)^{-5/2}$ $\quad f'''(0) = -3/8$

$$\sqrt{1+x} = \sqrt{1+x} + \frac{x^1}{\lfloor 1}\left(\frac{1}{2}\right) + \frac{x^2}{\lfloor 2}\left(\frac{-1}{4}\right) + \frac{x^3}{\lfloor 3}\left(\frac{-3}{8}\right) \cdots$$

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Taylor series

Q15) $f(x) = e^{-6x}$ $\quad x = -4$

$f(x) = e^{-6x}$ $\quad f(-4) = e^{+24}$

$f'(x) = e^{-6x}(-6)$ $\quad f'(4) = e^{24}(6)^1$

$f''(x) = (-6)e^{-6x}(-6)$ $\quad f''(-4) = e^{24}(6)^2$

$f'''(x) = (-6)^3 e^{-6x}$ $\quad f'''(-4) = e^{24}(6)^3$

$$e^{-6x} = e^{+24} + \frac{(x-4)(e^{24})(6)}{\lfloor 1} + \frac{(x-4)^2(e^{24})(6)^2}{\lfloor 2} + \frac{(x-4)^3(e^{24})(6)^3}{\lfloor 3} \ldots$$

Q16) $f(x) = \ln(3+4x)$ $\quad x = 0$ $\quad \ln(3)$

$f'(x) = \frac{4}{3+4x}$ $\quad f'(0) = 4/3$

$f''(x) = (-4)(4x+3)^{-2}(4)$ $\quad f''(0) = (-1)(4)^2(3)^{-2}$

$f'''(x) = (+8)(4x+3)^{-3}(4)^2$ $\quad f'''(0) = (-1)(-2)(3)^{-2}(4)^3$

$$\ln(3+4x) = \ln(3) + \frac{x}{\lfloor 1}\,4/3 + \frac{x^2}{\lfloor 2}(-1)(4)^2(3)^{-2} + \frac{x^3}{\lfloor 3}(4)^3(2)(3)^{-2} \ldots$$