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Calculus
Assignment 2

Q1 $\int_{1/30}^{2} \frac{e^{2/\omega}}{\omega^2} \, d\omega$

wt $t = e^{2/10}$

differentiating w.r.t. ω

$\frac{dt}{dx} = -2e^{2/\omega} \frac{a}{\omega}$

$= \int_{1/30}^{2} \frac{t\omega^2 \, dt}{-2\omega^2 e^{2/\omega}}$

$\frac{-1}{2} \int_{1/5}^{2} dt$

$-\frac{1}{2} (x)^{2}_{1/50}$

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

$= -0.99$

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Q2 $\int \frac{2t^3+1}{(t^4+2t)^5}\,dt$

let $x = (t^4+2t)^5$

diff w.r.t t

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

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

$= \frac{1}{6}\int \frac{x^8\,dx}{9'}$

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

Q3 $f'(x) = x^4+3x-9$

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

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

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

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

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

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

$$1 \cancel{+} 8 + 18 - 6 = 4$$

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

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

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

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

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$3x + C$

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

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

$f'(x) = \int 15\sqrt{x} + 5x^2 + 6\,dx$

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

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

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

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

$k + C = -8 - 5$

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

$4k + C = 164$

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

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

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

$\log(9.8 - 0.196v)$

$= 0.196t + C$

Q12 Taylor series for $f(x) = x^3 - 10x^2 + 6$

$f(x) = x^3 - 10x^2 + 6$
$f'(x) = 3x^2 - 20x$
$f''(x) = 6x - 20$
$f'''(x) = 6$

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

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

Q13 Maclaurin series

$f(x) = (1+x)^{u}$

$f'(x) = u(1+x)^{u-1}$

$f''(x) = (u)(u-1)(1-x)^{u-2}$

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

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

$(1+x)^{u} = 1 + u + (u-1)(u) + (u)(u-1)(u-2)$

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

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

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

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

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