$\boxed{\text{EXE 9.3}}$

For each of the diff. eq in EXE 1 to 10 find The general solution:

(1) $\frac{dy}{dx} = \frac{1-\cos x}{1+\cos x} \Rightarrow dy = \left(\frac{1-\cos x}{1+\cos x}\right) dx$

$dy = \frac{1-\cos x}{1+\cos x} \cdot \frac{1-\cos x}{1-\cos x} \, dx$

$dy = \frac{1-2\cos x+\cos^2 x}{1-\cos^2 x} \, dx$ $\boxed{1-\cos^2 x = \sin^2 x}$

$dy = \frac{1 - 2\cos x + \cos^2 x}{\sin^2 x} \, dx$

$dy = \frac{\sin^2 x - 2\cos x}{\sin^2 x} \, dx$

$dy = \left(1 - 2\frac{\cos x}{\sin x} \cdot \frac{1}{\sin x}\right) dx$

$dy = (1 - 2\cot x \csc x) \, dx$ integrating both side we get

$\int dy = \int dx - 2\int \cot x \csc x \, dx$

$\boxed{\text{P.1}}$

$y = x^2 - 2(-\csc x) + c$

$\Rightarrow x^2 + 2\csc x - y + c$

is general solution for given diff. eq

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② $\frac{dy}{dx} = \sqrt{4-y^2} \Rightarrow dy = \sqrt{4-y^2}\, dx$

$\Rightarrow \frac{1}{\sqrt{4-y^2}}\, dy = dx \Rightarrow \cancel{(4-y^2)^{-\frac{1}{2}} dy = dx}$

$\Rightarrow \int \frac{1}{\sqrt{2^2-y^2}}\, dy = \int dx$

$$\boxed{\int \frac{dy}{\sqrt{a^2+y^2}} = \sinh^{-1}\left(\frac{y}{a}\right)+C}$$

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

$\Rightarrow x - \sinh^{-1}\left(\frac{y}{2}\right) + C$
is general solution for given diff. eq.

3. $\frac{dy}{dx} + y = 1 \quad (y \neq 1)$

$\Rightarrow \frac{dy}{dx} = 1-y \Rightarrow dy = (1-y)\, dx$

$\left[\frac{dy}{(1-y)} = dx\right]$ integrating both sides

$-1\int \frac{dy}{(1-y} (-1) = \int dx$

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$-\ln(1-y) = x + C$

$\Rightarrow x + \ln(1-y) + C.$
is general solution for given diff. eq.

[ExE : 9.3]

④. $[\sec^2 x \tan y \, dx + \sec^2 y \tan x \, dy = 0]$

divided both sides on

$\tan x . \tan y$

we get

$$\frac{\sec^2 x}{\tan x} dx + \frac{\sec^2 y}{\tan y} dy = 0$$

integral both sides

$\sec^2$. المشتقة

المشتقة

$$\int \frac{\sec^2 x}{\tan x} dx + \int \frac{\sec^2 y}{\tan y} dy = 0$$

$$\ln \tan x + \tan y + c$$

is general solution of given diff. eq.

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⑤ $e^x + e^{-x} dy - (e^x - e^{-x}) dx = 0$

$$(e^x + e^{-x}) dy = (e^x - e^{-x}) dx$$

divided both side

on $e^x + e^{-x}$

$$dy = \left(\frac{e^x - e^{-x}}{e^x + e^{-x}}\right) dx$$

P-3

$$\because \boxed{\tanh x = \frac{e^x - e^{-r}}{e^x + e^{-x}}}$$

$\Rightarrow dy = \tanh x \, dx$ integral both side

$$\int dy = \int \tanh x \, dx$$

$$\boxed{\int \tanh x \, dx = \operatorname{sech}^2 x}$$

$$y = \operatorname{sech}^2 x + c$$

$\sec^2 h - y + c$

is general solution of given diff. eq

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EXE 9.3

(6) $\frac{dy}{dx} = (1+x^2)(1+y^2)$

$\left[dy = (1+x^2)(1+y^2)\,dx\right] \div (1+y^2)$

$\frac{dy}{1+y^2} = (1+x^2)\,dx$ integral both side

$\int \frac{dy}{1+y^2} = \int (dx) + \int x^2\,dx$

$\boxed{\int \frac{dy}{1+y^2} = \tan^{-1}y + c}$

$\tan^{-1}y = x + \frac{x^3}{3} + c$

$\frac{x^3}{3} + x - \tan^{-1}y + c$

is general solution for given diff. eq.

(7) $\left[y\log y\,dx - x\,dy = 0\right] \div (y\log y)(x)$

$\int \frac{dx}{x} - \int \frac{dy}{y\log y} \Rightarrow \ln x - \ln(\ln y) + c$

(8) $x^5\frac{dy}{dx} = -y^5$

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$\left[x^5 dy = -y^5\,dx\right] - x^5y^5$

P.4

$-\frac{dy}{y^5} = \frac{dx}{x^5}$

$-\int y^{-5}\,dy = \int x^{-5}\,dx$

$\Rightarrow -\left(\frac{-y^{-4}}{4}\right) = -\frac{x^{-4}}{4} + c$

$\frac{1}{4y^4} + \frac{x^4}{4} + c$

$\boxed{EXE\ 9.3}$

9. $\frac{dy}{dx} = \sin^{-1} x$

$dy = \sin^{-1} x \, dx$ integral both side

$\int dy = \int \sin^{-1} x \, dx$

$y = \frac{1}{\sqrt{1-x^2}} + c$

$\Rightarrow \frac{1}{\sqrt{1-x^2}} - y + c$

$\boxed{\int \sin^{-1} x = \frac{1}{\sqrt{1-x^2}} + c}$

10. $e^x \tan y \, dx + (1-e^x) \sec^2 y \, dy = 0$

divided by $(\tan y \, (1-e^x))$

$\frac{e^x}{1-e^x} dx + \frac{\sec^2 y}{\tan y} dy = 0$

integral both side

$\frac{1}{-1} \int \frac{e^x * (-1)}{1-e^x} dx + \int \frac{\sec^2 y}{\tan y} dy$

$-\ln(1-e^x) + \ln \tan y + c$

$\boxed{P.5}$

EXE 9.4

In each of The Ext 1 – 10, show that the given diff eq is homogenous and solve each of Them.

1. $(x^2+xy)\,dy = (x^2+y^2)\,dx$

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$$\frac{dy}{dx} = \frac{x^2+xy}{x^2+y^2}$$

$$\frac{\cancel{x^2}(1+\frac{y}{x})}{\cancel{x^2}(1+\frac{y^2}{x^2})} = \frac{1+\frac{y}{x}}{1+(\frac{y}{x})^2} \quad \text{—(1)}$$

It is a diff. eq of The form $\frac{dy}{dx} = F(x,y)$

Here $F(x,y) = \dfrac{1+\frac{y}{x}}{1+(\frac{y}{x})^2}$ — (*)

Replacing x by λx and y by λy, we get

$$F(\lambda x, \lambda y) = \frac{1+\frac{\cancel{\lambda} y}{\cancel{\lambda} x}}{1+\frac{\cancel{\lambda^2} y^2}{\cancel{\lambda^2} x^2}} = \lambda^0\left[F(x,y)\right]$$

Thus $F(\lambda x, \lambda y)$ is homogenous function of degree Zero.

To solve it we make the substitution

$$y = vx \quad \text{—(2)}$$

$$v = \frac{y}{x} \quad \text{—(3)}$$

Differentiating eq (2) with respect to x

$$\frac{dy}{dx} = v + x\frac{dv}{dx} \quad \text{—(4)}$$

substituting values of eq (2) ~~and~~ eq (3) and eq.(4) in eq(1) we get

$$v + x\frac{dv}{dx} = \frac{1+v}{1+v^2}$$

$$x\frac{dv}{dx} = \frac{1+v}{1+v^2} - v$$

$$x\frac{dv}{dx} = \frac{1+\cancel{v^2}-v-\cancel{v^2}}{1+v}$$

$$x\frac{dv}{dx} = \frac{1-v}{1+v}$$

$$x(1+v)\,dv = (1-v)\,d\cancel{x}$$

$$\int \frac{(1+v)}{(1-v)}\,dv = \int \frac{dx}{x}$$

$$\int \frac{(1+v)}{(1-v)}\cdot\frac{(1-v)}{(1-v)}\,dv = \int \frac{dx}{x}$$

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$$\int \left(\frac{1-v-v-v^2}{1-v^2}\right)dv = \ln x + c$$

$$\int \left(\frac{1-2v-v^2}{1-v^2}\right)dv = \ln x + c$$

$$\int \frac{-2v}{1-v^2} + 1\,dv = \ln x + c$$

الشق متوزع

P.7

$$\log(1-v^2) + v = \log x + c$$

$$\log x - \log(1-v^2) = v + c \quad \ldots \ (5)$$

replacing v by $\frac{y}{x}$ in eq (5) we get

$$\log x - \log\left(1-\frac{y^2}{x^2}\right) - \frac{y}{x} + c$$

$$\log x - \log\left(\frac{x^2-y^2}{x^2}\right) - \frac{y}{x} + c$$

$$\log\left(x/(x^2-y^2)/x^2\right) - y/x + c \Rightarrow \log\left(\frac{x^3}{x^2-y^2}\right) - \frac{y}{x} + c$$

EXE : 9.4

(2) $\dfrac{dy}{dx} = \dfrac{x+y}{x}$ —(*)

نفس الخطوات الاولى للتمرين (١) خ: (P.6) لاختبار التجانس homogenous function
ويجب اختبارها وكتابة الخطوات اولا"
سوف نبدأ هنا من الخطوة الثانية وهي الفرضية (الخطوات الاولى على الطالب)

$$\frac{dy}{dx} = \frac{\cancel{x}(1+\frac{y}{x})}{\cancel{x}} = \frac{dy}{dx} = 1+\frac{y}{x} \quad \text{—(1)}$$

to solve it we make the substitution

$$y = vx \quad \text{— (2)}$$

$$v = \frac{y}{x} \quad \text{—(3)}$$

differentiating eq (2) with respect to y

$$\frac{dy}{dx} = v + x\frac{dv}{dx} \quad \text{—(4)}$$

substituting values of eq (2), eq (3) and eq (4) in eq (1) we
we get

$$v + x\frac{dv}{dx} = 1+v$$

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$$x\frac{dv}{dx} = 1+v-v \Rightarrow x\frac{dv}{dx} = 1$$

$$\Rightarrow [x\, dv = dx] \div x$$

$$\Rightarrow dv = \frac{dx}{x}$$ integrating both side

$$\int dv = \int \frac{dx}{x} \Rightarrow$$

$\boxed{P.8}$

$$v = \log x + c \Rightarrow \log x = v + c$$

replacing v by $\frac{y}{x}$ we get

$$\log x = \frac{y}{x} + c$$

is general solution for give the diff. eq.

④ $(x^2-y^2)\,dx + 2xy\,dy = 0$

$$\frac{dy}{dx} = \frac{x^2-y^2}{2xy}$$

(ثم نختبر انها متجانسة ، يترك للطالب علما هو كخطوة اولى)

$$\frac{dy}{dx} \quad \cancel{\frac{x^2(1-\frac{y^2}{x^2})}{2x(\frac{y}{x^2})}} \quad \frac{\frac{x^2}{x^2}-\frac{y^2}{x^2}}{\frac{2xy}{x^2}} =$$

$$\frac{dy}{dx} = \frac{1-(\frac{y}{x})^2}{2\frac{y}{x}} \quad — (1)$$

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To solve it we make

$$\cancel{v = yx} \quad y = vx \quad — (2)$$

$$v = \frac{y}{x} \quad — (3)$$

differential eq (2) with respect to x

$$\frac{dy}{dx} = v + x\frac{dv}{dx} \quad — (4)$$

Substituting values of eq (2), eq (3) and eq (4) in eq (1), we get

$$v + x\frac{dv}{dx} = \frac{1-v^2}{2v}$$

$$x\frac{dv}{dx} = \frac{1-v^2}{2v} - v \Rightarrow x\frac{dv}{dx} = \frac{1-v^2-2v^2}{2v}$$

$$\left[x\,dv = \frac{3v^2}{2v}\,dx\right] \div (x)\left(\frac{1-3v^2}{2v}\right)$$

P.9

$$-\frac{1}{3}\int \frac{2v \cdot -3}{1-3v^2}\,dv = \int \frac{1}{x}\,dx$$

$$-\frac{1}{3}\log(1-3v^2) = \log x + c$$

$\log x + \log (1-3v^2)^{\frac{1}{3}} + C$

$\log (x \cdot \sqrt[3]{1-3v^2} + C$

replacing $v = \frac{y}{x}$ we get

$\log (x \sqrt[3]{1-3(\frac{y}{x})^2} + C$

6 $x\,dy - y\,dx = \sqrt{x^2+y^2}\,dx$

الخطوات الاولى لاختبار تجانس والم تترك للطالب

$x\,dy = (\sqrt{x^2+y^2} - y)\,dx$

$$\frac{dy}{dx} = \frac{\sqrt{x^2+y^2} - y}{x}$$

R.10

تقسم البسط والمقام على x وداخل الجذر على x^2 لان $x = \sqrt{x^2}$

$$\frac{dy}{dx} = \frac{\sqrt{\frac{x^2}{x^2} + \frac{y^2}{x^2}} - \frac{y}{x}}{\frac{\cancel{x}}{\cancel{x}}_{1}} \Rightarrow \frac{dy}{dx} = \sqrt{1+\frac{y^2}{x^2}} - \frac{y}{x} \quad \text{—} \ 1$$

To ~~make~~ solve, it we make

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$$y = vx \quad \text{—} \ 2$$

$$v = \frac{y}{x} \quad \text{—} \ 3$$

differential both side for eq 2 we get

$$\frac{dy}{dx} = v + x\frac{dv}{dx} \quad \text{—} \ 4$$

Substitution values ~~for~~ of eq (2), eq (3) and eq (4) in eq (2), we get

$$v + x\frac{dv}{dx} = \sqrt{1+v^2} - v$$

$$x\frac{dv}{dx} = \sqrt{1+v^2} \cancel{-v} \cancel{+v}$$

$$\left[x\,dv = (\sqrt{1+v^2})\,dx \right] \div x\sqrt{1+v^2}$$

$$\frac{d}{\sqrt{1+v^2}} = \frac{dx}{x}$$ integration for both side

$$\int \frac{d}{\sqrt{1+v^2}} = \int \frac{dx}{x}$$

$$\boxed{\int \frac{dx}{\sqrt{1-x^2}} = \sin^{-1}x + c}$$

$$\sin^{-1}v = \log x + c$$

$\Rightarrow \log x - \sin^{-1}v + c$

replacing v by $\frac{y}{x}$, we get

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$$\log x - \sin^{-1}\left(\frac{y}{x}\right) + c$$

which is general solution for given diff. eq

7) $\{x \cos\frac{y}{x} + y\sin(\frac{y}{x})\}y\,dx$

$= \{y\sin(\frac{y}{x}) - x\cos(\frac{y}{x})\}x\,dy$

Sol $xy\cos(\frac{y}{x}) + y^2\sin(\frac{y}{x})\,dx = xy\sin(\frac{y}{x}) - x^2\cos(\frac{y}{x})\,dy$

$$\frac{dy}{dx} = \frac{xy\cos(\frac{y}{x}) + y^2\sin(\frac{y}{x})}{xy\sin(\frac{y}{x}) - x^2\cos(\frac{y}{x})}$$

نقسم البسط والمقام على x^2

$$\frac{dy}{dx} = \frac{\frac{xy}{x^2}\cos\left(\frac{y}{x}\right) + \frac{y^2}{x^2}\sin\left(\frac{y}{x}\right)}{\frac{xy}{x^2}\sin\left(\frac{y}{x}\right) - \frac{x^2}{x^2}\cos\left(\frac{y}{x}\right)}$$

$$\frac{dy}{dx} = \frac{\frac{y}{x}\cos\frac{y}{x} + \left(\frac{y}{x}\right)^2\sin\left(\frac{y}{x}\right)}{\frac{y}{x}\sin\left(\frac{y}{x}\right) - \cos\left(\frac{y}{x}\right)} \quad -(1)$$

يترك اختبار هل ان الدالة متجانسة (homogenous funct) الى الطالب.

To solve, it make $y = vx \quad -(2)$

$v = \frac{y}{x} \quad -(3)$

differential both side of eq (2) we get

$$\frac{dy}{dx} = v + x\frac{dv}{dx} \quad -(4)$$

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substitution values of eq (2), eq (3) and eq (4) in eq (1), we get

$$v + x\frac{dv}{dx} = \frac{v\cos v + v^2\sin v}{v\sin v - \cos v}$$

P.12

$$x\frac{dv}{dx} = \frac{v\cos v + v^2\sin v}{v\sin v - \cos v} - v$$

$$x\frac{dv}{dx} = \frac{v\cos v + \cancel{v^2\sin v} - \cancel{v^2\sin} + v\cos v}{v\sin v - \cos v}$$

$$x\frac{dv}{dx} = \frac{2v\cos v}{v\sin v - \cos v}$$

$$\left[x\,dv = 2\frac{v\cos v}{v\sin v - \cos v}dx\right] \div x\frac{v\cos v}{v\sin v - \cos v}$$

EXE 9.4

$$\left(\frac{v\sin v - \cos v}{v\cos v}\right) dv = 2\frac{dx}{x}$$

therefor

$$\int \frac{v\sin v - \cos v}{v\cos v}\, dv = 2\int \frac{dx}{x}$$

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$$\int \left(\frac{\cancel{v}\sin v}{\cancel{v}\cos v} - \frac{1}{v}\right) dv = 2\int \frac{dx}{x}$$

$$\int \tan v \, dv - \int \frac{dv}{v} = 2\int \frac{dx}{x}$$

$$\log|\sec v| - \log v = 2\log x + \log|c_1|$$

$$\log\left|\frac{\sec v}{v}\right| = |\log x^2| + \log|c_1|$$

$$\log\left|\frac{\sec v}{v}\right| - \log|x^2| = \log|c_1|$$

$$\boxed{\log|a| - \log|b| = \log\left|\frac{a}{b}\right|}$$

$$\left[\log\left|\frac{\sec v}{v x^2}\right| = \log c_1\right] * e$$

$$\boxed{n\log a = \log a^n}$$

$$\frac{\sec v}{v x^2} = \pm c_1 \quad \text{—— (5)}$$

Replacing v by $\frac{y}{x}$ in eq (5), we get

$\boxed{P-13}$

$$\frac{\sec\frac{y}{x}}{\frac{y}{\cancel{x}}\cancel{x^2}} = c \quad , \text{where } c = \pm c_1$$

$$\Rightarrow \frac{\sec(\frac{y}{x})}{yx} = c \Rightarrow \sec\frac{y}{x} = c\,xy$$

which is general solution of the give diff. eq.

$\boxed{\text{ExE } 9.4}$

(8) $x\dfrac{dy}{dx} - y + x\sin\left(\dfrac{y}{x}\right) = 0$

$$x\frac{dy}{dx} = y - x\sin\left(\frac{y}{x}\right)$$

$$\frac{dy}{dx} = \left[\frac{y - x\sin\left(\frac{y}{x}\right)}{x}\right] \Rightarrow \frac{dy}{dx} = \frac{y}{x} - \sin\left(\frac{y}{x}\right)$$

x ÷ نقسم البسط والمقام

homogenous fun. يترك للطالب اختيار تجانس الدالة

To solve it make it

$$y = vx \quad \text{—— (2)}$$

$$v = \frac{y}{x} \quad \text{—— (3)}$$

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differential both side of eq (2) we get

$$v + x\frac{dv}{dx} \quad \text{—— (4)}$$

substitute values of eq (2), eq (3) and eq (4) in eq (1) we get

$$v + x\frac{dv}{dx} = v - \sin(v)$$

$$x\frac{dv}{dx} = v - \sin v - v$$

p.1-1

$$x\frac{dv}{dx}\cancel{x} \quad - \sin v$$

$$\left[x\,dv = -\sin v)\,dx\right] \quad \div (x)(\quad -\sin v)$$

$$-\int \frac{dv}{\sin v} = \int \frac{dx}{x}$$

dv

$$-\int \sin^{-1} v = \int \frac{dx}{x} \Rightarrow v\sin^{-1} v + \sqrt{1-v^2} = \log x + c$$

$$\Rightarrow \log x - v\sin^{-1} v = \sqrt{1-v^2} + c \quad \text{—— (5)}$$

replacin v by $\frac{y}{x}$. in eq (5) , we get

$$\log x - \frac{y}{x}\sin^{-1}\left(\frac{y}{x}\right) - \sqrt{1-\left(\frac{y}{x}\right)^2} + C$$

which is general solution for given diff. eq.

(10) $(1+e^{\frac{x}{y}})\,dx + e^{y/x}\left(1-\frac{x}{y}\right)dy = 0$

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EXE 9.5

(2) $\frac{dy}{dx} + 3y = e^{-2x}$

~~The~~ given diff. eq. is of the form

$\frac{dy}{dx} + Py = Q$, where $P = 3$ and $Q = e^{-2x}$

Therefore $I.F = e^{\int p\,dx} = e^{\int 3\,dx} = e^{3x}$

$y * I.F = \int (Q * I.F)\,dx + c$

$y\,e^{3x} = \int e^{3x} \cdot e^{-2x}\,dx + c$

$y\,e^{3x} = \int e^{x}\,dx + c$

$[y e^{3x} = e^{x} + c]\ e^{3x}$

$y = e^{-2x} + e^{-3x} c_1$

$y = e^{-2x} + c$, where $c = e^{-3x} c_1$

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p.16

(3) $\frac{dy}{dx} + \frac{y}{x} = x^2$

Given diff. eq is of the form

$\frac{dy}{dx} + Py = Q$, where $P = \frac{1}{x}$, $Q = x^2$

$I.F = e^{\int p\,dx} = e^{\int \frac{1}{x}\,dx} = e^{\ln x} = x$

$y \cdot I.F = \int (Q * I.F)\,dx + c$

$xy = \int x^2 \cdot x + c \Rightarrow xy = \frac{x^4}{4} + c \Rightarrow$

$\Rightarrow$

$\boxed{ExE : 9.5}$

$[xy = \frac{x^3}{3} + c] \div x$ (1)

$y = \frac{x^3}{3} + \frac{c}{x}$

$y = \frac{x^3}{3} + c_1$, where $c_1 = \frac{c}{x}$

(4) $\frac{dy}{dx} + \sec x\, y = \tan x$

Given diff. eq. of form

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$\frac{dy}{dx} + Py = Q$ where $P \sec x$, $Q = \tan x$

$I.F = e^{\int P\,dx} = e^{\int \sec x\,dx} = e^{\ln|\sec x + \tan x|}$

$= \sec x + \tan x$

$y * I.F = \int (Q * I.F)\,dx + c$ $\boxed{P.17}$

$y(\sec x + \tan x) = \int \tan x(\tan x + \sec x)\,dx + c$

$\boxed{\begin{array}{l}\tan^2 x = 1 + \sec^2 x \\ \int \tan^2 x = \int dx + \int \sec^2 x\end{array}}$

$= \int (\tan^2 x + \tan x \sec x)\,dx + c$

$= \int \tan^2 x + \int \tan x \sec x\,dx + c$

$y(\sec x + \tan x) = \tan x - x + \sec x + c$

$y = \frac{\tan x - x + \sec x + c}{\sec x + \tan x} = \frac{1}{\tan x} + \frac{1}{\sec x} - \frac{x}{\sec x + \tan x} + c$

$\boxed{\text{ExE } 9.5}$

(5) $\cos^2 x \frac{dy}{dx} + y = \tan x$

$$\frac{dy}{dx} + \frac{y}{\cos^2 x} = \frac{\tan x}{\cos^2 x}$$

~~Given~~ this eq of form

$$\frac{dy}{dx} + Py = Q \quad \text{where } P = \frac{1}{\cos^2 x}$$

$$Q = \frac{\tan x}{\cos^2 x}$$

$$I.F = e^{\int P\,dx} = e^{\int \cdots^{-2}}$$

$$= e^{\int \sec^2 x\,dx} = e^{\tan x}$$

$$y * I.F = \int (Q * I.F)\,dx + C$$

$$y \cdot e^{\tan x} = \int \left(\frac{\tan x}{\cos^2 x} * e^{\tan x}\right) dx$$

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