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$$a(x)y' + b(x)y = c(x)$$

$$a(x) \neq 0 \quad y' + \frac{b(x)}{a(x)}y = \frac{c(x)}{a(x)}$$

$$y' + p(x)y = h(x)$$

assume  $\mu(x)$

$$\mu(x)y' + p(x)\mu(x)y = \mu(x)h(x)$$

$$(\mu y)' = \mu'y + \mu y'$$

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$$y' + p(x)y = h(x)$$

assume  $\mu(x)$

$$\mu(x)y' + p(x)\mu(x)y = \mu(x)h(x)$$

$$(\mu y)' = \mu'y + \mu y'$$

$$\mu'y = p\mu y$$

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The image shows a video player window within a Microsoft Word document. The video displays handwritten mathematical work on a piece of paper. The equations shown are:
$$\mu' = p\mu$$
$$\frac{d\mu}{dx} = p\mu(x)$$
$$\int \frac{d\mu}{\mu} = \int p(x) dx$$
$$\ln \mu(x) = \int p(x) dx$$

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The image shows a video player window within a web browser. The video displays handwritten mathematical work on a piece of paper. The equations shown are:
$$\frac{d\mu}{dx} = p\mu(x)$$
$$\int \frac{d\mu}{\mu} = \int p(x) dx$$
$$e^{\ln \mu(x)} = e^{\int p(x) dx}$$
$$\mu(x) = e^{\int p(x) dx}$$

$\mu(x)$  is the integrating factor

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assume  $\mu(x)$

$$\mu(x)y' + p(x)\mu(x)y = \mu(x)h(x)$$

$$(\mu y)' = \mu(x)h(x)$$

$$\mu y = \int^x \mu(\bar{x})h(\bar{x})d\bar{x} + C$$

$$y(x) = \frac{1}{\mu(x)} \int^x \mu(\bar{x})h(\bar{x})d\bar{x} + \frac{C}{\mu(x)}$$

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Equation Symbol

assume  $\mu(x)$

$$a(x)y' + b(x)y = c(x)$$

$$y' + \frac{b(x)}{a(x)}y = \frac{c(x)}{a(x)}$$

$$y' + p(x)y = h(x) \begin{cases} y' + p(x)y = 0 \Rightarrow y_{\text{homog}} \\ y' + p(x)y = h(x) \Rightarrow y_{\text{partic}} \end{cases}$$

$$y_{\text{TOT}} = y_{\text{homog}} + y_{\text{partic}}$$

assume  $\mu(x)$

$$\mu(x)y' + p(x)\mu(x)y = \mu(x)h(x)$$

$$(\mu y)' = \mu(x)h(x)$$

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$y_{\text{particular}}$ 
 $y_{\text{homog}}$

$$(1-x)y' + y = 2x$$

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

$\downarrow$ 
 $\downarrow$ 
  
 $p(x)$ 
 $h(x)$

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$a(x)=1-x$ ,  $b(x)=1$ ,  $c(x)=2x \rightarrow$  leads to  $p(x)=b(x)/a(x)=1/(1-x)$  and  $h(x)=c(x)/a(x)=2x/(1-x)$

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$$\mu(x) = e^{\int p(\bar{x}) d\bar{x}} = e^{\int \frac{d\bar{x}}{1-\bar{x}}} = e^{-\ln(1-\bar{x})} = \frac{1}{1-\bar{x}}$$

$$y(x) = \frac{1}{\mu(x)} \cdot \int \mu(\bar{x}) h(\bar{x}) d\bar{x} + \frac{C}{\mu(x)}$$

$$= (1-x) \int \frac{1}{1-\bar{x}} \cdot \frac{2\bar{x}}{1-\bar{x}} d\bar{x} + C(1-x)$$

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$$= (1-x) \int \frac{1}{1-\bar{x}} \cdot \frac{2\bar{x}}{1-\bar{x}} d\bar{x} + C(1-x)$$

$$= (1-x) \int \frac{2\bar{x}}{(1-\bar{x})^2} d\bar{x} + C(1-x)$$

let  $\frac{d\bar{x}}{(1-\bar{x})^2} = du$   $v = 2\bar{x}$

$$\frac{1}{1-\bar{x}} = u \quad dv = 2d\bar{x}$$

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$$y(x) = (1-x) \left[ \frac{2\bar{x}}{1-\bar{x}} - \int \frac{2d\bar{x}}{1-\bar{x}} \right] + C(1-x)$$

$$y(x) = 2x + (1-x) \cdot 2 \ln(1-x) + C(1-x)$$

$$y(x) = \frac{1}{\mu(x)}$$

(1-x)

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Handwritten work on a whiteboard:

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

$$y(x=-1) = -2$$

$$y(-1) = 2(-1) + (1+1) \cdot 2 \ln(1+1) + C(1+1)$$

$$-2 = -2 + 4 \ln 2 + 2C$$

$$C = \frac{-4 \ln 2}{2} = -2 \ln 2$$

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If we are given the initial condition  $y(x = -1) = -2$ , which is needed to evaluate the unknown  $C$ , then  $C = -2 \ln 2 = -\ln 4$

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05:35 02:10

Handwritten work on a whiteboard:

$$-2 = -2 + 4 \ln 2 + 2C$$

$$C = \frac{-4 \ln 2}{2} = -2 \ln 2$$

$$y(x) = 2x + 2(1-x) \ln(1-x) - 2 \ln 2 \cdot (1-x)$$

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