**Math 128 : Calculus 2 for the Sciences** **Winter 2016**

Lecture 16: February 8, 2016

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## 16.1 1st Order Linear Differential Equations

A 1st order linear DE os a DE that can be written in the form $\frac{dy}{dx} + P(x)y = Q(x)$ such that y is degree 1 and there is no $yy'$ terms

**Example 16.1** $\frac{dy}{dx} + \frac{1}{x}y = \frac{\cos x}{x}$
*Solution : Multiply by x*

$$x\frac{dy}{dx} + y + y = \cos x$$
$$\frac{dy}{dx}(xy) = \cos x \text{ (Integrate with respect to x)}$$
$$xy = \int \cos x$$
$$xy = \sin x + c$$
$$y = \frac{\sin x}{x} + \frac{c}{x}$$

**How to solve a 1st order linear DE :**
Start with DE in standard form

$$\frac{dy}{dx} + P(x) = Q(x)$$

Multiply by I(x) "The Integrating Factor"

$$I(x)\frac{dy}{dx} + P(x)I(x)y = I(x)Q(y)$$

We want the final result to become

$$\frac{dy}{dx}(I(x)y) = \frac{dI}{dx}y + I(x)\frac{dy}{dx}$$

So we need $\frac{dI}{dx} + P(x)I(x)$ (which is separable)

$$\text{So, } \int \frac{dI}{I(x)} = \int P(x)dx$$

$$\therefore I(x) = e^{\int P(x)dx}$$

**End of Lecture Notes**
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