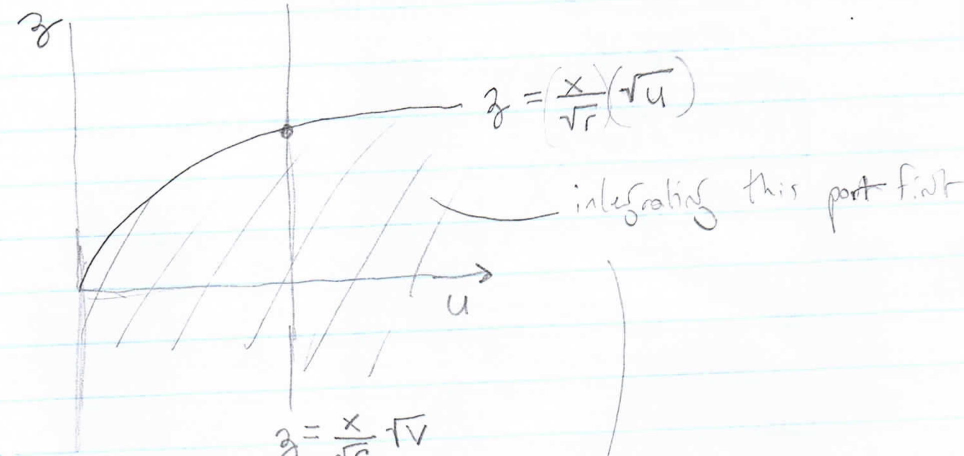
For any $x \in (-\infty, \infty)$,

$$P[T \le x] = P\left[\left(Z/\sqrt{V/r}\right) \le \overset{\text{Fixed}}{x}\right] = P\left[Z \le \left(\sqrt{V/r}\right) x\right]$$



$$= \iint_{\Delta} g(z, u)\, dz\, du$$

$$= \int_0^{\infty} \int_{-\infty}^{\left(\frac{x}{\sqrt{r}}\right)\left(\sqrt{u}\right)} \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}} \frac{1}{\Gamma\left(\frac{r}{2}\right) 2^{r/2}} u^{(r/2)-1} e^{-\frac{u}{2}}\, dz\, du$$

$$= \int_0^{\infty} \frac{1}{\sqrt{\pi}\,\Gamma\left(\frac{r}{2}\right)} \left[\int_{-\infty}^{\frac{x}{\sqrt{r}}\sqrt{u}} e^{-\frac{z^2}{2}}\, dz\right] \frac{1}{2^{\left(\frac{r+1}{2}\right)}} u^{\left(\frac{r}{2}-1\right)} e^{-\frac{u}{2}}\, du$$

And we differentiate w.r.t. x to get

$$f(x) = \frac{1}{\sqrt{\pi}\,\Gamma\left(\frac{r}{2}\right)} \int_0^{\infty} \left[e^{-\frac{\left(\frac{x}{\sqrt{r}}\sqrt{u}\right)^2}{2}} \frac{\sqrt{v}}{\sqrt{r}}\right] \frac{1}{2^{\left(\frac{r+1}{2}\right)}} u^{\frac{r}{2}-1} e^{-\frac{u}{2}}\, du$$