1. $e^{zt} = e^{xt} e^{iyt}$

$$= e^{xt}\cos yt + i e^{xt}\sin yt$$

$$\therefore \left(e^{z_0 t}\right)' = x_0 e^{x_0 t}\cos y_0 t - y_0 e^{x_0 t}\sin y_0 t + i x_0 e^{x_0 t}\sin y_0 t + i e^{x_0 t} y_0 \cos y_0 t$$

$$= (x_0 + i y_0)\left(e^{x_0 t}\cos y_0 t + i e^{x_0 t}\sin y_0 t\right)$$

$$= z_0 e^{z_0 t}$$

2. $\displaystyle\int_0^1 (2-it)^2\,dt = \int_0^1 4 - t^2 - 4it\,dt$

$$= 4t\Big|_0^1 - \frac{t^3}{3}\Big|_0^1 - i\left(\frac{4t^2}{2}\Big|_0^1\right)$$

$$= 4 - \frac{1}{3} - 2i$$

3. $\displaystyle\int_0^{\pi/8} e^{4it}\,dt = \int_0^{\pi/8} \cos 4t + i\sin 4t\,dt$

$$= \frac{\sin 4t}{4}\Big|_0^{\pi/8} - i\,\frac{\cos 4t}{4}\Big|_0^{\pi/8}$$

$$= \frac{1}{4} + \frac{i}{4}$$

4. $\displaystyle\int_C \frac{z-2}{z}\,dz = \int_0^{\pi} \frac{2e^{it} - 2}{\cancel{2}\cancel{e^{it}}}\,\cancel{2}i\cancel{e^{it}}\,dt$

$$= 2i\int_0^{\pi} e^{it} - 1$$

$$= 2i\int_0^{\pi} \cos t + i\sin t - 1\,dt$$

$$= 2i\left(\sin t\Big|_0^{\pi} - i\cos t\Big|_0^{\pi} - t\Big|_0^{\pi}\right)$$

$$= 2i\,(2i - \pi)$$

$$= -4 - 2\pi i$$