Exterior differential:

$$\omega = e^{x^2y}\,dx\wedge dz + \sin(xyz)\,dx\wedge dy$$

Then

$$\begin{aligned} d\omega = {} & \frac{\partial e^{x^2y}}{\partial x}\,dx\wedge dx\wedge dz + \frac{\partial e^{x^2y}}{\partial y}\,dy\wedge dx\wedge dz + \frac{\partial e^{x^2y}}{\partial z}\,dz\wedge dx\wedge dz \\ & + \frac{\partial \sin(xyz)}{\partial x}\,dx\wedge dx\wedge dy + \frac{\partial \sin(xyz)}{\partial y}\,dy\wedge dx\wedge dy + \frac{\partial \sin(xyz)}{\partial z}\,dz\wedge dx\wedge dy \\ = {} & 0 + x^2e^{x^2y}\,dy\wedge dx\wedge dz + 0 \quad + 0 + 0 + xy\cos(xyz)\,dz\wedge dx\wedge dy \\ = {} & (-x^2e^{x^2y} + xy\cos(xyz))\,dx\wedge dy\wedge dz \end{aligned}$$

Contraction (inner product) and Lie derivative:

$$X = e^x\frac{\partial}{\partial y} + (y^3+\sin x)\frac{\partial}{\partial z}, \qquad \alpha = (x^2+y^2+z^2)\,dx\wedge dz$$

Then

$$i_X\alpha = -(y^3+\sin x)(x^2+y^2+z^2)\,dx, \qquad d\alpha = 2y\,dy\wedge dx\wedge dz = -2y\,dx\wedge dy\wedge dz$$

(there is a typo in the sign of $d\alpha$ in the lecture notes), and

$$\begin{aligned} L_X\alpha &= (i_Xd + di_X)\alpha = i_Xd\alpha + di_X\alpha \\ &= i_X(-2y\,dx\wedge dy\wedge dz) + d(-(y^3+\sin x)(x^2+y^2+z^2)\,dx) \\ &= 2e^xy\,dx\wedge dz - 2y(y^3+\sin x)\,dx\wedge dy \\ &\quad + (-3y^2(x^2+y^2+z^2) - 2y(y^3+\sin x))\,dy\wedge dx - 2z(y^3+\sin x)\,dz\wedge dx \\ &= (2e^xy + 2z(y^3+\sin x))\,dx\wedge dz + 3y^2(x^2+y^2+z^2)\,dx\wedge dy\,. \end{aligned}$$

Pull-backs:

For $F:\mathbb{R}^3\to\mathbb{R}^2$ given by $(x,y,z)\mapsto(u,v) = (y^2z, xy)$ the pull-back of the 2-form $e^u\,du\wedge dv$ is

$$\begin{aligned} F^*(e^u\,du\wedge dv) &= e^{y^2z}\,d(y^2z)\wedge d(xy) \\ &= e^{y^2z}\,(2yz\,dy + y^2\,dz)\wedge(x\,dy + y\,dx) \\ &= e^{y^2z}\,(-2y^2z\,dx\wedge dy - xy^2\,dy\wedge dz - y^3\,dx\wedge dz) \end{aligned}$$