Exercise 2

① (b) $\lambda a.a$

② (b) $\lambda a\,(\lambda b.ba)$

③ (b) $\lambda z\,(\lambda x.xz)$

Exercise 3

① $(\lambda x.x)y$

$[x := y].x$

y → Don't diverge

② $\lambda x.xx$

$[x := x].x$

x → Dont diverge

③ $(\lambda z.zz)(\lambda y.yy)$

$[z := \lambda y.yy].zz$

~~$(\lambda y.yy)\,zz$~~

$(\lambda y.yy)(\lambda y.yy)$ → Diverge

④ $(\lambda x.xx)y$

$[x := y].xx$ → Dont diverge

yy

Exercise 4

i) $(\lambda y.zy)a$

$[y := a].zy$

za #

ii) $(\lambda x.x)(\lambda x.x)$

$[x := \lambda x.x].x$

$(\lambda x.x) : \lambda x.x$ #

iii) $(\lambda x.xy)(\lambda x.xx)$

$[x := \lambda x.xx]xy$

$(\lambda x.xx)y$

$[x := y].xx$ yy #

iv) $(\lambda z.z)(\lambda a.aa)(\lambda z.zb)$

~~$[z := \lambda a.aa].z\,(\lambda z.zb)$~~

~~$(\lambda a.aa)(\lambda z.zb)$~~

~~$[a := z]\,aa\,(\lambda z.zb)$~~

~~$(\lambda z.zb).zz$~~

~~$[z := z].zb\,(z)$~~

~~zb~~

iv) $(\lambda z.z)(\lambda a.aa)(\lambda z.zb)$

$[z := \lambda a.aa].z\,(\lambda z.zb)$

$(\lambda a.aa)(\lambda z.zb)$

$[a := \lambda z.zb].aa$

$(\lambda z.zb)(\lambda z.zb)$

$[z := \lambda z.zb].zb$

$(\lambda z.zb)b$

$[z := b].zb$

bb #

Exercise 5

i) $\lambda x.z.x$

$= z$

ii) $\lambda x.x.z$

→ cannot be reduced by eta

iii) $(\lambda x.bx)\ (\lambda y.ay)$

$[x := \lambda y.ay].bx$

$(b)(\lambda y.ay)$

$[y := b].ya$

ba ✱

Exercise 6

i) $\lambda x.xxx$

$[x := x].xx$

xx

→ combinator

ii) $\lambda xy.zx$

$\lambda x \lambda y.zx$

→ not a combinator

iii) $\lambda xyz.xy(zx)$

$(\lambda x \lambda y \lambda z.xy)(zx)$

$[x := zx]\ \lambda y \lambda z.xy$

$\lambda y \lambda z.zxy$

→ not a combinator

iv) $\lambda xyz.xy(zxy)$

$(\lambda x \lambda y \lambda z.xy)(zxy)$

$[x := zxy]\ \lambda y \lambda z.xy$

$\lambda y \lambda z.zxyy$

→ not a combinator