Needham, Chapter 5, Section IX, p. 235
G. Palmer, December 14, 2015

Recreation of Figure [17]. Objects are created for two figures. The second figure is transposed to the right side of Figure 1.

```
Clear["Global`*"]

(* CONSTANTS *)

pr = 2; (* plot range *)

θ = Pi / 4; (* arbitrary angle *)

z = Exp[I θ]; (* arbitrary vector for slanted line *)

x = 1.5;  (* offset of slanted line at y intercept *)

p = .5 z - x; (* point on slanted line *)

ξ = .5 z; (* arbitrary small complex vector; blue arrow *)

a = .5;

b = 2 I;


(* FUNCTIONS *)

v[z_] := {Re @ z, Im @ z}; (* complex to vector *)

f[z_] := Exp[z];

(* sign given as 1 or -1 *)
arc[q_, r_, θ0_, θ1_, sign_] :=
  {Arrowheads @ .02, Arrow[ v @ Table[r Exp[I θ] + q, {θ, Range[θ0, θ1, sign .01]}]]};

(* The dampened sign function arrow is a bit tedius to get
 right. If someone knows a better way, please let me know. *)

squigglyArrow := Module[{points, squigglyLn, hdPt1, head, squigArrow},

   pts = Table[{x, (.5 / (x^4)) Sin[9 Pi x]}, {x, Range[1, 2, .01]}];

   squigglyLn = Line[pts];

   hdPt1 = {2, (.25 / 2^3) Sin[12 Pi 2]};

   head =
    {Arrowheads @ .03, Arrow[{hdPt1, {hdPt1[[1]] + .02, 0}, {hdPt1[[1]] + .18, 0}}]};

   squigArrow = {squigglyLn, head};

   Translate[squigArrow, {-1, 0}]
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  ];

SetAttributes[{v, f}, Listable];


(* FRAMES *)

xAxis1 = Line[v @ {-pr, pr / 2}];

xAxis2 = Line[v @ {-pr / 2, pr}];

yAxis = Line[v @ {-pr I / 3, pr I}];

frame1 = {xAxis1, yAxis};

frame2 = {xAxis2, yAxis};


(* POINTS *)

ptSz = .02;

points1 = {EdgeForm @ Black, FaceForm @ White,
   Table[Disk[v @ pt, ptSz], {pt, {0, p, a, b, a + b}}]};

points2 = {EdgeForm @ Black, FaceForm @ White,
   Table[Disk[v @ pt, ptSz], {pt, Join[f @{p, a, b, a + b}, {0}]}]};


(* CURVES *)

d = .01; (* distance between points *)

slantLnPts = Table[a z - x, {a, Range[-.8, 3, d]}];

slantLn = {Line[v @ slantLnPts]};

fSlantLnPts = f @ slantLnPts;

fStrtCrv = { Line[v @ fSlantLnPts]};


vertLnPts = Table[a + I y, {y, Range[0, pr, d]}];

vertLn = {Dashed, Line[v @ vertLnPts]};

fVertCrv = {Dashed, Line[v @ f @ vertLnPts]};


horizLnPts = Table[x + b, {x, Range[0, a, d]}];

horizLn = {Dotted, Line[v @ horizLnPts]};

fHorizCrv = {Dotted, Line[v @ f @ horizLnPts]};
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```
curves1 = {slantLn, vertLn, horizLn};

curves2 = {fStrtCrv, fVertCrv, fHorizCrv};


(* ARROWS, LINES *)

hdSz = .02;

xiArrow = {Blue, Thick, Arrowheads @ hdSz, Arrow[v @ {p, p + ξ}]};

arcArrow1 = arc[p, Abs @ ξ, 0, Arg @ ξ, 1];

arcBase1 = {Dotted, Gray, Line[v @ {p, p + Abs @ ξ}]};

headPos = -IntegerPart[Length[fSlantLnPts] / 4];

slantCrvArrow = {Arrowheads @ hdSz, Arrow[v @ fSlantLnPts[[1 ;; headPos]]]};

sArrow = Scale[squigglyArrow, 1 / 2];

sArrow = Translate[sArrow, {1, 0}];

arrows1 = {xiArrow, arcArrow1, arcBase1, sArrow};

arrows2 = {slantCrvArrow};


(* TEXT *)

default = 12;
small = 8;
large = 14;

data1 = {
    {"0", 0 - .1 - .15 I, default},
    {"p", p - .15, default},
    {"ξ⃗", p + ξ / 2 - .1 + .05 I, small},
    {"a", a - .1 I, default},
    {"b", b - .1, default},
    {"ϕ", p + 1.2 (Abs @ ξ) Exp[I Arg[ξ] / 2], small},
    {"e^z", 1.6 + .3 I, default},
    {"Figure 1. Curvature of e^z on various straight lines\nfrom
       Figure [17], Ch. 5, Needham", .75 pr - pr I / 1.5, large}
  };

data2 = {
    data1[[1]],
    {"e^p", f @ p + .15 + .05 I, default},
    {"e^a", f @ a - .15 I, default},
    {"e^b", f @ b - .17 I, default}
```

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  };

text = Table[Text[Style[item[[1]], item[[3]]], v @ item[[2]]], {item, #}] & /@
    {data1, data2};


(* GRAPHICS *)

Graphics[
 {
  {frame1, curves1, arrows1, points1, text[[1]]},
  Translate[{frame2, curves2, arrows2, points2, text[[2]]}, v @ 3]
 }, Background → White, PlotRange → {{-1.5 pr, 3 pr}, {-pr, 1.5 pr}},
 ImageSize → Large]
```