```
> restart;
  with(plots);
```

$[$*animate, animate3d, animatecurve, arrow, changecoords, complexplot,* **(1)**
    complexplot3d, conformal, conformal3d, contourplot, contourplot3d,
    coordplot, coordplot3d, densityplot, display, dualaxisplot, fieldplot,
    fieldplot3d, gradplot, gradplot3d, implicitplot, implicitplot3d, inequal,
    interactive, interactiveparams, intersectplot, listcontplot, listcontplot3d,
    listdensityplot, listplot, listplot3d, loglogplot, logplot, matrixplot, multiple,
    odeplot, pareto, plotcompare, pointplot, pointplot3d, polarplot, polygonplot,
    polygonplot3d, polyhedra_supported, polyhedraplot, rootlocus, semilogplot,
    setcolors, setoptions, setoptions3d, spacecurve, sparsematrixplot, surfdata,
    textplot, textplot3d, tubeplot$]$

► Calculator

▼ Constants (*g* is protected in MAPLE, *d* is used instead)

```
> ν := 1;
  L := 30;
  α := 0.5;
  β := 2;
  δ := -1;
  η := 2·Pi / L;
```

$$\nu := 1$$
$$L := 30$$
$$\alpha := 0.5$$
$$\beta := 2$$
$$\delta := -1$$
$$\eta := \frac{1}{15}\pi \qquad\qquad \textbf{(2.1)}$$

▼ Shock

```
> R := (alpha·L)^{-0.319};
  R2 := 2·R;
  m1 := alpha;
  b1 := m1·L / 2;
  peakdiff := 2;
```

$$m2 := \frac{peakdiff}{R2 - R};$$
$$b2 := m1 \cdot (-R2) + b1 - m2 \cdot (-R2);$$
$$m3 := \frac{-(m2 \cdot (-R) + b2)}{R};$$
$$b3 := 0;$$

$$R := 0.4215284469$$
$$R2 := 0.8430568938$$
$$m1 := 0.5$$
$$b1 := 7.500000000$$
$$peakdiff := 2$$
$$m2 := 4.744638267$$
$$b2 := 11.07847155$$
$$m3 := -21.53703176$$
$$b3 := 0 \qquad \textbf{(3.1)}$$
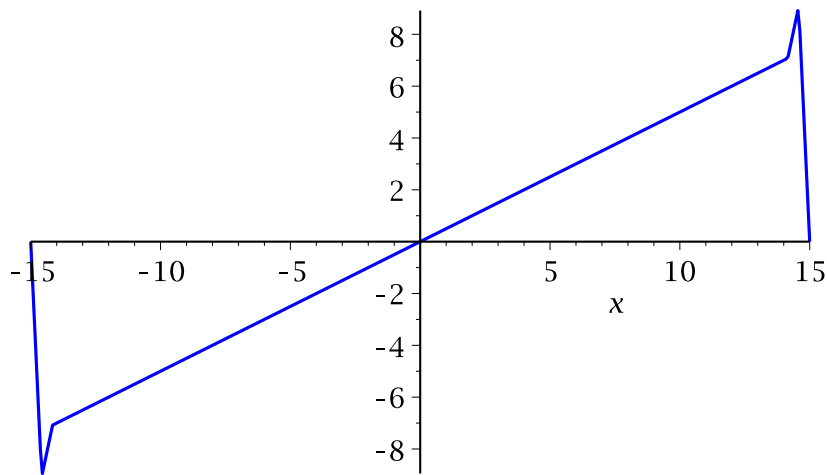
> $f := x \rightarrow piecewise\left(x \le -\frac{L}{2} + R,\ m3 \cdot \left(x + \frac{L}{2} \right) + b3,\ -\frac{L}{2} + R < x \le -\frac{L}{2} + R2,\ m2\right.$
$\cdot \left(x + \frac{L}{2} \right) - b2,\ -\frac{L}{2} + R2 < x \le 0,\ m1 \cdot \left(x + \frac{L}{2} \right) - b1,\ 0 < x \le \frac{L}{2} - R2,\ m1 \cdot \left(x\right.$
$\left. - \frac{L}{2} \right) + b1,\ \frac{L}{2} - R2 < x \le \frac{L}{2} - R,\ m2 \cdot \left(x - \frac{L}{2} \right) + b2,\ \frac{L}{2} - R < x,\ m3 \cdot \left(x\right.$
$\left.\left. - \frac{L}{2} \right) + b3 \right);$

$fPlot := plot\left(f(x),\ x = -\frac{L}{2} .. \frac{L}{2},\ scaling = constrained,\ color = blue \right):$
$display(fPlot);$

$f := x \rightarrow piecewise\left(x \le -\frac{1}{2} L + R,\ m3 \left(x + \frac{1}{2} L \right) + b3,\ -\frac{1}{2} L + R < x \textbf{ and } x \le \right.$
$-\frac{1}{2} L + R2,\ m2 \left(x + \frac{1}{2} L \right) - b2,\ -\frac{1}{2} L + R2 < x \textbf{ and } x \le 0,\ m1 \left(x + \frac{1}{2} L \right)$
$- b1,\ 0 < x \textbf{ and } x \le \frac{1}{2} L - R2,\ m1 \left(x - \frac{1}{2} L \right) + b1,\ \frac{1}{2} L - R2 < x \textbf{ and } x$
$\left. \le \frac{1}{2} L - R,\ m2 \left(x - \frac{1}{2} L \right) + b2,\ \frac{1}{2} L - R < x,\ m3 \left(x - \frac{1}{2} L \right) + b3 \right)$

Basis functions

> $BaseSin := n \rightarrow \left(x \rightarrow \sin\left(\dfrac{n \cdot 2 \cdot \text{Pi} \cdot x}{L} \right) \right);$
> $BaseCos := n \rightarrow \left(x \rightarrow \cos\left(\dfrac{n \cdot 2 \cdot \text{Pi} \cdot x}{L} \right) \right);$

$$BaseSin := n \rightarrow x \rightarrow \sin(2 * n * \text{Pi} * x / L)$$
$$BaseCos := n \rightarrow x \rightarrow \cos(2 * n * \text{Pi} * x / L)$$

(4.1)

Fourier coefficients

Coefficient integrals

> $FSin := (n, f) \rightarrow \dfrac{2}{L} \cdot int\left(f(x) \cdot BaseSin(n)(x), x = -\dfrac{L}{2} .. \dfrac{L}{2} \right);$
> $FCos := (n, f) \rightarrow \dfrac{2}{L} \cdot int\left(f(x) \cdot BaseCos(n)(x), x = -\dfrac{L}{2} .. \dfrac{L}{2} \right);$

$$FSin := (n, f) \rightarrow \frac{2 \left(\displaystyle\int_{-\frac{1}{2}L}^{\frac{1}{2}L} f(x) \, BaseSin(n)(x) \, dx \right)}{L}$$

$$FCos := (n, f) \rightarrow \frac{2 \left(\displaystyle\int_{-\frac{1}{2}L}^{\frac{1}{2}L} f(x) \, BaseCos(n)(x) \, dx \right)}{L} \tag{5.1.1}$$

Listing of the Cosine series

```
> CosList := proc(n, f)
    local i;
    for i from 1 to n do
      print( evalf( FCos(i, f) ) );
    od;
  end;
```

$$CosList := \mathbf{proc}(n, f) \tag{5.2.1}$$
$$\quad \mathbf{local}\ i;$$
$$\quad \mathbf{for}\ i\ \mathbf{to}\ n\ \mathbf{do}$$
$$\qquad print(\,evalf(\,FCos(i, f)\,)\,)$$
$$\quad \mathbf{end\ do}$$
$$\mathbf{end\ proc}$$

Actual list

```
> CosList(2, f);
```

$$0.$$
$$0. \tag{5.2.1.1}$$

Listing of the Sine series

```
> SineList := proc(n1, n2, f)
    local i;
    for i from n1 to n2 do
      print( evalf( FSin(i, f) ) );
    od;
  end;
```

$$SineList := \mathbf{proc}(n1, n2, f) \tag{5.3.1}$$
$$\quad \mathbf{local}\ i;$$
$$\quad \mathbf{for}\ i\ \mathbf{from}\ n1\ \mathbf{to}\ n2\ \mathbf{do}$$
$$\qquad print(\,evalf(\,FSin(i, f)\,)\,)$$
$$\quad \mathbf{end\ do}$$
$$\mathbf{end\ proc}$$

Actual list

> $SineList(1, 90, f)$

$$4.777309076$$
$$-2.392556812$$
$$1.599177726$$
$$-1.203425477$$
$$0.9664879286$$
$$-0.8087138140$$
$$0.6959319080$$
$$-0.6110316342$$
$$0.5444905384$$
$$-0.4905856926$$
$$0.4456718602$$
$$-0.4073206900$$
$$0.3738571994$$
$$-0.3440947944$$
$$0.3171760848$$
$$-0.2924731234$$
$$0.2695225300$$
$$-0.2479818746$$
$$0.2275994366$$
$$-0.2081926268$$
$$0.1896321557$$
$$-0.1718301100$$
$$0.1547307431$$
$$-0.1383031949$$
$$0.1225356165$$
$$-0.1074303432$$
$$0.09299987314$$
$$-0.07926348440$$
$$0.06624437374$$
$$-0.05396723534$$
$$0.04245622222$$
$$-0.03173324822$$
$$0.02181659966$$
$$-0.01271983199$$
$$0.004450931242$$
$$0.002988277864$$

```
-0.009602494474
 0.01540309227
-0.02040807606
 0.02464186320
-0.02813490962
 0.03092320138
-0.03304763314
 0.03455329582
-0.03548869606
 0.03590492940
-0.03585482954
 0.03539211456
-0.03457054998
 0.03344314734
-0.03206141470
 0.03047467368
-0.02872945540
 0.02686898496
-0.02493276182
 0.02295624062
-0.02097061458
 0.01900270079
-0.01707492468
 0.01520539835
-0.01340808568
 0.01169304537
-0.01006674130
 0.008532409066
-0.007090465954
 0.005738951928
-0.004473988412
 0.003290242334
-0.002181383066
 0.001140520923
-0.0001606167667
-0.0007651463360
 0.001643037113
-0.002478501786
```

$$0.003275945874$$
$$-0.004038574772$$
$$0.004768294072$$
$$-0.005465668870$$
$$0.006129939812$$
$$-0.006759092040$$
$$0.007349972066$$
$$-0.007898446280$$
$$0.008399594166$$
$$-0.008847928366$$
$$0.009237633414$$
$$-0.009562814900$$
$$0.009817750526$$
$$-0.009997135166$$
$$0.01009631226$$

<div align="right">(5.3.1.1)</div>

▶ Graph from the Sine series

▼ Graph from an external Sine series

```
> with(ColorTools);
  SineExtGraph := proc(Coefficients, myL, myColor, myLegend)
   local i, sineSum;
   sineSum := 0;
   for i from 1 to nops(Coefficients) do
```
$$sineSum := sineSum + evalf\left(-2 \cdot Coefficients[i] \cdot \sin\left(i \cdot \frac{2 \cdot Pi}{myL} \cdot x\right)\right);$$
```
   od;
```
$$\textbf{return } plot\left(sineSum, x = -\frac{myL}{2} .. \frac{myL}{2}, color = ColorTools{:}{-}Color("RGB",\right.$$
$$\left. myColor), legend = myLegend\right);$$
```
  end;
```

$[$ *AddPalette, AnalogousSpread, Color, ColorDefectiveTransform,*
    ColorDefectiveTransform2, ColorDescription, ColorToAnsi, Darken,
    Desaturate, Distance, EvenSpread, ExpandPalette, GetColorNames,
    GetPalette, Gradient, GraySpread, HSVColorWheel, HexToRGB24,
    HexToString, HueSplit, HueSpread, KnownPalette, Lighten,
    LocalInitialize, NameToRGB24, NearestNamedColor, NeutralSpread,
    Palette, PaletteNames, PlotColorToRGB24, RGB24ToHex,
    RGB24ToName, RGB24ToRGB, RGBGrid, RGBToRGB24,
    RemovePalette, Saturate, Swatches, ToDisplayable, ToRGB24$]$

```
SineExtGraph := proc(Coefficients, myL, myColor, myLegend)                    (5.5.1)
    local i, sineSum;
    sineSum := 0;
    for i to nops(Coefficients) do
        sineSum := sineSum + evalf(−2 * Coefficients[i] * sin(2 * i*Pi*x
        / myL))
    end do;
    return plot(sineSum, x = −1 / 2 * myL..1 / 2 * myL, color = ColorTools:-
    Color("RGB", myColor), legend = myLegend)
end proc
```

```
> L30alpha08flat := [-1.875012494830601, 1.596814483738187,
        −0.9572691032308286, 0.7579401615528715,
        −0.6912175212425128, 0.6394229033267567,
        −0.6232486070022748, 0.6445884218352488,
        −0.5738616182910095, 0.4518755172523224,
        −0.3263109278231441, 0.2255177537247528,
        −0.153718608521278, 0.1051048406340088,
        −0.07261457345031833, 0.05070278808375776,
        −0.0355180155344852, 0.02482734921787542,
        −0.0171639307121389, 0.01172102206896073,
        −0.007913713039854312, 0.005296330088477426,
        −0.00352374278313094, 0.002336143179532738,
        −0.001545603940971966, 0.001021027065073295,
        −0.0006733836174140018, 0.0004431870289392625,
        −0.0002909569409181171, 0.000190498023186182,
        −0.000124380850417133, 8.101781040249294e−05,
        −5.265288756589235e−05, 3.415321335710037e−05,
        −2.211627857494548e−05, 1.429990905948457e−05,
        −9.232824597350965e−06, 5.952995941921864e−06,
        −3.833080264269768e−06, 2.464814005813732e−06,
        −1.582932272976387e−06, 1.015328003317093e−06,
        −6.504949335693297e−07, 4.162971608249163e−07,
        −2.66140913242923e−07, 1.699777070352178e−07,
        −1.084586944170597e−07, 6.914262148173317e−08,
        −4.40404048474052e−08, 2.802815598884208e−08,
        −1.782332588082219e−08, 1.132522819084326e−08,
        −7.190878141219064e−09, 4.56253323720284e−09,
        −2.892884784958801e−09, 1.833024953429208e−09,
        −1.160721941300124e−09, 7.345482464615194e−10,
        −4.645729274910221e−10, 2.936550786810064e−10,
        −1.855151388895097e−10, 1.171351457061709e−10,
        −7.392112808451495e−11, 4.66262619691481e−11,
        −2.939544928221139e−11, 1.852352456561109e−11,
        −1.166722032161523e−11, 7.345432363579996e−12,
```

$-4.622524171308941e-12, 2.907758249555061e-12,$
$-1.828352226697462e-12, 1.149182126279557e-12,$
$-7.22021371057073e-13, 4.534694203576121e-13,$
$-2.846997672152471e-13, 1.786782074511773e-13,$
$-1.120999658846893e-13, 7.030604782873591e-14,$
$-4.407952887174246e-14, 2.762751715791072e-14,$
$-1.731055095317797e-14, 1.084294817316958e-14,$
$-6.789761944249686e-15, 4.250455653485537e-15,$
$-2.660070817920577e-15, 1.664295981679086e-15,$
$-1.040999159161721e-15, 6.509615629283547e-16,$
$-4.069566010242569e-16, 2.543496924079577e-16,$
$-1.58930507939187e-16, 9.928389977081638e-17,$
$-6.200809641476163e-17, 3.8718479942002e-17,$
$-2.417081684208429e-17, 1.508588575018302e-17,$
$-9.41137102665711e-18, 5.873133536070648e-18,$
$-3.663750389875431e-18, 2.285298474148892e-18]$:
$L30alpha08viscous := [-3.837142562775751, 1.957813811050634,$
$-1.348151091615086, 1.063827562676406, -0.9101810361203946,$
$0.8256896696740648, -0.7786764641587226,$
$0.7483226801383304, -0.7070271392027565,$
$0.6242799191128041, -0.5064404046655412,$
$0.3834073308845385, -0.277917093241338, 0.1972590812875716,$
$-0.1392034987964144, 0.09848158861241678,$
$-0.07004487363632436, 0.05003584210722101,$
$-0.0357830275465026, 0.02552102425096145,$
$-0.01809595077932016, 0.01273454456304826,$
$-0.008892037740469169, 0.006165931688377225,$
$-0.004251770593646109, 0.00291967769664261,$
$-0.001998973085705016, 0.001365626954916712,$
$-0.0009312988775115234, 0.0006340542563631614,$
$-0.0004309386023393117, 0.0002923486848808436,$
$-0.0001979429232240337, 0.0001337577094858266,$
$-9.021080415364967e-05, 6.073046733235627e-05,$
$-4.081548259279057e-05, 2.738910923304273e-05,$
$-1.83537013372663e-05, 1.228314052959728e-05,$
$-8.210521893471259e-06, 5.481930289737787e-06,$
$-3.656089976672925e-06, 2.435772329787223e-06,$
$-1.621092841131623e-06, 1.077819251614479e-06,$
$-7.159246731722563e-07, 4.751047099187057e-07,$
$-3.150136669151994e-07, 2.086913589159862e-07,$
$-1.381435154364715e-07, 9.137390393729954e-08,$
$-6.039386785322697e-08, 3.988913683927236e-08,$
$-2.632805145674302e-08, 1.736582730471813e-08,$
$-1.144708076729272e-08, 7.54094755815012e-09,$
$-4.964757363228645e-09, 3.266779023447747e-09,$
$-2.148322352116073e-09, 1.412033716475067e-09,$
$-9.276074168355294e-10, 6.090656418637654e-10,$
$-3.997160484714933e-10, 2.622002944722106e-10,$

$-1.719155118787636e{-10}, 1.126686683759182e{-10},$
$-7.380794454414037e{-11}, 4.833039208912907e{-11},$
$-3.163442649184555e{-11}, 2.069793518159116e{-11},$
$-1.353711940682836e{-11}, 8.850386862686843e{-12},$
$-5.784148063316996e{-12}, 3.778869710700811e{-12},$
$-2.467935790148461e{-12}, 1.61123581533214e{-12},$
$-1.051577808717611e{-12}, 6.860951870438753e{-13},$
$-4.474983644494482e{-13}, 2.917870338460774e{-13},$
$-1.902003012158138e{-13}, 1.239453358451315e{-13},$
$-8.074691686820203e{-14}, 5.258978262178888e{-14},$
$-3.42420118544564e{-14}, 2.228960484716287e{-14},$
$-1.450552111061926e{-14}, 9.437453186875367e{-15},$
$-6.138601063046705e{-15}, 3.991900537417033e{-15},$
$-2.59530417951043e{-15}, 1.686932712020688e{-15},$
$-1.096254169920342e{-15}, 7.122503180868301e{-16},$
$-4.626662191698749e{-16}, 3.00488281460743e{-16},$
$-1.951368459813556e{-16}, 1.267406704917515e{-16}]$:
$L30alpha05viscous := [-2.179371828309645, 1.209090237146905,$
$-0.8008784579210915, 0.6663306409622729,$
$-0.5836637919722736, 0.561076970710537,$
$-0.5575218813007168, 0.5577350836860289,$
$-0.4852053996191519, 0.3662067806097004,$
$-0.2532951670093805, 0.1689195744161786,$
$-0.1121574701655123, 0.07532680488663521,$
$-0.0513668225025337, 0.03540772909484751,$
$-0.02443833547092595, 0.01672737920508244,$
$-0.01129203803556676, 0.007513696522929546,$
$-0.0049413832043516, 0.003224307133430544,$
$-0.00209471752151155, 0.001358019551744783,$
$-0.0008794184332793886, 0.0005687865624759132,$
$-0.0003671852224519765, 0.0002364279178274179,$
$-0.00015177618656706, 9.713480761683615e{-05},$
$-6.198961071261959e{-05}, 3.946477036196083e{-05},$
$-2.507400303737156e{-05}, 1.590368898335349e{-05},$
$-1.00721701884314e{-05}, 6.370173276428744e{-06},$
$-4.023733328532919e{-06}, 2.538779302554613e{-06},$
$-1.601081571186745e{-06}, 1.011238049257198e{-06}]$:
$L30alpha10rollshock := [-1.324256278922126, 1.461645296133214,$
$-1.034659729271229, 0.7428200697424406,$
$-0.6540253780493224, 0.6431526064974814,$
$-0.6123754243653433, 0.6914981267684551,$
$-0.5780905568634825, 0.4430849604399676,$
$-0.3156160849351393, 0.2168082385361638,$
$-0.147736885723464, 0.1014708876112442,$
$-0.07045964100630929, 0.0495909746441 0446,$
$-0.03487942539551746, 0.0243228163712712,$
$-0.01674043884505294, 0.01136991285745047,$
$-0.007639161415856063, 0.0050942785482365,$

$$-0.003381848634793433, 0.002239748274577731,$$
$$-0.001481149202411609, 0.0009780000621279286,$$
$$-0.0006444589163403318, 0.0004235708249429845,$$
$$-0.0002775799229835683, 0.0001813717393503063,$$
$$-0.0001181853954366676, 7.682791241909102e{-}05,$$
$$-4.984100220833182e{-}05, 3.227661266911542e{-}05,$$
$$-2.086894456063723e{-}05, 1.347300395309651e{-}05,$$
$$-8.685532919792401e{-}06, 5.591203485795291e{-}06,$$
$$-3.594204208994193e{-}06, 2.307324717716569e{-}06,$$
$$-1.479281409927425e{-}06, 9.472418466289825e{-}07,$$
$$-6.058582700457878e{-}07, 3.870886894170755e{-}07,$$
$$-2.470609040957451e{-}07, 1.575332439301731e{-}07,$$
$$-1.003534552011707e{-}07, 6.387040788096568e{-}08,$$
$$-4.061521353951731e{-}08, 2.580558303415525e{-}08,$$
$$-1.638281755356439e{-}08, 1.039267538944496e{-}08,$$
$$-6.587844513986139e{-}09, 4.173007393473067e{-}09,$$
$$-2.641536242194225e{-}09, 1.671000259290986e{-}09,$$
$$-1.056377506565533e{-}09, 6.674119664234575e{-}10,$$
$$-4.214150819082123e{-}10, 2.659353119711606e{-}10,$$
$$-1.677258610977009e{-}10, 1.057280025536716e{-}10,$$
$$-6.661216358174593e{-}11, 4.194669592988948e{-}11,$$
$$-2.640155626891787e{-}11, 1.660945432395629e{-}11,$$
$$-1.04435138505759e{-}11, 6.564683259824704e{-}12,$$
$$-4.12437292059604e{-}12, 2.590116737054801e{-}12,$$
$$-1.6259350676319e{-}12, 1.020268500913029e{-}12,$$
$$-6.399675463175796e{-}13, 4.012713844167222e{-}13,$$
$$-2.515125082484114e{-}13, 1.575891670690173e{-}13,$$
$$-9.870577299368499e{-}14, 6.180335626019064e{-}14,$$
$$-3.868464538947345e{-}14, 2.420615630044799e{-}14,$$
$$-1.514178813095291e{-}14, 9.468822033309124e{-}15,$$
$$-5.91950534756863e{-}15, 3.699547914411987e{-}15,$$
$$-2.311472142876373e{-}15, 1.443804289857598e{-}15,$$
$$-9.015928107460589e{-}16, 5.628565232738478e{-}16,$$
$$-3.512956313478396e{-}16, 2.191987920669296e{-}16,$$
$$-1.367402891248895e{-}16, 8.528061917461026e{-}17,$$
$$-5.317436662266306e{-}17, 3.314778034933321e{-}17,$$
$$-2.065902273596487e{-}17, 1.287274417003594e{-}17,$$
$$-8.019423919778827e{-}18, 4.99501042943891e{-}18,$$
$$-3.110780584129435e{-}18, 1.93702726969554e{-}18]:$$

$L30alpha10viscous := [-4.805190395797637, 2.440377845127333,$
$\quad -1.675644687810652, 1.310085586430048, -1.109319911311726,$
$\quad 0.9908441760104405, -0.9199088370514217,$
$\quad 0.8722672502789067, -0.8269238610677495,$
$\quad 0.7565677669743062, -0.6496216547827034,$
$\quad 0.5220311521768964, -0.3983199220746758, 0.294079580533197,$
$\quad -0.2135078101399601, 0.1541475842119156,$
$\quad -0.1113742218838503, 0.0807269152390664,$
$\quad -0.05868095747797394, 0.04269317013016994,$

$-0.03100758869730819, 0.02242843341564634,$
$-0.01613135062897876, 0.0115298206169338,$
$-0.0081913122391775, 0.005788887219804099,$
$-0.004073575840707452, 0.002857018024796493,$
$-0.001998691879782259, 0.001395429759587667,$
$-0.0009725912022637254, 0.0006768048560064671,$
$-0.0004702271448981769, 0.0003261686909711215,$
$-0.0002258643249051624, 0.000156141574417471,$
$-0.0001077627017120058, 7.425531423305631e-05,$
$-5.109013324731843e-05, 3.510288594077071e-05,$
$-2.40873880637085e-05, 1.65088806730054e-05,$
$-1.130211892509751e-05, 7.7293514499602e-06,$
$-5.28066007557812e-06, 3.604229468178609e-06,$
$-2.457709158565091e-06, 1.674388096254112e-06,$
$-1.139732444385856e-06, 7.751478817824673e-07,$
$-5.267626609752844e-07, 3.576910042778296e-07,$
$-2.427041421607749e-07, 1.645642196944452e-07,$
$-1.115051285077341e-07, 7.550344464117479e-08,$
$-5.109302821216313e-08, 3.455327214059938e-08,$
$-2.335384733661435e-08, 1.577531136950151e-08,$
$-1.065015141047958e-08, 7.186206458376064e-09,$
$-4.846375618044477e-09, 3.266743483692569e-09,$
$-2.200900442272019e-09, 1.482107475126702e-09,$
$-9.976062990950205e-10, 6.711889868822005e-10,$
$-4.513800004049802e-10, 3.034290056556931e-10,$
$-2.038892654873511e-10, 1.369490688531496e-10,$
$-9.195090743371758e-11, 6.171485761160545e-11,$
$-4.140612597913555e-11, 2.77705723832634e-11,$
$-1.861891944925999e-11, 1.247893194035711e-11,$
$-8.360984227380703e-12, 5.600129119647808e-12,$
$-3.749754145904048e-12, 2.51000742343587e-12,$
$-1.679646527107336e-12, 1.123659094066062e-12,$
$-7.51498346798927e-13, 5.024596309820081e-13,$
$-3.358588738971496e-13, 2.244386984853927e-13,$
$-1.499431492363564e-13, 1.001488967450318e-13,$
$-6.687426443321859e-14, 4.46448275556667e-14,$
$-2.979718029003446e-14, 1.988309724175319e-14,$
$-1.326471140751188e-14, 8.847508756795116e-15,$
$-5.90011726981115e-15, 3.933962927985058e-15,$
$-2.622792667168269e-15, 1.749057277872456e-15]:$
$L40alpha05viscous := [-3.199642837103509, 1.616793228362764,$
$\quad -1.101282071257464, 0.8506786451028905,$
$\quad -0.7094272214560156, 0.6228019556049502,$
$\quad -0.5691261189460165, 0.5359116334222644,$
$\quad -0.5159031841233228, 0.5019240404868887,$
$\quad -0.4860461786669438, 0.4577682850410765,$
$\quad -0.410573301864149, 0.3485226204617853,$
$\quad -0.2821162798719141, 0.2207145645212967,$

$-0.1691626395327855, 0.1283952583060021,$
$-0.09723360918085086, 0.07379661528920668,$
$-0.05624380716006271, 0.04305267196410586,$
$-0.03306190269390467, 0.02542393183375509,$
$-0.01953490910962753, 0.01496834909044075,$
$-0.01142053825242379, 0.008669465779225448,$
$-0.006546614972809901, 0.004919383147104781,$
$-0.00368101397371309 2, 0.00274499619692307,$
$-0.002041654758211183, 0.001515608839670916,$
$-0.001123516955058234, 0.0008319609039564455,$
$-0.0006154990824547966, 0.000454953282976696,$
$-0.0003359678703164516, 0.0002478444863482385,$
$-0.0001826286925713329, 0.0001344109697915885,$
$-9.880076414728423e{-}05, 7.253495118292479e{-}05,$
$-5.318789651959474e{-}05, 3.895696247319501e{-}05,$
$-2.850353460057267e{-}05, 2.083482518215187e{-}05,$
$-1.521572021582426e{-}05, 1.11028914719018e{-}05,$
$-8.09551190324819e{-}06, 5.898412953247603e{-}06,$
$-4.294590313058558e{-}06, 3.124736378939071e{-}06,$
$-2.272046092887582e{-}06, 1.650969061454852e{-}06,$
$-1.198904442002699e{-}06, 8.70082262272744e{-}07,$
$-6.310637135913348e{-}07, 4.574367524419198e{-}07,$
$-3.313921673844159e{-}07, 2.399470663812112e{-}07,$
$-1.736438232265496e{-}07, 1.255978805971896e{-}07,$
$-9.080134204432884e{-}08, 6.561400208156492e{-}08,$
$-4.739164612347111e{-}08, 3.421481402825264e{-}08,$
$-2.469103594120671e{-}08, 1.781075726017952e{-}08,$
$-1.284246235443863e{-}08, 9.256391934327171e{-}09,$
$-6.669099538191063e{-}09, 4.803182476806628e{-}09,$
$-3.458053323307921e{-}09, 2.488738060738455e{-}09,$
$-1.790505590179824e{-}09, 1.287730922533145e{-}09,$
$-9.258302162134331e{-}10, 6.65423369024268e{-}10,$
$-4.78111029964645e{-}10, 3.43421036509847e{-}10,$
$-2.466014991922887e{-}10, 1.770265344203206e{-}10,$
$-1.270450982416899e{-}10, 9.115013799437567e{-}11,$
$-6.537919104897856e{-}11, 4.688213920280051e{-}11,$
$-3.36096325610147e{-}11, 2.408858630454737e{-}11,$
$-1.726047761313851e{-}11, 1.236491457425902e{-}11,$
$-8.855832256802981e{-}12, 6.341197073011812e{-}12,$
$-4.539639492848652e{-}12, 3.249274325428667e{-}12,$
$-2.325290461950949e{-}12, 1.663855495639789e{-}12,$
$-1.190574283708516e{-}12, 8.523690944576498e{-}13]:$

$L50alpha05viscous := [-3.98764232080829, 2.00717513178414,$
$-1.353357941912947, 1.031647880472079, -0.8432360857620286,$
$0.7219210897318, -0.639346216453209 4, 0.5813058554861951,$
$-0.5398110098880582, 0.509880542092616,$
$-0.488018233586541, 0.4713787095230527,$
$-0.4572418995020172, 0.4427028334667332,$

$-0.4246619700723589, 0.4003584496828811,$
$-0.3684894972875891, 0.3299976128705471,$
$-0.2876807549466616, 0.2449624871119091,$
$-0.2047410977897389, 0.1688420558086192,$
$-0.1380288594955593, 0.1122909549180406,$
$-0.09117214472668882, 0.07402640794044041,$
$-0.06017877215251003, 0.04900940538967274,$
$-0.03998760660196178, 0.03267765444803799,$
$-0.02673103567485195, 0.02187343696826178,$
$-0.01789082976493968, 0.0146166357959613,$
$-0.01192074558261187, 0.00970058320970746,$
$-0.007874141640683743, 0.006374775320510506,$
$-0.005147458894428424, 0.004146186511041104,$
$-0.003332194219849081, 0.002672731414385988,$
$-0.002140170916410267, 0.001711314100824817,$
$-0.001366804766052098, 0.001090607359474695,$
$-0.0008695314988407256, 0.0006927985824635061,$
$-0.0005516517328336747, 0.0004390110111106287,$
$-0.0003491744044058471, 0.0002775631258984317,$
$-0.00022050808642336 5, 0.0001750732881012397,$
$-0.0001389113671633153, 0.0001101464614652376,$
$-8.727985224993932e{-}05, 6.911429513426684e{-}05,$
$-5.469350636961785e{-}05, 4.325383280008168e{-}05,$
$-3.418566078930684e{-}05, 2.700258549092386e{-}05,$
$-2.131675750650683e{-}05, 1.681914970596081e{-}05,$
$-1.326374917961993e{-}05, 1.045488709544838e{-}05,$
$-8.237082409314986e{-}06, 6.486903024482031e{-}06,$
$-5.106447938833001e{-}06, 4.018132507583196e{-}06,$
$-3.160521145991919e{-}06, 2.485001373308957e{-}06,$
$-1.953132881582757e{-}06, 1.534537408466707e{-}06,$
$-1.205221182112089e{-}06, 9.462427897909729e{-}07,$
$-7.426564301755827e{-}07, 5.826743771318791e{-}07,$
$-4.570037018875751e{-}07, 3.583213532562486e{-}07,$
$-2.808589798822001e{-}07, 2.200747231024168e{-}07,$
$-1.723938859245043e{-}07, 1.350041167007852e{-}07,$
$-1.056937186728065e{-}07, 8.272405861195638e{-}08,$
$-6.472892300666427e{-}08, 5.063516063986063e{-}08,$
$-3.960013559382461e{-}08, 3.096245307292376e{-}08,$
$-2.420316018025293e{-}08, 1.891520914924238e{-}08,$
$-1.477943459239122e{-}08, 1.154566411933693e{-}08,$
$-9.017873286608815e{-}09, 7.042527669482336e{-}09,$
$-5.499442192600344e{-}09, 4.294651913940771e{-}09,$
$-3.355007525450827e{-}09, 2.625281802274697e{-}09] :$

> $plotL30alpha08flat \coloneqq SineExtGraph(L30alpha08flat, 30, [0.6, 0.6, 0.6],$
 $\text{"flat shock"}) : plotL30alpha08viscous$
 $\coloneqq SineExtGraph(L30alpha08viscous, 30, [0.6, 0, 0],$
 $\text{"viscous shock"}) : plotL30alpha10rollshock$
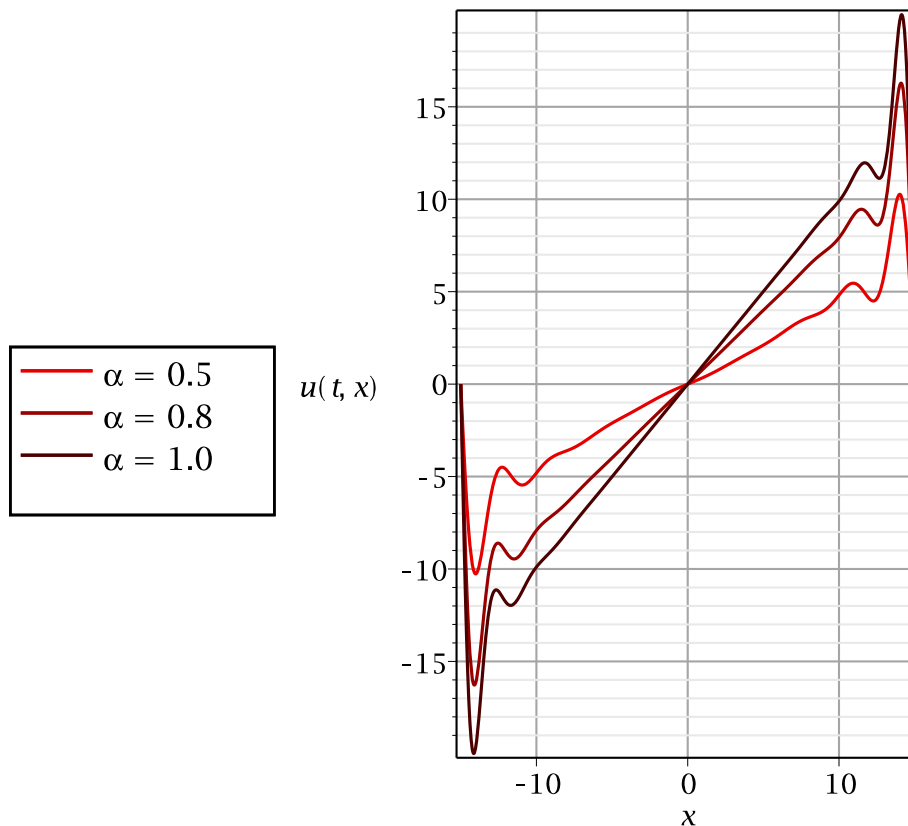 $\coloneqq SineExtGraph(L30alpha10rollshock, 30, [0.6, 0.6, 0.6],$

"roll shock") : *plotL30alpha10viscous*
:= *SineExtGraph*(*L30alpha10viscous*, 30, [0.3, 0, 0],
"viscous shock") : *plotL30alpha05viscous*
:= *SineExtGraph*(*L30alpha05viscous*, 30, [0.9, 0, 0],
"viscous shock") : *plotL40alpha05viscous*
:= *SineExtGraph*(*L40alpha05viscous*, 40, [0.9, 0.25, 0.25],
"viscous shock") : *plotL50alpha05viscous*
:= *SineExtGraph*(*L50alpha05viscous*, 50, [0.9, 0.5, 0.5],
"viscous shock") :

> *display*(*plotL30alpha05viscous*, *plotL30alpha08viscous*,
plotL30alpha10viscous, *axes* = *boxed*, *gridlines* = *true*, *labels* = [*x*,
u(*t*, *x*)], *scaling* = *constrained*);

> *display*(*plotL30alpha08flat*, *plotL30alpha08viscous*, *axes* = *boxed*,
gridlines = *true*, *labels* = [*x*, *u*(*t*, *x*)]);
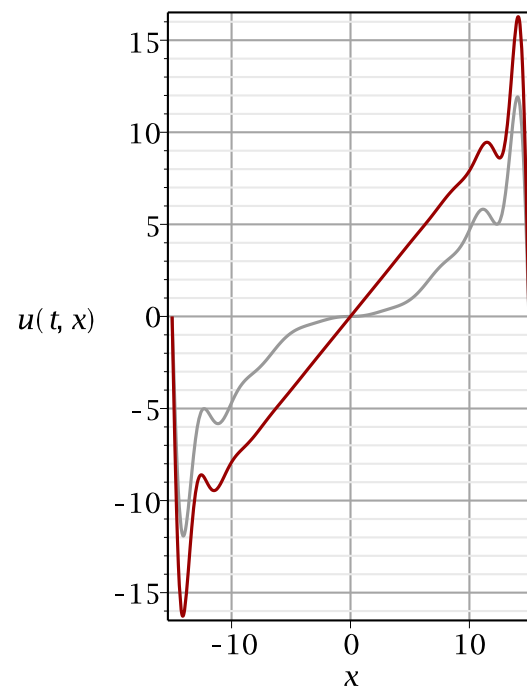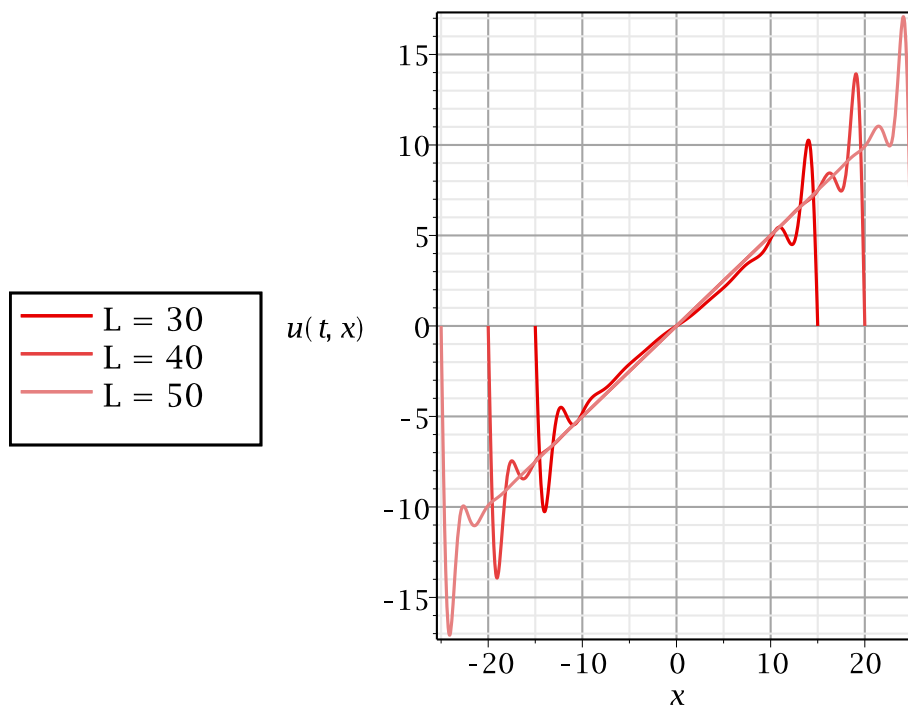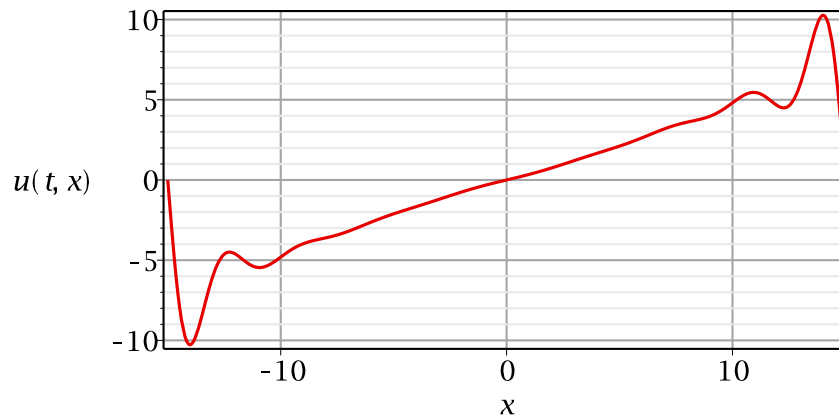
> $display(plotL30alpha10rollshock, plotL30alpha10viscous, axes = boxed,$
  $gridlines = true, labels = [x, u(t, x)], scaling = constrained);$
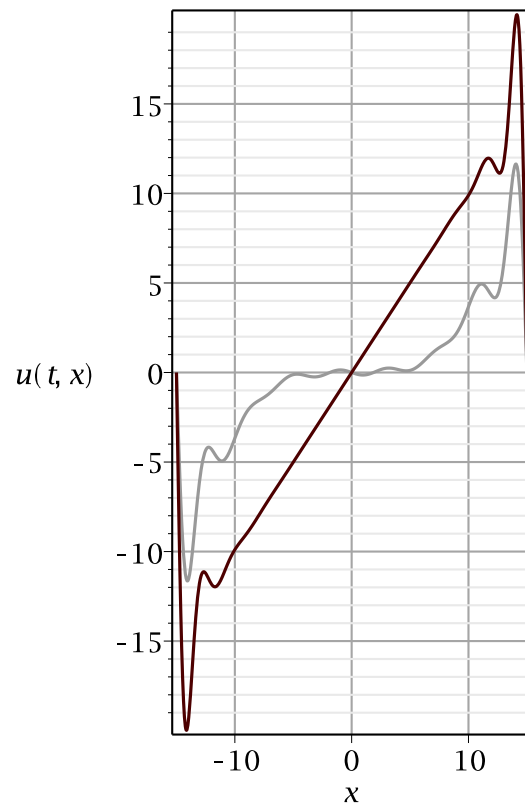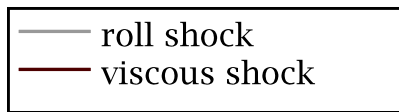
> *display*(*plotL30alpha05viscous, plotL40alpha05viscous,*
    plotL50alpha05viscous, axes = *boxed, gridlines* = *true, labels* = [*x,*
    u(*t, x*)], *scaling* = *constrained*);

> display(plotL30alpha05viscous, axes = boxed, gridlines = true, labels = [x, u(t, x)]);

▼ Eigenvalues

> rho := $k \rightarrow \alpha + \beta \cdot \eta^2 \cdot k^2 - \nu \cdot \eta^4 \cdot k^4$;

$$\rho := k \rightarrow \alpha + \beta \eta^2 k^2 - \nu \eta^4 k^4 \qquad (6.1)$$

Listing the eigenvalues

```
> for k from 1 to 30 do
    evalf(rho(k));
  od;
```

$$0.5858056867$$
$$0.8201331846$$
$$1.133713806$$
$$1.411099741$$
$$1.490664052$$
$$1.164600677$$
$$0.178924434$$
$$-1.766528993$$
$$-5.018103029$$
$$-9.968320247$$
$$-17.05588233$$
$$-26.76567007$$
$$-39.62874341$$
$$-56.22234143$$
$$-77.16988227$$
$$-103.1409633$$
$$-134.8513609$$
$$-173.0630306$$
$$-218.5841071$$
$$-272.2689043$$
$$-335.0179150$$
$$-407.7778113$$
$$-491.5414446$$
$$-587.3478448$$
$$-696.2822215$$
$$-819.4759634$$
$$-958.1066385$$
$$-1113.397993$$
$$-1286.619952$$
$$-1479.088622$$

(6.1.1)

```
>
```