4.8.2 While °j°é

```
while °j°é¬O¥Î¦b·í°;"¬¬Y"DZø¥ó«h«½Æ°õ¦æ³°°â¦;;A¥¡³°µ²°c¦p¤U;G
while expression
command group A
end
"Ò¦p¡G
sum = 0;
k = 1;
while x(k) \ge 0 & k \le length(k)
sum = sum + x(k);
k = k+1;
end
\P \cdot ^a \cdot N^{ao} \neg O | b^3] @w \pm \emptyset \$ \acute{e} n | \grave{O} \frac{1}{4} \{ \P g \$ \dot{p}_i A \S \_ \  \   \  \langle h \cdot |^2 \pounds \$ \acute{l} \mu L^a k \mu^2 \S \hat{o}^{ao} \circ j^o \acute{e}_i C \} 
'¹¥~ÁÙ'³¤@Ó break ao«ü¥O¡A¬O¥Î"Ó¸õ¥X°j°é;A¥i¥H¥Î¦b¤Wzao for, while
aou2oc¤¤;C"Ò'p;G
>> num=0; EPS=1; % <sup>3</sup>oÓ¨Ò¤l¬O§ä¥XMATLAB¥ip°â¨ì³Ì¤p<sup>ao</sup>¥¿È
>> for num=1:1000 % EPS±q1p°â°_¡A¹w³]np°â¦¸¼Ænum¬° 1000
EPS=EPS/2; % "C', ±NEPS'î¤Ö¤@¥b
```

 $if (1+EPS) <= 1 \% pº\^a"i³\grave{l} «á³¹⁄₂"ìEPS¤Ó¤p"\"I±o 1+EPS ¤p©\'oµ¥©\'o 1$

break % ¦pªG°¡¨¬¤Wz±ø¥ó§Y¸õ¥X°j°é

end

end

>> EPS, num

>> EPS =

1.1102e-016

>> num =

53





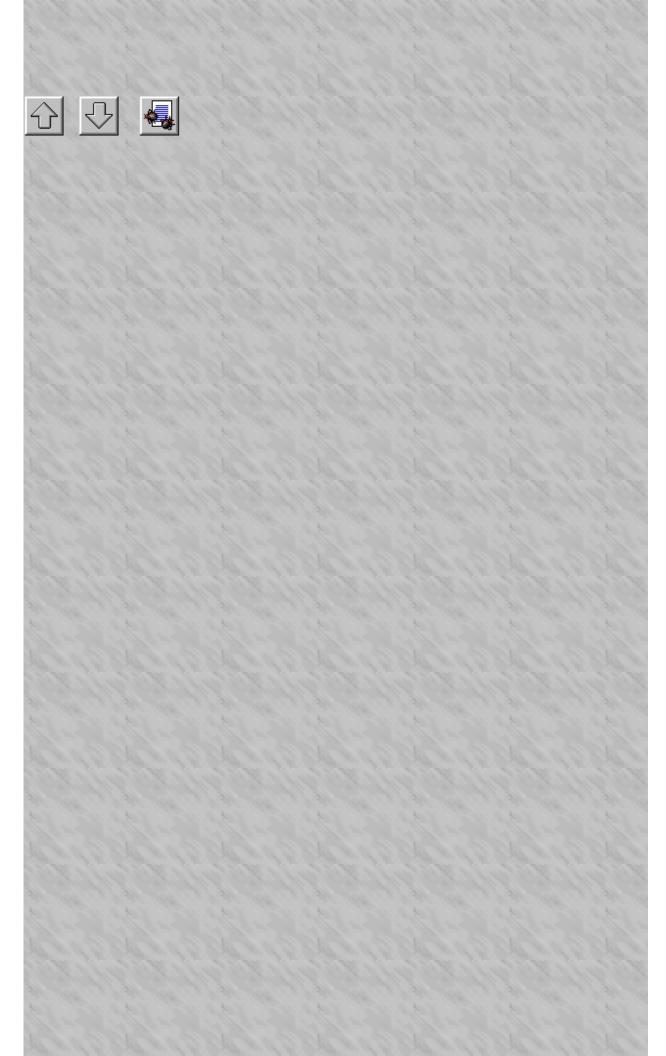


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4.8.1 For

```
for
for index = array
command A
end
                                                                 (d) 10
                                 v)
if d \le 10, v = 0.425 + 0.0175d^2
if 	 d > 10, 	 v = 0.625 + 0.12d - 0.00025d^2
              d
                   for
>> for k = 1:length(d)
if d(k) \le 10
velocity = 0.425 + 0.00175*d(k)^2;
else
velocity = 0.625 + 0.12*d - 0.00025*d(k)^2;
end
fprintf('d= %f velocity= %f\n',d(k),velocity)
end
>> for n=1:10
```

```
x(n)=\sin(n*pi/10);
end
>> disp(x)
>> for n=1:5
for m=5:-1:1
A(n,m)=n^2+m^2;
end
disp(n)
end
>> disp(A)
                                   for
>> n=1:10;
>> x=sin(n*pi/10);
   for
 1. for (index)
                      k=1:0
 2. array
                      k=1:1
 3. array
                      k=1:b, b=[1 3 5]
 4. array
                                                         k=1:B, B=[1 2; 3 4]
 5. array
            for k = first:increment:last
                                          first, increment, last
 6. for
floor((last-first)/increment)+1
```



$^{2}\ddot{A}^{2}$ 1 1 2 u $^{2}\ddot{E}$ 1 1 4 2

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¥H¯x°}¤è¦¡«Ü¾A¦Xªí¥Ü¤uμ{¤Î¬ì¾Çªº¼Æ¾Ú¡A¦Ó¦b«e±´X³¹§Ṳ́]¬Ý¹L»P¯x°}¬ÛÃö^{ao}¹B°â¨ç¼Æ¤Î«ü¥O¡C¦b³o³¹ §Ú̱ΝμÛ«©ó¤¶²Đ±N¯x°}μø¬°³æ
¤@¹ï¶H^{ao}¹B°â¨ç¼Æ¤Î«ü¥O¡A¦Ó¦³§O©ó«e±´X³¹ao¨ç¼Æ¤Î«ü¥O¥u¬O°w¹ï¯x°}¤°
«Ó§O¤¸¯À°μ¹B°â¡C

 $\label{eq:continuity} $$ \frac{b^3o^{31} \cdot E^{"}}{u} = V^{\circ} \hat{A} - D^{3}\hat{O}_{i} = H^{\circ} \hat{O}_{i}^{\circ} \hat{A}^{\circ} \hat{O}_{i}^{\circ} \hat{A}^{\circ} \hat{O}_{i}^{\circ} \hat{A}^{\circ} \hat{O}_{i}^{\circ} \hat{A}^{\circ} \hat{O}_{i}^{\circ} \hat{A}^{\circ} \hat{O}_{i}^{\circ} \hat{$

½Đ°Ñ¦Ò¦³Ãö<u>¤HÅé°ò¦]³°¤¶²Đ</u>¡C

- ${}^{2}\ddot{A}^{31} \frac{1}{2}u @ \hat{E} Y N 4 A P x^{\circ}$
 - $\circ 5.1 x^{\circ} B^{\circ} \hat{a}$
 - $\circ \ 5.2 \, \tfrac{1\!/2}{d^{\prime\prime}} \grave{O}^{\circ} \acute{Y} \tilde{A} D_{\dagger} G^{3} J \underbrace{\tilde{O}^{1\!/2}} \grave{e}^{ao} \underline{\overset{\circ}{a}} \grave{A} \underline{\overset{\circ}{a}} \underline{\overset{\overset{\circ}{a}} \underline{\overset{\circ}{a}} \underline{\overset{\overset{\circ}{a}}} \underline{\overset{\overset{\overset}{a}}} \underline{\overset{\overset{\overset{\overset{\overset}{a}}{a}}} \underline{\overset{\overset{\overset{\overset}{a}}{a}}} \underline{$
 - 5.3 <u>x</u>°}"c½Æ







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o 1.1 · 1.2 · 1.3 /_ <u>MATLAB</u> • 2.1 <u>MATLAB</u> o 2.2 ■ 2.2.1 <u>MATLAB</u> **2.2.2 2.2.3 2.2.4** · 2.3 o 2.4 _____ **2.4.1 2.4.2 2.4.3 2.4.4 2.4.5** · 2.5. · 2.6 **2.6.1 2.6.2** • 2.7 <u>MATLAB</u> **2.7.1** · 2.8 0 2.9 o 2.10 · 3.1 **3.1.1 3.1.2 3.1.3 3.1.4 3.1.5**

```
3.1.6
· 3.2
 3.1.1
  3.1.2
MATLAB ---
· 4.1
 4.1.14.1.2
 4.1.3
  4.1.4
· 4.2
4.2.14.2.2
4.2.3
· 4.3
4.3.14.3.2 <u>if-else-end</u>
 o 4.4 ___
4.54.6
4.6.14.6.2
· 4.7
· 4.8
4.8.1 For4.8.2 While
 o 5.1
5.1.15.1.2
o 5.2 ___
 o 5.3
5.3.1 _5.3.2 _5.3.3 _
```

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- 6.16.2
- · 7.1
 - **7.1.1**
 - **7.1.2**
 - 7.1.3 <u>Spline</u>
 - o 7.2 ____
 - o 7.3
 - **7.3.1**
 - **7.3.2**
 - **7.3.3**
 - · 8.1
 - · 8.2
- ---
 - o 9.1.
 - 9.1.1
 - 9.1.2
 - o 9.2 ___
 - · 9.3
 - 9.3.1
 - 9.3.2
- o 10.1
 - · 10.2 <u>-</u>
 - · 10.3 _
 - · 10.4
- o 11.1
 - **11.1.1**
 - **11.1.2**
 - **11.1.3**
 - o 11.2
 - **11.2.1**

- **11.2.2**
- o 11.3
- 11.3.111.3.2
- o 11.4 ___

- o 12.1
- **12.1.1**
- **12.1.2**
- o 12.2
- 12.2.112.2.212.2.3
- 12.3
- 0 12.4
- 12.4.1 IIR
 12.4.2 IIR
 12.4.3 FIR
- o 12.5 :___

- · 13.1
- 13.1.1 13.1.2 <u>-</u>
- 13.1.3
- · 13.2
- 13.3
- 13.3.1 <u>Bode</u>13.3.2 <u>Nyquist</u>
 - **13.3.3**
 - **13.3.4**
- · 13.4 ___

4.8.2 While °j°é

```
while °j°é¬O¥Î¦b·í°;"¬¬Y"DZø¥ó«h«½Æ°õ¦æ³°°â¦;;A¥¡³°µ²°c¦p¤U;G
while expression
command group A
end
"Ò¦p¡G
sum = 0;
k = 1;
while x(k) \ge 0 & k \le length(k)
sum = sum + x(k);
k = k+1;
end
\P \cdot ^a \cdot N^{ao} \neg O | b^3] @w \pm \emptyset \$ \acute{e} n | \grave{O} \frac{1}{4} \{ \P g \$ \dot{p}_i A \S \_ \  \   \  \langle h \cdot |^2 \pounds \$ \acute{l} \mu L^a k \mu^2 \S \hat{o}^{ao} \circ j^o \acute{e}_i C \} 
'¹¥~ÁÙ'³¤@Ó break ao«ü¥O¡A¬O¥Î"Ó¸õ¥X°j°é;A¥i¥H¥Î¦b¤Wzao for, while
aou2oc¤¤;C"Ò'p;G
>> num=0; EPS=1; % <sup>3</sup>oÓ¨Ò¤l¬O§ä¥XMATLAB¥ip°â¨ì³Ì¤p<sup>ao</sup>¥¿È
>> for num=1:1000 % EPS±q1p°â°_¡A¹w³]np°â¦¸¼Ænum¬° 1000
EPS=EPS/2; % "C', ±NEPS'î¤Ö¤@¥b
```

 $if (1+EPS) <= 1 \% pº\^a"i³\grave{l} «á³¹⁄₂"ìEPS¤Ó¤p"\"I±o 1+EPS ¤p©\'oµ¥©\'o 1$

break % ¦pªG°¡¨¬¤Wz±ø¥ó§Y¸õ¥X°j°é

end

end

>> EPS, num

>> EPS =

1.1102e-016

>> num =

53







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$^{\circ}\dot{\mathbf{o}}^{\dagger}_{1}$, $\mathbf{t}^{3}4\hat{\mathbf{O}}$ ($\mathbf{\mu}^{2}$ $\mathbf{t}^{2}\mathbf{y}$)

$\hat{\hat{y}}_{i}^{\dagger}\hat{\mathbf{U}}^{"\circ}\hat{\mathbf{o}}_{i}^{\dagger}]_{s}t^{3}\hat{\mathbf{O}}^{"},$ ¤ $\hat{\mathbf{N}}$ ¤ $\mathbf{U}\mathbf{Y}\mathbf{X}^{a}\mathbf{\mathbb{C}}^{a}\hat{\mathbf{A}}$

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¥Ç¿ù¡X;X©¿²¤¤F¤é«á³QÃÒ©ú¬°«D±`«n³⁰¨Æ¥ó;A¦Ó¹L¤À±j½Õμo®i¦³³⁰®Ç¤ä

¥½¸`¡C¥u¦³¦b³\¦h¦~«á;A¾ú¥v¾Ç®a¤~¯à¦^ÅU³Ì»ô³Æ³°¸ê®Æ;A°ë½T«ü

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¤¦â¡C¸ÜÁö¦p¦¹;A¦³®É¨ÌμM·|¥X²{¤@¨Ç«¤j¬ì¾Ç¬ð¯};A¹ï¤HÃþåÀ·|³y¦¨·¥

¤j½ÄÀ»;A¦Ó¥ß¨è´NÅã²{¥X¥¦Ì³⁰«n©Ê;CÂǥѥ¿§Ö³tµo®i³⁰·s¿³¾Ç³ù;X;X¤À

¤l¿ò¶Ç¾Ç;]molecular genetics;^;A¨Ó©w¦ì¨Ã¿ëÃѤHÅ餰³°·CÓ°ò¦];A´N¬O²

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"S^{'3}¥ô¦ó¤H¡A¯à·Ç½T»¡¥X¦b¹L¥h¤Q¤¦~¶¡¡B¦"¦Ê^{ao}¹êÅ礤¡Aþ"Ǥ~¬O¯u¥¿°V¶} $YN^{z}(A;A') = (a^{-1}A^{-1}$ ¸§Ö¼W³ø¡F¦p¤μ¡Aμο²{·s°ò¦]³ο³t«×«h´X¥G¥H´X¦ó¯Å¼Æ¦¨³ø¡CμM¦Ó¡A³o¨Ç·s $XXA^{a^0} \otimes W^{a^3} \otimes O^{a^1} \otimes A^{a^1} \otimes A^{a^1} \otimes O^{a^1} \otimes O^$ $f^{a}(3a^{a}) = f^{a}(3a^{a}) + f^{a}(3a^{a}$ ¤î¡A©Ò¦³Ãö©ó¡u¦ó®É¯à§ä¥X¤HÅé¨CÓ°ò¦]¡v^{ao1}w´ú¡A¥þ³£μυμø^{ao}§½-¦b;u¦pªGμο®i¥X¬Y¶μ©l®Æ¥¼ ¤Ĵao¤À¤l¿ò¶Ç·s§Þ3N;v»q±¥´Âà;C¤Q¤¦~«e;A $\mathbb{P}[\mu \rightarrow i 4 \mathbb{Q}] = i 4 \mathbb{Q}$ $°o'_i]'_ia^i\ddot{I}_iA'_ip^{\mu}\neg\acute{Y}"\acute{O}_iA^{1/4}\cancel{E}^{\mu}Q'_i\sim^{\mu}^{0}\S Y \\ ¥i\S^{1}_i"_iC \acute{A}\ddot{o}\mu M\cdot s°o'_i]^{ao}\mu o^{2}\{\pm q"\acute{O}'N^{\mu}E^{\mu}\}_{i}^{a}(a^{\mu})^{\mu}$ ʹ¿³Qμø¬°¯¦±K;A¦ýªÀ·|¤j²³«ο¥¼ª`·N¨ì¥¦Ìªº«n©Ê;A¬Æ¦Ü¥¼¤©¥HÆg¬ü;C¦p ¦P $\alpha G_{\infty}^{\prime} = 3^{\circ} A^{\circ} A^{\circ} = 3^{\circ} A^{\circ} A^{\circ}$ ¤§®Èao¬ã¨s¤W¡A«Ü¤Ö¤H¦³®É¶¡©Î¦³·NÄ@¸ó¥X¹êÅç«Ç¡A«ä¯Á³o¶µ¬ã¨s ¥i¯à³y¦¨ao«¤j¼vÅT¡C¦Ó¥B¡A³o¨Ç·sµo²{¤]ÂA¤Ö¯àÀ¸¼@¤Æaoµn¤W¬ü°ê ³ø¯ÈÀY±ø¡A©Î¨ü¨ì¤½^{23a}`¥Ø¦Ó¤Þµo³§ÅG¡C ¤@¤E¤K¤T¦~¡A³oÓ∙s¿³¾Çªùª°²Ä \mathbb{Z}^{0} \mathbb{Z}^{1} \mathbb{Z}^{0} \mathbb{Z}^{0} °ò¦]¡A´¿,gµn¤W¥þ¬ü³ø¯ÈÀYª©¡A¦P¼Ëªº¡A¤@¤E¤K ¤C¦~μο²{¦Ù¦×μäÁY¯g¡]muscular dystrophy¡^a°P¯f °ò¦]¤]¬O¦p¦¹¡C

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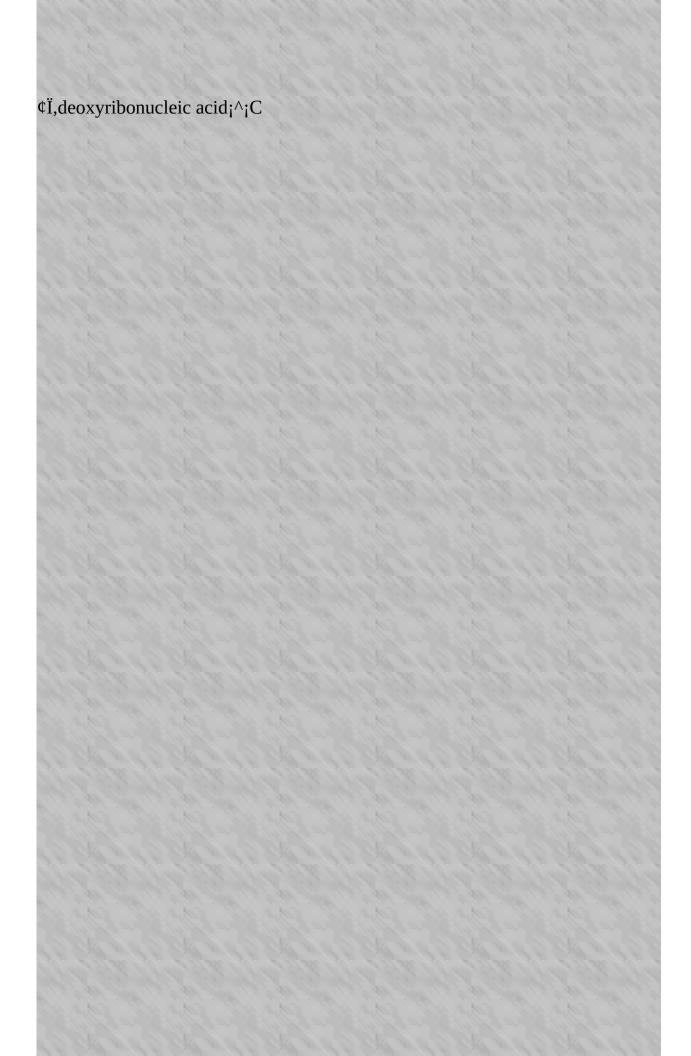
 $\square @\square E\square K\square E' - \square \S «\acute{a}; A¥\~N @\acute{o}\muo^2 \{°o',]^{ao_3}t «×·U"\acute{O}·U\S\ddot{O}; A', \ddot{U}\square\ddot{O}', [³\square @',]^3 »', v\square A\square I$ $Y^{a} = \frac{1}{2} W' u' G = \frac{3}{4} C = \frac{1}{4} W' u' G = \frac{3}{4} C = \frac{1}{4} W' u' G = \frac{3}{4} C = \frac{1}{4} W' u' G = \frac{3}{4} W' u' G = \frac{$ $;A^{13}\neg O"M@w''4^-$ à $;B';a=\circ;A\neg A';U';u^{1}4O;BAA^{3}N@lAe"|§P$@^{ao\circ}o';];C;u';b§U'»{¬°}$ °ò¦];C;v»;³o¸Ü^{ao}¬O¬ü°ê²Ä¤@¬y ^{ao}¤À¤l¥Ía«¾Ç®a·Å§B®æ;]Robert $We in berg; ^{\uparrow}CYL^{1}w'u; A \neg i^{3}4Q \otimes a \pm N\tilde{A}O^{1}\hat{e}^{"}M \otimes w' \otimes a \neg \circ ^{-}S \otimes \hat{E};] "O'|p \otimes @'_{1}\pm p \sim -a; ^{ao\circ}O' \otimes a \neg \circ ^{-}S \otimes \hat{E};] "O'|p \otimes (a) \otimes$ ¦]¡A¦³¤»¨ì¤@¥´¤§¦h¡C¡u©;®É¡A¦³Ãö¥ý¤Ñ©Î«á¤Ñ¡Aþ¼Ë¹ïÓ¤H¼vÅT¤ñ¸û ¤j^{ao}ÅG½×;A°¨¤W´N·|¦]¬°¤@¹D¥b·s^{ao} ÀÆ¥ú;A¦Ó¹ý©³§áÂà;C;v \cdot Ŭf®æ¬OÃh®ü¼w¬ã"s©Ò;]Whitehead Institute;A¦ì©ó³Â¬Ù²z¤u¾Ç°|ao $\square @ \bigcirc D_{\mu} U^{\dagger}W^{ao} \square A^{\mu} = A^{\mu} A^{\mu} + \alpha G^{\mu} - \alpha G^{\mu} - \alpha G^{\mu} + \alpha G^{\mu} - \alpha G^{\mu} + \alpha G^{\mu} - \alpha G^{\mu} - \alpha G^{\mu} + \alpha G^{\mu} - \alpha G^{\mu$ $\pm \acute{O}$ ³/U^{ao} $\neg i$ ³/C[®]a; A¹/ \acute{O} ¥B \square] $\neg O$ ³i¹/4~ \square ß; u°o¹/i³/2©w§ \acute{Y} ³/4C²`»·i⁴vÅT; v^{ao} \square À ¤l¿ò¶CÂå®v¤§¤@;A¥L¤jÁn¯e©I;G°ò¦]Ų©w¬ì¾C¹ï©óªÀ·|±N²£ ¥Í;u»G»k©Ê;v^{ao}½ÄÀ»;C "ä¹ê¦b¤@¤E¤K¤E¦~¤U¥b¦~;A¦n"ǪÀ·|¹D¼w¾ÇªÌ¤w¶} $@l^{\circ}Q^{1/2} \times \text{$$L$} L^{ao} \acute{A} \acute{o}^{1/4} \sim : G \mathring{A}^{2} @w^{\circ} \acute{o}^{!} \\ \text{$$|$$} b^{3} N \text{$$$$$$$$$$$$$$!} '' \acute{O} \cdot |\text{$$\underline{\alpha}$} \pounds \cdot |^{3} D^{3} V \text{$$$$$$$$$$$$$$$$} X \text{$$\underline{\alpha}$} @^{\circ} \mathscr{O} \cdot s^{aoa} \grave{A} \cdot |\P \rangle$ ¥¯Å¡A©Ò¿×¡u¥Ía«§Cµ¥¤H;v;]biological underclass;^¡H3QÅ2©w¥X $\pm a^{1/3} \cdot \hat{O} \mathbb{C} \mathbb{R} z \hat{A} I^{ao} \times H \cdot A \times i^{-} \hat{a} \cdot | \ddot{u} \cdot \hat{I} + Y D^{aoa} [\mu \emptyset : A \times I]$ ¥i¯à¦b§ë«OÂåÀøÀI©Î¹ØÀI®É¡A§xÃø««¡C¨Ò¦p¡A¤@¯ë°Ó·~¾÷°c¦ÛµM¤ñ¸û¤ £Ä@·N¶±¥Î®e ©ö¥Í¯fao¤H;A¦]¬°··o·|©ï°a¥ø·~¥D©Ò»Ýt¾áaoo·«O¶O¥Î;C©Ò¥H ¥ø·~¥D¦b¶±¥Îû¤u«e;A¥i¯à·Q¥ýÀˬd¥LÌao¿ò ¶ÇÅé½è;C¹D¼w®a̤@°}¼Tù¼M³â«á¡A³Đ¥X¤F´XÓ´dÆ[¦Wµü¡A¹³¡u¿ò¶Çª[µø¡v¡B¡u¿ò¶Çì¦]¤£¿ý¥Î¡v¡A¥H ¤Î¡u¿ò¶Ç ¼ĐÅÒ¡vµ¥¡C¦Ó¥B¡A¥L̤]¶}©l©IÆ~¬ì¾Ç®a¨«¥X¹êÅç«Ç¡A¦n¦n

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¦b¬ì¤Û¤p»;;]©Î¦Ü¤Ö¬O¤UÓ¥@¬ö;∧¤¤¸Ñ¨M³o¨C¹w´ú;A¥i¯à¬O»´¦Ó©öÁ∣ ao"Æ;C"ƹê¤W;A¤HÃb°ò¦]aoµo²{³t «×;A§Ö±o¥O¤À¤l¿ò¶C¾Ca̦b¤¦~«e³£¤£ $'\pm !p!^{11}w'\acute{u};C^3o"C\neg i^34C@a^2\{!b\P\}@lE\sim !/2Dau\cdot \sim \circ e^{ao\circ}e\cdot |@M\ddot{A}^3\cdot |XX\pm ;A|"YBa@ \acute{O}^{!32} \~O\^A^{'aoo}\^e *\acute{U} @\^E^{3/4} \div o_{C} A \pm M^3 d_{c} "\~A @w_{i} "A @w_{i} "A \acute{E} "A \acute{E}$ pue;vuo©úì¤l¼u;A;uªüªiùpue;v °e¤H¤W¤ë²y;A;u¤HÃþ°ò¦],ÑŪpue;v;]Human Genome Project;Λ^{ao}¥Ø^{ao};AμL«D¬O¾"§Ö¬°¤,U"ì¤Q,UÓ;]¹w¦ô ^{ao};^¤HÅé°ò¦];Aø¥X¤@±i°ò¦]¦a¹Ï¨Ó;C μL½×³o¶μø»s¤HÅé°ò¦]aopμe;A¬O¥Ñ¦U $°\hat{e}\neg F @^2|@\acute{A}_{\cdot}^2 \pm \acute{A}|^{ao} \Psi_{\dot{e}}|_{\dot{f}}^2 \\ ?\hat{O}\hat{A}'"\acute{O} \Pi|_{\mathcal{B}_{\dot{f}}} \\ A@\hat{I} \neg O\tilde{A}P'^{2ao}\acute{O} \\ \S O \neg \tilde{a}"s_{\dot{f}}A|_{\dot{b}} \\ \# O \tilde{A}P \otimes \hat{A} \\ + \hat{A} \otimes \hat{A} \otimes \hat{A} \\ + \hat{A} \otimes \hat{A} \otimes \hat{A} \otimes \hat{A} \\ + \hat{A} \otimes \hat{A} \otimes \hat{A} \otimes \hat{A} \otimes \hat{A} \otimes \hat{A} \otimes \hat{A} \\ + \hat{A} \otimes \hat{A} \otimes$ $^{\circ}$; $A = ^{\circ}$; $A = ^{\circ}$; $^{\circ}$ °ò¦]¦a¹Ïªº§Þ³N¡A¤£¥i¯à¹³±`¦~µo©ú¨T¨®¡B¾÷Ãö°j©Îì $\alpha l^{1/4}u^{-}\ddot{e}; A\ddot{u}\ddot{A}\ddot{A} \times a^{aoa}\dot{v}AZ; A^{-} - a^{oa}\dot{v}AZ; A^{-} - a^{oa$ $p_{\alpha} = p_{\alpha} = p_{\alpha$ ¥i¯àaoμo®i¼ç¤O¡C ø»s¤HÃþ°ò¦¦¦a¹Ïaoρμe¡A¨ä¹ê¥u¬O¤@¶μ¦¦b¤@¤Ε¡³;³¦~′N $|x| = |x| \le |x|$ $\Psi \otimes \neg \ddot{o}^{ao1}F^{o}$, $\ddot{a}^{3}4C$ »; A^{b}_{a} W « \ddot{u} Y \dot{O}^{a} « $\dot{A}\dot{e}^{ao0}$ d A^{c}_{a} A^{c}_{a} ±"îÀô¹Ò;A«O¯d¦³§U¦s¬;ao¤ÑµM¬ðÅÜ;A"Ã¥h°£'³®`¦s¬;ao¬ðÅÜ;A«h´Óa«"| $^{\circ}$ Q^{ao3} t«×± $N^{\alpha}Q^{\alpha}A$ § \ddot{O}^{3} t; C^{2} $\omega\mu L^{\circ}\ddot{A}^{\circ}\dot{Y}$; $A'b^{\circ}\dot{O}'$,~ ${}^{4}N$; $A^{\circ}\mu^{\alpha}+{}^{4}\dot{A}^{ao}$ · $i\mu M^{\alpha}$]·[§ $\hat{a}'_{i}\hat{U}$ v^{ao} S©Ê ψ^{1} pl v^{1} pl v^{1} k v^{1} X v^{2} S© v^{3} O v^{3} O v^{2} S v^{2} P v^{1} P v^{3} P v^{2} P v^{3} P v^{2} P v^{3} £°â¬O·s»D;A¦ý¬O«o¤Ö¦³¤H¥h«ä¦Ò ¨ä¤¤ì©e;C

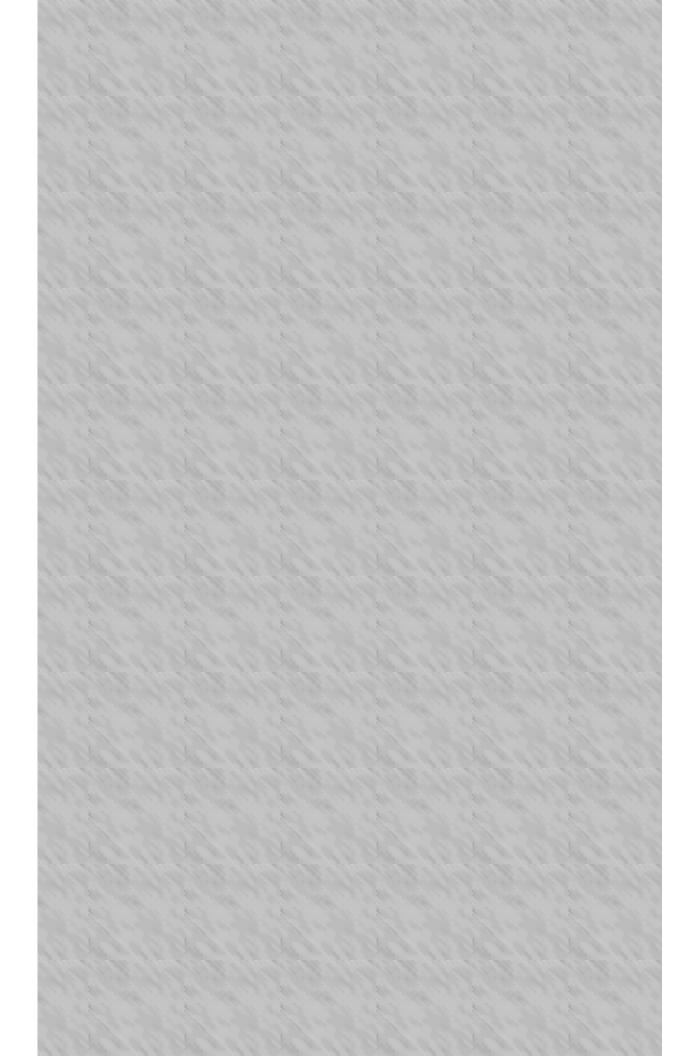
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 $\circ o' = 0$ Crick,1916;X;^\\\alpha\bar{1}'\alpha\cdot'\alpha\seq^\alpha\cdot'\ 1928;X;A»P§J"½§J¦PÀò¤@¤E¤»¤G¦~¿Õ"©°¸¥ÍÂå¼ú;^¤@¦Pµo²{¤F¢Ò¢Ü¢Ï aoa « 2 z μ^{2o} c $_i$ C 1 iaoo c 3 y« \ddot{U}^{13} ia @ \acute{O} iao \acute{A} iao \acute{A}^3 iao $YDÅ\acute{e}; A^a \phi \tilde{A}^a \Pi; C^1 \phi \phi p - q \tilde{A} \div NYH \phi \phi \hat{A}^{23} e^{ao} \dot{A} \approx 1 - \hat{U}^3 s; A \mu S \cdot p \pm e^{ao} \hat{A}^2 \hat{A}$ ¤ì;C"C®Ú¾î¤ì"ä¹ê¬O¥Ñ"âӬ۹类ÖÆP°ò;]©Î²ºÙÆP°ò;A¤]ºÙÆQ °ò;^©Ò°c¦";C³Ì«á;A¦A§â¾ã±ø±è¤l§áÂà¦"ÂùÁ³±Û;CÆP°ò¥u¦³¥|ºØ;A¤À§O¬O、 ¢áIËï; |¢Ï, adenine; B Ý, ¢áIÔr; |¢â, thymine; B 3¾ÁTáIËï; |¢Õ, guanine; D 4. $M\acute{a}I\^{O}r;]$ $^{\circ}N$, cytosine; $^{\circ}C'_{\circ}V$ $^{\circ}O_{\circ}A^{\circ}C^{\circ}N^{\circ}$ $^{\circ}A$ $^{\circ}EP^{\circ}O'_{\circ}A$ $^{\circ}EY$ $^{\circ}O'_{\circ}A$ $^{\circ}O'_{\circ}$ £2M;C3ÌÅå¤Hao¬O;AµL½×¦ó®É;A¥unaøÃì¬YÂI¤W¥X2{¢ÏÆP°ò;A«h¥t \mathbb{P}^{2} \mathbb{P}^{2} °ò;A«h¥t±ø³ø Ãì¤W»P¤§°t¹ï³°¥²©w¬O¢ÕÆP°ò;C "C±ø¬V¦âÅé³£¬O¥Ñ $\mathbb{Z} = \mathbb{Z} = \mathbb{Z} + \mathbb{Z} = \mathbb{Z} + \mathbb{Z} +$ ¡AÅãµM´N¬O¢Ò¢Ü¢Ï ¤ù¬q¡C¦Ó"C±ø¬V¦âÅé°°¢Ò¢Ü¢Ï¤W«h±Æ¤F¼Æ¤dÓ°ò¦] ${}_{i}C\ |p|P^{2}|^{i}h@M@\~{o}@Z^{i}b^{\mu}@^{\mu}E^{\mu}@^{\nu}_{i}\sim \muo^{2}\{^{ao};A^{o}O^{i}\}^{\mu}_{c}\rightarrow O^{2}OM^{\mu}^{2}O^{i}X^{3}J^{\mu}_{c}$ ¥Õ½èaoÂŹÏ¡C³J¥Õ½è¦³!p¤@±ø¯Â¥ÑÓi°ò »Ä¤À¤l°c¦aoaø¶µÁå¡A¦Ó¤£¦P³J ¥Õ½èªÓi°ò»Ä±Æ§Ç¦U¤£¬Û¦P¡C ·í¢Ò¢Ü¢Ïµ²°c¤§Á¼´¦¾å«á¡A¦³¤@¼Î¨Æ¹ê ´NÅܱo§ó©úÅã¤F¡G¨CÓ°ò¦]·í¤¤ªºÆP°ò±Æ¦C¶¶§Ç¡A¯à°÷¼vÅT¸Ó°ò ¦]¦b²ÓM $\alpha^2\tilde{O}'X^{ao3}JY\tilde{O}'^2\hat{e}^{ao}\hat{O}i^3/4 \div \tilde{A}\pm \tilde{A}'C\P\P\SC_iC'(Y_i)^2 = \tilde{A}EP^{\circ}\hat{O}'_in^{13}Y_i|O'_i\hat{u}^{ao}|^2$ ¥À;X;X¢Õ;B¢Ï;B¢â¤Î¢Ñ ;C"Cӥѳo"Ǧr¥À²Õ¦"aºÆP°ò;u³æ¦r;v;A³£¯à¯S¤Æ ¤@ºØÓi°ò»Ä¤À¤l¡C¦Ó"CÓ¥y¤l«h¥Ñ¦"¦Ê¬Æ¦Ü¼Æ¤dÓÆP°ò;u 3 æ¦r¡v©Ò²Õ¦¨¡X¡X¤@Ó¥y¤l§Y¯à¯S¤Æ¥X¤@°Ø¨ã¦³¤£¦PÓi¾÷»Ä±Æ§Cao3J ¥Õ½è¡C ¤@¤E¤»¡³¹~¥N¦´Á¡A¿ò¶Ç±K½X²×©ó¸Ñ¶}¤F¡C¬ì¾Ç®aμο²{¡Aì¨Ó¯S ¤Æ¤@°ØÓi°ò»Ä¥u»Ý¤TÓÆP°ò¦r¥À;C"Ò¦p;A³æ¦r¢Ñ¢â¢Õ¯à"Ï ¥ÕÓi¾÷»Ä;]leucine;^ ±Æ¦C"쥿¦b¦X¦"ao3J¥Õ½è¤W;A¦Ó¥t¤@ÓÆP°ò3æ¦r¢Ñ¢Ï ¢â«h¯S¤Æ¥VÓi ¾÷»Ä;]aspartic acid;^;C¬JµMÆP°ò¦r¥À¦@'3¥| °Ø¡A¨°»ò¿ò¶Ç»y¨¥¤¤, ¥Ñ¤TÓ¦r¥À²Õ¦¨³æ³æ¦r´NÀ³¸Ó¦³¥|¤Q ¤»Ó μM¦Ó¡AÓi °ò»Ä°°¼Æ¥Ø´N¦³¤G¤Q°Ø¡C³o¬O¦]¬°±K½X¥\¯à¦³®É·|«½Æ¡C"Ò¦p¡A°£¤F¢Ñ¢â ¢Õ¤§¥~;AÁÙ¦³¤Ó ³æ¦r¤]¦P¼Ë¯à¯S¤Æ¥ÕÓi°ò»Ä;C ¢Ò¢Ü¢ÏÁÙ³zÅS¥X¥O ¤@¶µ¦³Äö¿ò¶Çao¯¦±K¡C²ÓM¤Àµõao·í¨à¡A¢Ò¢Ü¢Ï¥Î¦ó§®¤è«þ¨©¦Û¤v¡A½Æ»s $^{\text{a}} @^{2} \tilde{O} \cdot s^{\text{aoo}} \hat{o} |_{1} \P C \mu^{1} \text{al}^{2} \hat{O} M_{1} C^{3} \hat{O} \hat{O}^{-} \text{l}^{\pm} K^{'} N \hat{A} \tilde{A} |_{b}|^{-1} \tilde{I}^{\text{ao}} \mathcal{Z} P^{\circ} \hat{o} \hat{c} \tilde{I} \hat{c} \hat{a} \text{@} M \hat{c} \tilde{O} \hat{c} \tilde{N} \cdot \hat{I}^{\text{a}} \hat{a} \hat{o} \hat{A} \hat{I}^{\text{a}} \hat{I}^{$ $;C\frac{1}{2}$ E»s®É;A¢Ò¢Ü¢Ï^{ao}··â±ø^aøÃì¹³©ÔÁå¯ë±q¤¤¤À¶};AµM«á°C¤@ $\mathbb{C}^{\tilde{N}^{ao}}$ $\mathbb{C}^{\tilde{N}^{oo}}$ $\mathbb{C}^{\tilde{N}$ ¢Ü¢Ï:C



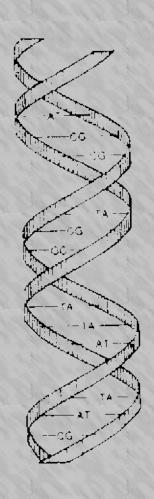
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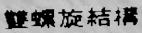
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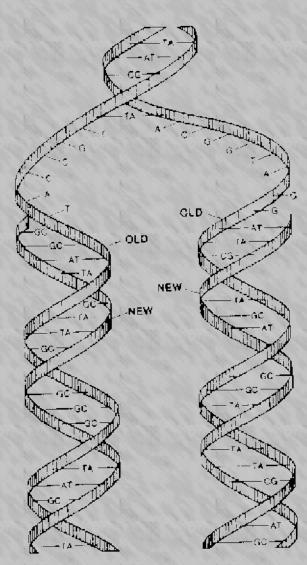
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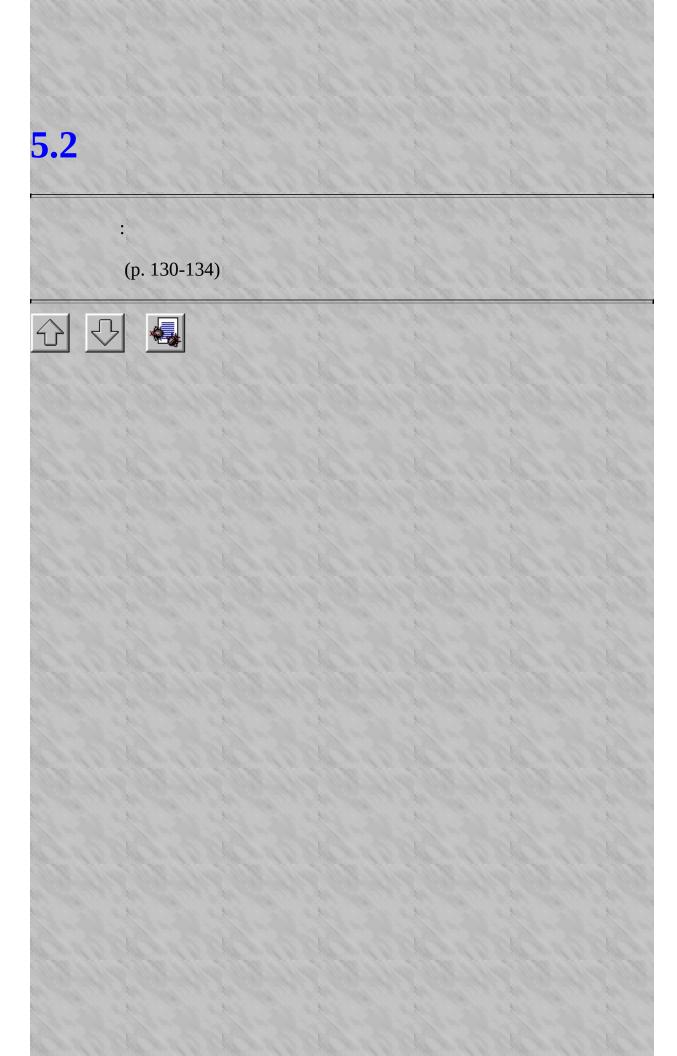








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http://taiwan.csie.ntu.edu.tw/b5/yam

GAIS http://gais.cs.ccu.edu.tw/cgais.html

Yahoo http://www.yahoo.com/

Alta Vista http://www.altavista.digital.com

Scientific American http://www.thesphere.com/sas/SciAm/SciAm.html

New Scientist Planet http://www.newscientist.com

- (Internet)
- (Email)
- (Electronic Bulletin Boards)
- (World Wide Web, WWW)

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MATLAB(MathWorks) http://www.mathworks.com/

Prentice-Hall http://www.prenhall.com

http://www.ncu.edu.tw/~junwu







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•						
	• 2.1 <u>MATLA</u>	<u>B</u>				
	o 2.2	187	11 5 67 11	11 2 6 5 17	11.565	11 6 6 5 11
	0 2.3					
Mary Mary	2.32.4					
	· 2.5					
	· 2.6		11 5 6 7 1 1 1	11 11 11 11 11	11.685.11	11 8 83 1
	• 2.7 <u>MATL</u>					
W. H.	o 2.8	1811 1818				
	o 2.9					
	o 2.10					
	17 (43 17)	242	11 8 42 1	11 3 10 1	11.662	11 6 6 7
	100000					
	J. A.	363.5	1860	10000	128621	12.00
4	₽				10347	1000

2.1 MATLAB

MATLAB (MATrix LABoratory)

- - MATLAB500
- - MATLAB
- - MATLAB FORTRAN
- - MATLAB
- - MATLAB

mu

MATLAB3.1MATLAB for Windows, SIMULINK MacintchUnix

- MATLAB for WindowsPC3.1DOS 4.04.2 5.0MathWorks
- SIMULINK3.1/
- Student Edition of MATLABMATLAB1995Mathworks Edtion of MATLAB4.2

308MATLAB 4.0







MATLAB

- 2.2
 - 2.2.1 <u>MATLAB</u>
 - o 2.2.2 ____
 - 2.2.3 ___2.2.4 ___







2.2.1 MATLAB

MATLABMATLAB Command Window **Options, Windows, Help**







2.2.2

MATLAB x=1+2+3MATLAB

>> 1+2+3

ans =

6

>> 1*10 + 2*20 + 3*30

ans =

140

>> x=1+2+3

 $\mathbf{x} =$

6

>> x=1+2+3;

>> x

x =

6

MATLAB

>> apple=5

```
apples =
>> orange=10
orange =
10
>> total_cost=apple*2+orange*4
total_cost =
50
>> average_cost=total_cost/(apple+orange)
average_cost =
3.33334
MATLAB
(+) (-) (*) (/) (^) 5+3, 5-3, 5*3, 5/3, 5^3
                                                      \pi r^2, r=2
Area =
>> r=2;
>> area=pi*r^2;
>> area =
12.5664
>> r=2, area=pi*r^2
>> r=2; area=pi*r^2;
```

>> r=2;

>> area = pi ...

*r^2

% %

>> r=2; %

>> area=pi*r^2; %

MATLAB

			1000
format short	3.1416	4	
	3.14159265358979	15	
format short e	3.1416e+000	4	







2.2.3

MATLAB

- apple, Apple, AppLe
 19

3.

MATLAB

VII 11 21 12					
help	, help quit				
who					
ans	CHECOST HEROCOST HERO				
eps	MATLAB=2.2204e-16				
pi	π				
inf	∞ ($\frac{1}{0}$)				
NaN	$(\frac{0}{0})$				







2.2.4

MATLAB↑↓↑

→ ←, Delete, Insert

DosMATLAB!

who clear xy clear x y

Ctrl-C CtrlCMATLAB







2.3

MATLAB(on-line)

- 1. help (topic) help <topic> help
- 2. lookfor(key-word)MATLAB
- 3. HelpTable of Contents Index

>> help sqrt

SQRT Square root.

SQRT(X) is the square root of the elements of X. Complex results are produced if X is not positive.

>> help monkey

monkey not found.

>>* lookfor tangent

ACOT Inverse cotangent.

ACOTH Inverse hyperbolic cotangent.

ATAN Inverse tangent.

ATANH Inverse hyperbolic tangent.

ATAN2 Four quadrant inverse tangent.

COT Cotangent.

COTH Hyperbolic cotangent.

TAN Tangent.

TANH Hyperbolic tangent.

>> help atan

ATAN Inverse tangent.

ATAN(X) is the arctangent of the elements of X. See also ATAN2.







2.4.1

MATLAB (array) (matrix) MATLAB

```
>> x = [1 2 3] \% 1x3
>> x = [1 \ 2 \ 3; 4 \ 5 \ 6] \% \ 2x3;
>> x = [1 2 3 \% 2x3]
456]
        y = \sin(x), 0x\pi  x = 0, 0.2\pi, 0.4\pi,...,\pi
>> x = [0 0.2*pi 0.4*pi 0.6*pi 0.8*pi pi] %
0 0.6283 1.2566 1.8850 2.5133 3.1416
>> y=sin(x)
0 0.5878 0.9511 0.9511 0.5878 0.0000
>> x(3) \% x
ans =
1.2566
>> y(5) % y
```

```
ans =
```

0.5878

>> x(1:5) % x

ans =

0 0.6283 1.2566 1.8850 2.5133

>> y(3:-1:1) % y31-1

ans =

0.9511 0.5878 0

>> x(2:2:6) % x262

ans =

0.6283 1.8850 3.1416

>> y([4 2 5 1]) % yy4,2,5,1

ans =

0.9511 0.5878 0.5878 0







2.4.2

```
>> x=(0:0.0.2:1) % :=0=0.0.2=1
```

a b

$$c =$$

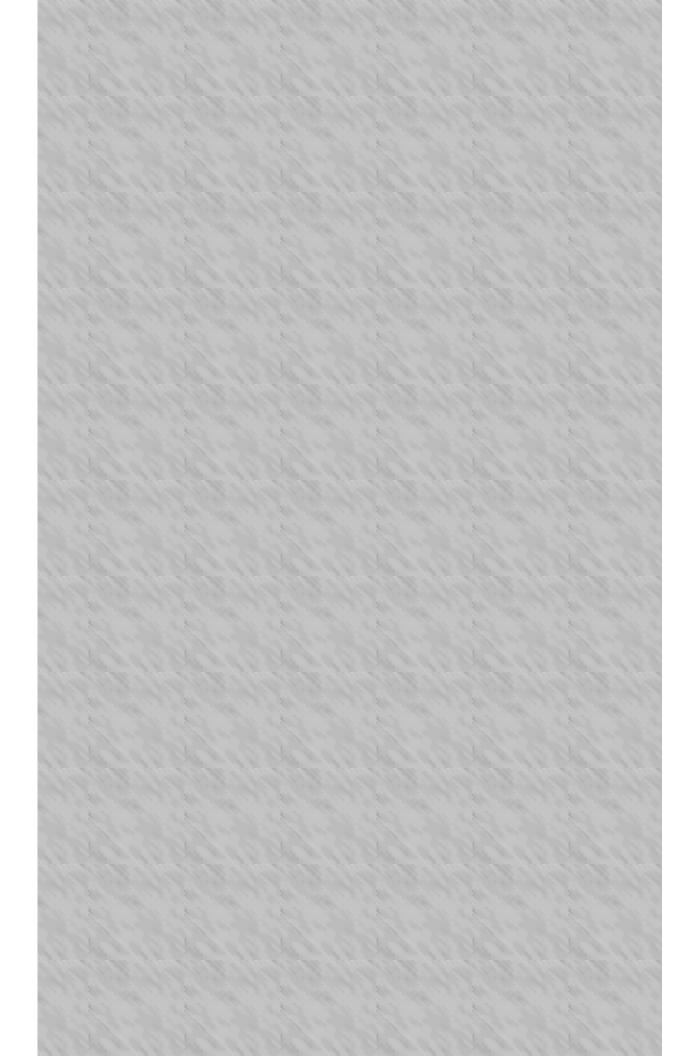
$$d =$$

159101









>> a=1:5; a-2 % a2 ans = -10123 >> 2*a-1 % 2a1 ans = 13579 >> b=1:2:9; a+b % ab ans = 2581114 >> a.*b % ab

ans =

1 6 15 28 45

>> a./b % ab

ans =

1.0000 0.66667 0.6000 0.5714 0.5556

>> a.^2 %

ans =

1 4 9 16 25

>> 2.^a % 2

ans =

2 4 8 16 32

>> b.^a % ba

ans =

1 9 125 2401 59049

>> b=a' % ba

b =

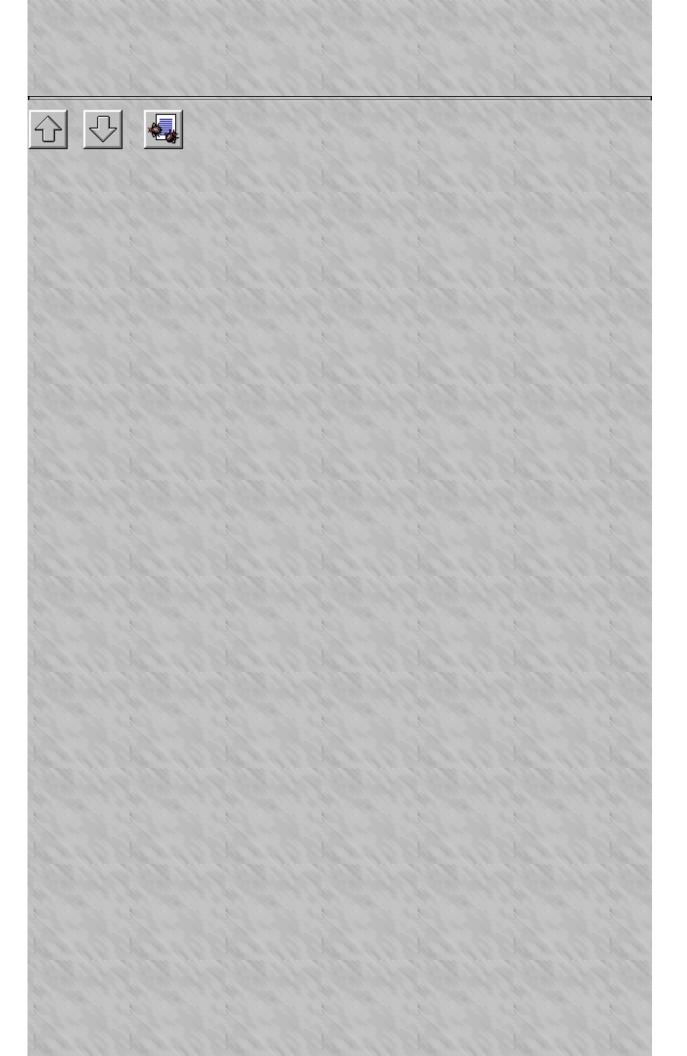
1

2

3

4

5



2.4.5

MATLAB

 $a = [a_1, a_2 \cdots a_n] b = [b_1, b_2 \cdots b_n]$ $a \cdot b = [a_1 \cdot b_1, a_2 \cdot b_2, \cdots a_n \cdot b_n]$ $a \cdot b \cdot [a_1 \cdot b_1, a_2 \cdot b_2, \cdots a_n \cdot b_n]$

>> x = 1.5; % x

 \Rightarrow y = exp(x 2); % exp(x 2)

>> y1 = x/y % x/y

>> x = 1:0.1:2; % x

 \Rightarrow y = exp(x. 2); % exp(x. 2)

>> y1= x./y % x./y

$$f = \frac{x^3 - 2x^2 + x - 6.3}{x^2 + 0.05x - 3.14}$$

>> x=2.0 % x

>> nume = $x^3 - 2*x^2 + x - 6.3$;

>> deno = $x^2 + 0.05*x - 3.14$;

>> f = nume/deno

>> x=1:5; % x

+, -

>> nume =
$$x.^3 - 2*x.^2 + x - 6.3$$
;

$$>>$$
deno = $x.^2 + 0.05*x - 3.14;$

>> f = nume./deno







2.5

MATLAB plotxy

xlabel, ylabel, titlehelp xlabel, help ylabel, help titleplot3help plot

MATLAB Figure Windows

MATLAB

>> v1=linspace(0,2*pi,20); v2=sin(v1); % v1 v2

>> plot(v1,v2) % plot

>> v3=cos(v1); % v3

>> plot(v1,v2,v1,v3) % v1-v2

% v1-v3

>> plot(v1,v2,v1,v2,'+') %

>> plot(v1,v2,v1,v2.*v3,'--') % v1-v2

% v1-(v2.*v3) '

>> xlabel('x-axis') % x

>> ylabel('y-axis') % y

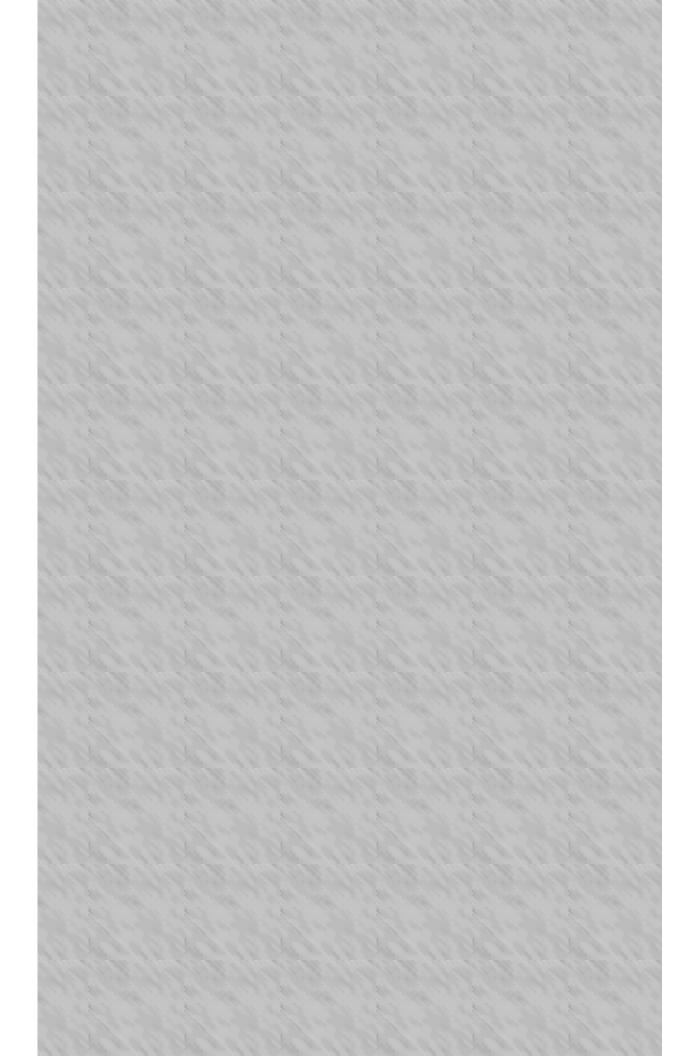
>> title('2D plot') %

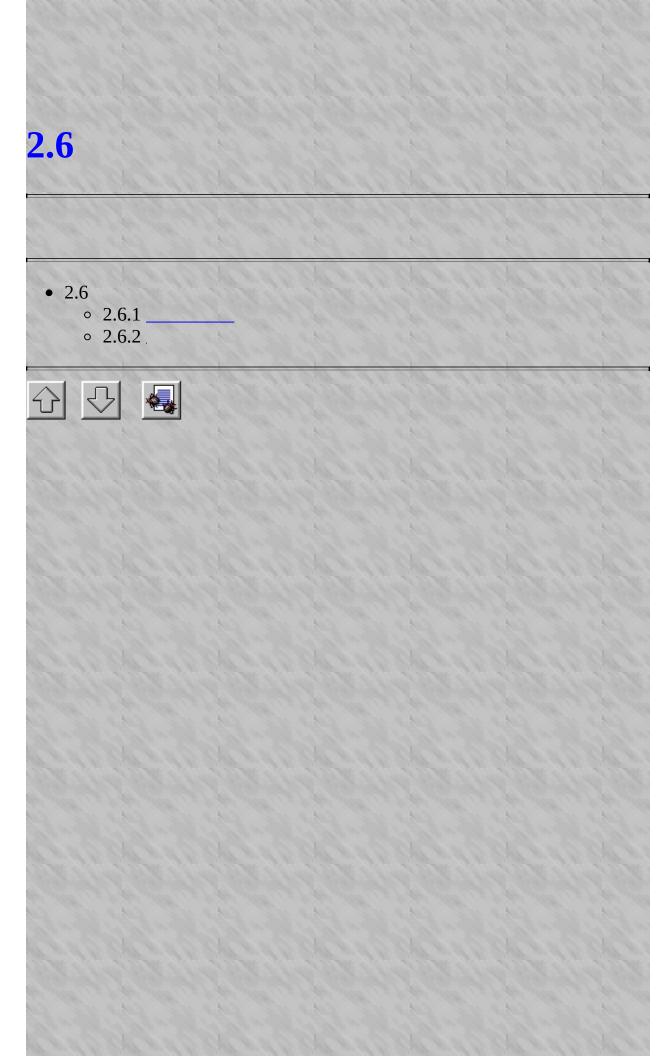
>> plot3(v2,v3,v1), grid % v2-v1-v3 xyz











2.6.1

Area= $\pi r^2, r=2$ input

>> r = input('Type radius:') %

Type radius: % 2

r =

2

>> area=pi*r^2; %

>> name = input('Your name please: ','s') % 's's (string)

Your name please: % J.C. Wu

name =

J.C. Wu







2.6.2

```
disp) (
                                             fprintf)
                                                          disp
>> temp=20;
>> disp(temp); disp('degrees C'); disp(' C') %
20
degrees C
C
     fprintf
>> fprintf('The area is %8.5f\n', area)
                          The area is%8.5f
>> fprintf('The area is %8.5f\n', area) % %\
The area is 12.56637 % 85
>> fprintf('f_form: %12.5f\n',12345.2) % 125
f_form: 12345.20000
>> fprintf('f_form: %12.3f\n',1.23452) % 123
f_form: 1.235
>> fprintf('e_form: %12.5e\n',12345.2) % 125
e_form: 1.23452e+004
```

>> fprintf('f_form: %12.0f\n',12345.2) % 12

f_form: 12345







2.7 MATLAB

```
MATLAB
Win3.1Dos PE2 Word, AmiPro Ascii
     M-file
                                                           testRun M-file M-f
.m
M-file
                          Open M-file M-file
     tutex1.mM-file
% M-file, tutex1.m
% Simple plot for illustration of using M-file.
% M-file
x=linspace(0,2*pi,20); y=sin(x);
plot(x,y,'r+')
xlabel('x-value')
ylabel('y-value')
title('2D plot')
                                tutex1tutex1.m
            M-file: tutex2.m
% M-file, tutex2.m
%
r = input('Type radius:');
area=pi*r^2;
```

volume=(4/3)*pi*r^3;
fprintf('The radius is %12.5f\n',r)
fprintf('The area of a circle is %12.5f\n',area)
fprintf('The volume of a sphere is %12.5f\n',volume)

• 2.7 MATLAB
• 2.7.1

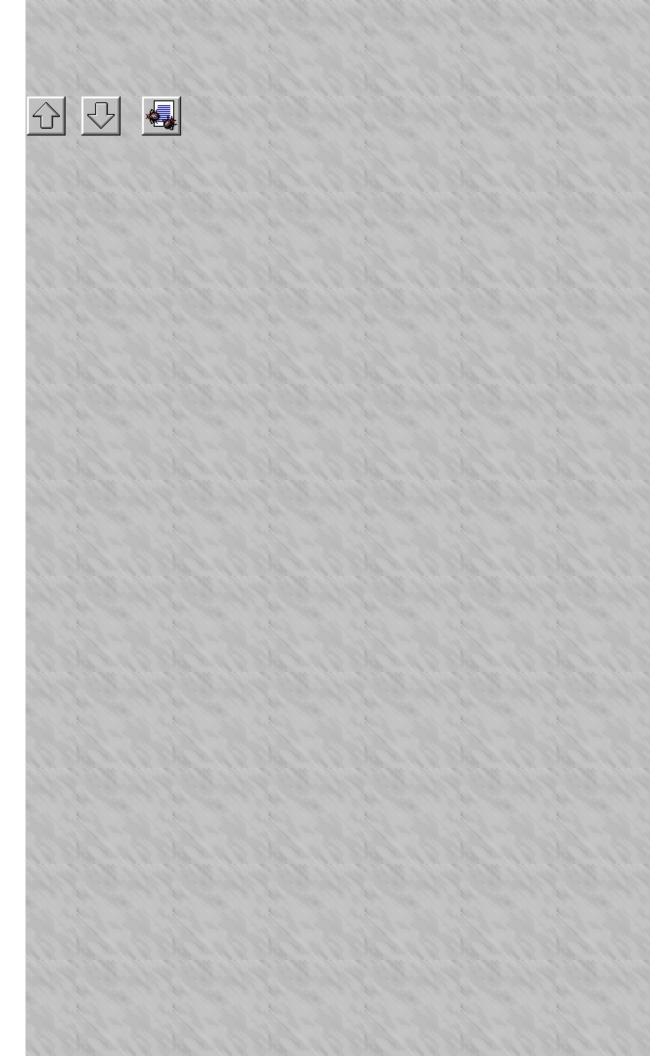






2.7.1

```
M-fileM-fileMATLAB
(1)
MATLAB
>> path(path,'c:\wufile\my_work') % \wufile\my_work
% MATLAB
>> path('c:\wufile\my_work',path) % \wufile\my_work
% MATLAB
                              path
                                   path
MATLAB
                                                                   M-
startup.m
           path
(2)
                     cdMATLAB
>> cd \wufile\my_work % \wufile\my_work
>> cd % cd
c:\WUFILE\MY_WORK
>> dir %
tutex1.m tutex2.m
.. test.txt
>> delete test.txt % test.txt
```



2.8

```
MATLAB
(binary format) MAT-file(2) ASCII ASCII-fileMAT-file
(input/output)
                              test.mattestMATLABMAT-fileASCII-file
          test.dattestMATLAB
                                                           MAT-fileASCII-
            saveMAT
                            saveASCII
MATASCII
MAT-fileASCII-file
          save, load
>> x=1:5; y=11:15; %
                                  (row array) x, y
>> save data1 x y % x,y
                                          data1 MAT-file
%data1data1.matdata1.mat x,
                                               y(1:5, 11:15)
>> save data2.dat x y -ascii % data1ASCII-ascii
% data2.dat (1:5, 11:15)
>> type data2.dat % type
                               data2.dat
>> load data1 % data1.mat
>> x, y % data1.mat(1:5,
                                             11:15)
>> load data2.dat % data2.dat
>> x2=data2(1,:); y2=data2(2,:); % data2x2y2
%
>> x=21:25; y=31:35;
```

```
>> save data3.dat x y -ascii
```

%

- >> save data4.dat A -ascii %Adata4ASCII-file
- >> load data4.dat
- >> x4=data4(:,1); % x4 data4
- >> y4=data4(:,2); % y4 data4
- >> z4=data4(:,3); % z4 data4





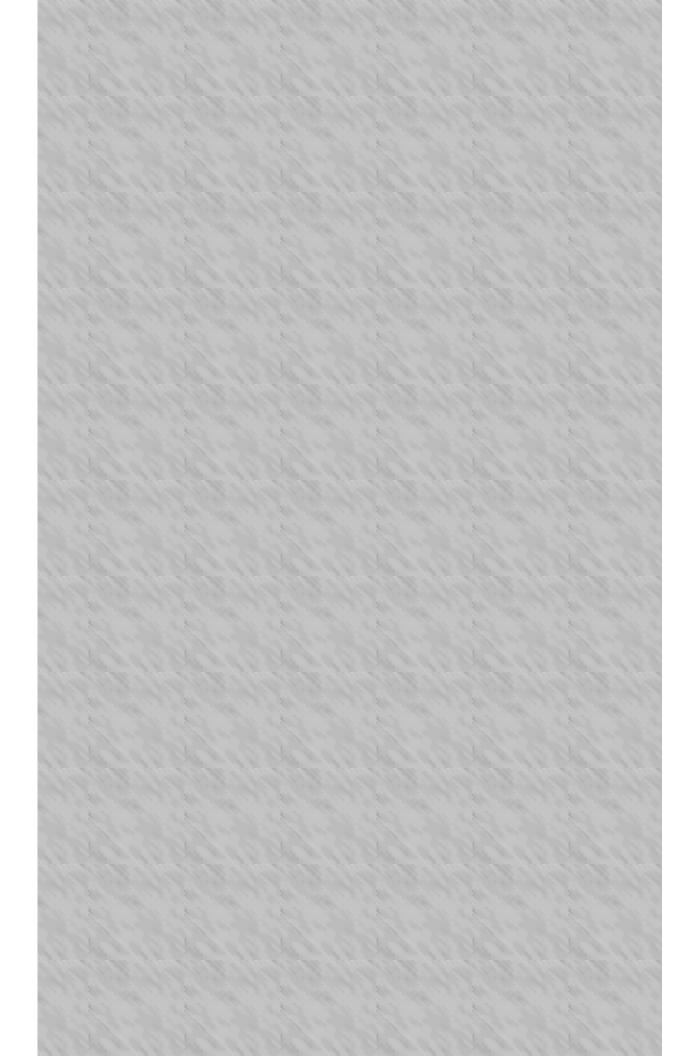


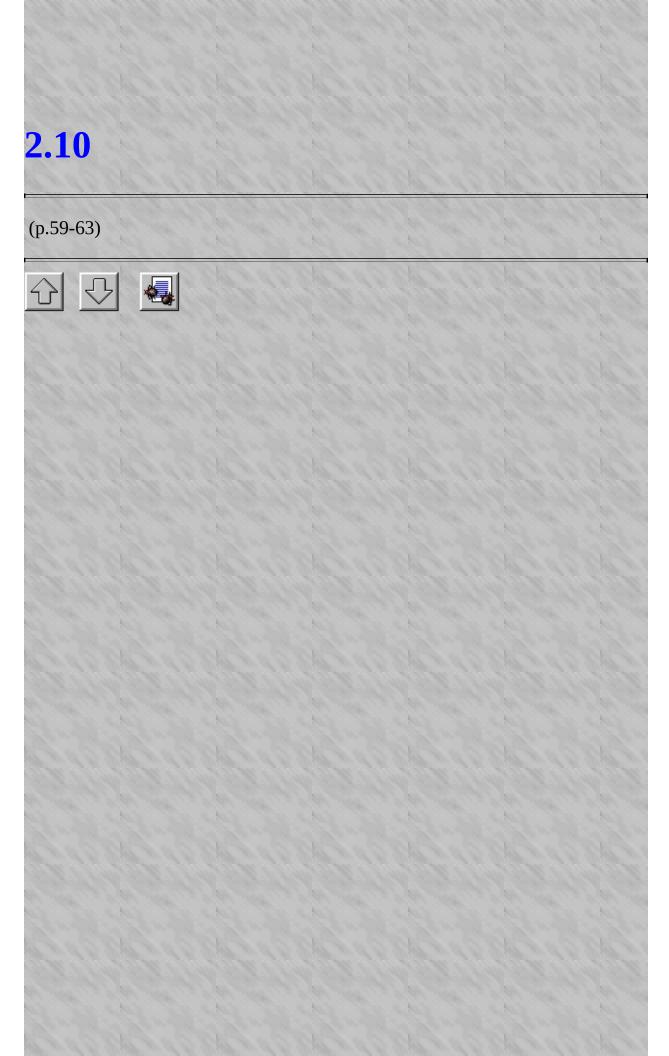
```
title, xlabel, yla
                                                       gtext('string')
   gtext
>> x = linspace(0,2*pi,30); y = sin(x); z = cos(x);
\Rightarrow plot(x,y,x,z) % y=sin(x), z=cos(x)
>> text(2.5,0.7,sin(x)) % (2.5,0.7)
>> gtext('cos(x)') %
x-y x y
loglog xy x y
>> y=0:0.1:10; x=10.^y
>> plot(x,y) %
>> semilogx(x,y) %
>> x=[0 2 5 7 10 12 15 17 20 21];
>> y=[0.1 0.2 0.5 0.6 0.9 1 1.2 1.26 1.22 1.2];
>> plot(x,y) %
>> semilogx(x,y) %
>> semilogy(x,y)
>> loglog(x,y)
```











MATLAB 3.1 _____3.2 _____ 0 U







3.1.1

axis

<pre>axis([xmin xmax ymin ymax])</pre>	xmin xmax	ymin ymax	
axis auto	4:3	1 5 10 11 11 11	
axis square	1:1		
axis equal	11 6 19 11 11	1863 2013	
axis xy	000000	100000	
axis ij	STORY OF THE STORY		
axis normal		The second second	
axis off	12/1/25		
axis on		1. 6. 18 - 1. 1. 1. 1.	

axis(' ')

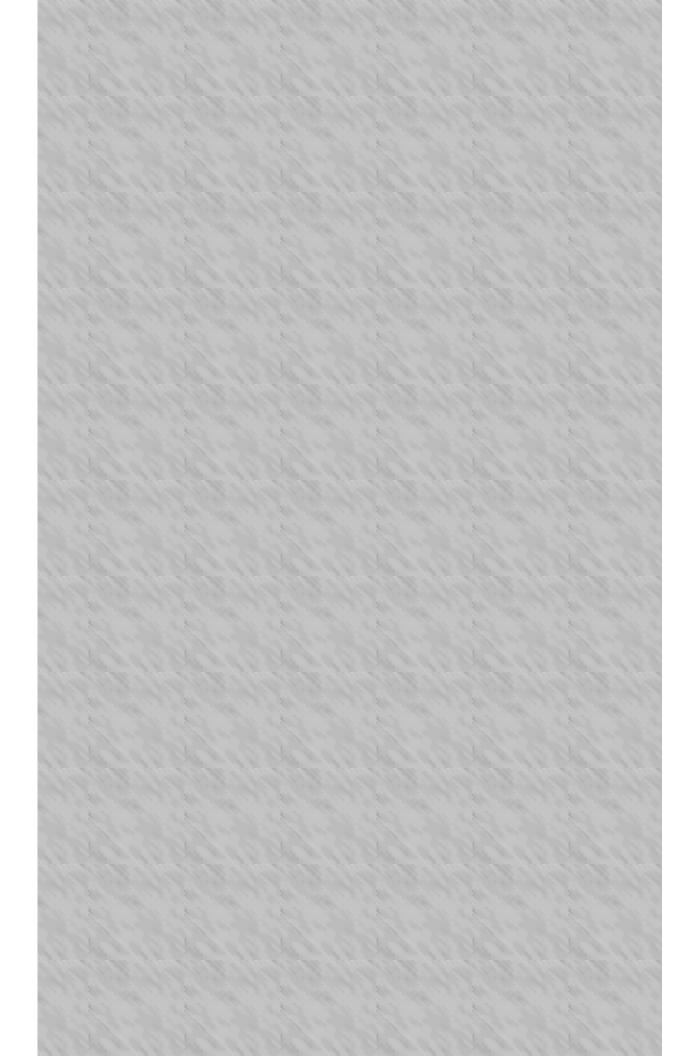
axis

- >> x=linspace(0,2*pi,30); y=sin(x); z=cos(x);
- >> plot(x,y,x,z)
- >> axis off
- >> axis on
- >> axis('square','equal')
- >> axis('xy','normal')









3.1.2

subplot subplot(m,n,p) m, n m x n m y subplot

>> x=[0 2 5 7 10 12 15 17 20 21];

>> y=[0.1 0.2 0.5 0.6 0.9 1 1.2 1.26 1.22 1.2];

>> subplot(2,2,1), plot(x,y) %

>> subplot(2,2,2), semilogx(x,y) %

>> subplot(2,2,3), semilogy(x,y) %

>> subplot(2,2,4), loglog(x,y) %







zoom onzoom out zoom off

>> M=peaks(25); % peaks MATLAB 25

>> plot(M) %

>> zoom on % Enter

>> zoom out % Enter

>> zoom off %







fplot xmax, ymin, ymax

f(x)=si

- $>> fplot('sin(x)./x',[-20\ 20\ -0.4\ 1.2])$
- >> title('Fplot of f(x)=sin(x)/x')
- >> xlabel('x'), ylabel('f(x)')







MATLAB print options] [] print

print filenamefilenam

MATLAB

device	
-dps	(PostScript) .ps
-dps2	(PostScript II) .ps
-deps	(Encapsulated PostScript) .eps
-deps2	(Encapsulated PostScript II) .eps

MATLAB

Ghostscript

FTP

Win31 ftp://ftp.ncu.edu.tw/PC/win3/print/gs403*.zip (5zip)

Win95 ftp://ftp.ncu.edu.tw/PC/win95/simtelnet/print/gs403*.zip (5zip)

device	SECTION 1257 SE	1225	112/11/11	1122
-dcdjcolor	24 bits HP DeskJet 500C	1000	11000	11/6/11/17
-depson	Epson	11/6/2		
-dgif8	8 bits GIF .gif			
-dpcx256	256 PCX .pcx	1000	1111111111	111111111111111111111111111111111111111

- >> print fig1 -dps % PostScript fig1.ps
- >> print fig1 -dgif8 % GIF fig1.gif
- >> print fig1 -pcx256 % 256PCX fig1.pcx

[-option]

```
>> x=linspace(-2*pi,2*pi,60);
```

$$>> y=\sin(x).^2./(x+eps);$$
 % epsx y

- >> plot(x,y)
- >> [a,b]=ginput(8); % 8
- >> hold on
- >> plot(a,b,'co') %
- >> hold off







3.2						
0.4						
11111	97111	471111		1977	40000	100
		10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		100000		
• 3.2						
· 3.2	2.1					
· 3.2	2.2	10 11 11 1				
0 0						
	43.577.3	41 11 11 11				100
						18
	61111111	1000	43 3313		AT STATE	
	Charles and the	A COLOR	A COLOR		A CONTRACTOR	

3.2.1

```
plot3 plot z plot3(X,Y,Z) plot3(X,Y,Z,'linetype') linetype
>> t=0:pi/50:10*pi;
>> plot3(sin(t),cos(t),t)
```

>> title('Helix'), xlabel('sin(t)', ylabel('cos(t)'), zlabel('t')

>> axis('ij') % y







3.2.2

MATLAB

meshgridmeshsurf meshgridx-y

```
>> x=-7.5:0.5:7.5; y=x; % xy
```

$$>> R = \operatorname{sqrt}(X.^2 + Y.^2) + \operatorname{eps};$$
 % epsR

$$>> Z=sin(R)./R; \% z$$

$$\gg$$
 mesh(X,Y,Z) % z

zx,y

 $\begin{array}{c} contour, contour 3 contour \\ contour(X,Y,Z), contour(X,Y,Z,n)X,Y,\ Zx,y,z \end{array}$

contour contour3

contour, contour3

>> subplot(2,2,3)

- >> contour3(Z,20) % peaksZ
- >> subplot(2,2,4)
- >> contour3(X,Y,Z,20) % peaks x,y







MATLAB MATLAB

• MATLAB

MATLAB

- · 4.1
- o 4.2
- o 4.3 _
- 0 4.4
- · 4.5
- o 4.6
- o 4.7 ___
- o 4.8 ___







MATLAB >> angle1=pi/2; >> b=sin(angle1); %angle1sin >> angle2=90; %angle2 >> b=sin(angle2*pi/180); % >> x=sqrt(2)/2; y=asin(x); y_deg=y*180/pi >> x = 0.7071 >> y = 0.7854 >> y_deg =

round(x) x

45.0000

fix(x) x0

floor(x) $x-\infty$

ceil(x) x∞

sign(x) x < 0-1x = 00 x > 01

rem(x,y) x/y rem(25,4)1

exp(x)

log(x) 2.718282

log10(x) 10

MATLAB







sinh(x), cosh(x), tanh(x), asinh(x), acosh(x), atanh(x)MATLAB







$$f(\pi) = \pi^2 + 4\pi + 13$$

 $\pi_{12} = -2 \pm 3\sqrt{-1} = -2 \pm 3i$
(-2) (± 3) MATLABMATLAB
lookfor complex $x = a + bi$
 $\bar{x} = a - bi$, $r = \sqrt{a^2 + b^2}$, $\theta = \tan \frac{-1}{1}(b/a)$
 $a = r \cos \theta$, $b = r \sin \theta$, $x = r e^{i\theta}$
MATLAB
 $a = real(x)$, $b = imag(x)$, $\bar{x} = conj(x)$, $r = abs(x)$, $\theta = angle(x)$, $x = r \exp(i * angle(x))$
>> $x = 1 - 2 * i$; % $2 * i$ $2i$
>> $real(x)$ %
 $ans = 1$
>> $imag(x)$ %
 $ans = -2$
>> $conj(x)$ %

```
ans =
1.0000 + 2.0000i
>> abs(x) %
ans =
2.2361
>> angle(x) %
ans =
-1.1071
>> a=1; b=4; c=13;
>> x1=(-b+sqrt(b^2-4*a*c))/(2*a) %
x1 =
-2.0000 + 3.0000i
>> x2=(-b-sqrt(b^2-4*a*c))/(2*a)
x2 =
-2.0000 - 3.0000i
>> y=exp(i) %
0.5403 + 0.8415i
\Rightarrow y=exp(i*pi*0.75)
-0.7071 + 0.7071i
```

```
polar
```

```
>> t=0:0.01:2*pi;
```

$$>> r = \sin(2*t).*\cos(2*t);$$

>> grid







p(x)

$$p(x) = x^3 + 4x^2 - 7x - 10$$

MATLAB

p=[1 4 -7 -10]

p

X

$$>> p=x.^3+4*x.^2-7*x-10$$

polyval

polyval(p,x)p

$$>> p=[1 4 7 -10];$$

$$a(x) = x^3 + 2x^2 + 3x + 4$$
, $b(x) = x^3 + 4x^2 + 9x + 16$

$$c(x) = a(x) + b(x)$$

$$c(x) = 2x^3 + 6x^2 + 12x + 20$$

$$d(x) = a(x) - b(x)$$

$$d(x) = -2x^2 - 6x - 12$$

$$e(x) = a(x)b(x)$$

$$\varepsilon(x) = x^{6} + 6x^{5} + 20x^{4} + 50x^{3} + 75x^{2} + 84x + 64$$
$$f(x) = \frac{e(x)}{b(x)} = a(x)$$

$$f(x) = x^3 + 2x^2 + 3x + 4$$

(de-convolution)

deconv

convdeconv
[q,r]=deconv(a,b)q,r

(convo

$$>> c=a+b$$

C =

2 6 12 20

>> d=a-b

d =

0 -2 -6 -12

>> e=conv(a,b)

e =

1 6 20 50 75 84 64

>> g=e+[0 0 0 c]

g =

1 6 20 52 81 96 84

>> [f,r]=deconv(e,b)

f =

```
1234
```

$$r =$$

$$f =$$

$$0\ 0\ 0\ 0\ 2\ 6\ 12\ \%\ 2*x^2 + 6*x$$

$$r =$$

```
roots poly, real
```

2, 1

$$p(x) = (x-2)(x-1) = x^2 + 3x + 2$$

poly

poly(r) r real

$$>> r=[-2 -1];$$

>> pp=poly(r) % pp=(x+2)(x+1)=
$$x^2+3x+2$$

132

$$>> p=[1-46-4];$$

r =

I

r =

$$-1.0303 + 0.8721i$$

pp =

1.0000 7.0000 12.0000 9.0000 + 0.0000i

>> pp=real(pp) % real

pp =

1.0000 7.0000 12.0000 9.0000







4.2				
	12000	112 (12)	777	77.77
MATLAB				
WITT LITE				
	6.00	16000	10000	116211
• 4.2 • 4.2.1				
4.2.24.2.3				
o 4.2.3	10.00			
11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				
ar had ar ha				
	3/3			
0111361111				
	367			
STATE OF THE PARTY.				
		13.16.20		

4.2.1

```
max(x) x
max(x,y) xy xy
[y,i]=\max(x) xy xi
min(x) x
min(x,y) xy xy
[y,i]=min(x) xy xi
mean(x) x
median(x) x
sum(x) x
prod(x) x
cumsum(x) x
cumprod(x) x
>> rains % rains2x1
rains =
126.8 148.5 173.0 148.4 194.7 208.9
328.8 300.7 268.3 210.5 278.4 321.5
```

```
>> avg_rain=mean(rains) % rains
avg_rain =
227.8000 224.6000 220.6500 179.4500 236.5500 265.2000
>> avg_rain=mean(avg_rain) %
avg_rain =
225.7083
>> max_rain=max(rains) % rains
max_rain =
328.8000 300.7000 268.3000 210.5000 278.4000 321.5000
>> [max_rain,x]=max(rains) % rains
max_rain =
328.8000 300.7000 268.3000 210.5000 278.4000 321.5000
\mathbf{x} =
222222
>> min_rain=min(rains) % rains
min rain =
126.8000 148.5000 173.0000 148.4000 194.7000 208.9000
>> s_sort=sort(rains) % rains
s sort =
126.8000 148.5000 173.0000 148.4000 194.7000 208.9000
328.8000 300.7000 268.3000 210.5000 278.4000 321.5000
```

```
>> x=[1 2 3 4 5];
```

ans =

15

>> prod(x) % x

ans =

120

>> cumsum(x) % x

ans =

1 3 6 10 15

>> cumprod(x) % x

ans =

1 2 6 24 120







4.2.3

(histogram) MATLAB

hist

>> x=-3:0.1:3;

>> y=sin(x); % x

>> hist(y) % sin(y)histogramy[-1,1]y

>> hist(y,25) % 1025

>> hist(y,x) % -33







4.3

MATLAB (sequential)

- 4.3

 4.3.1

 4.3.2 <u>if-else-end</u>







4.3.1

MATLAB (True)

<

<=

>

>=

==

~=

& and

or

~ not

>> a=1:5, b=5-a,

a =

12345

b =

43210

>> tf = a > 4

$$\Rightarrow$$
 tf= \sim (a>4)

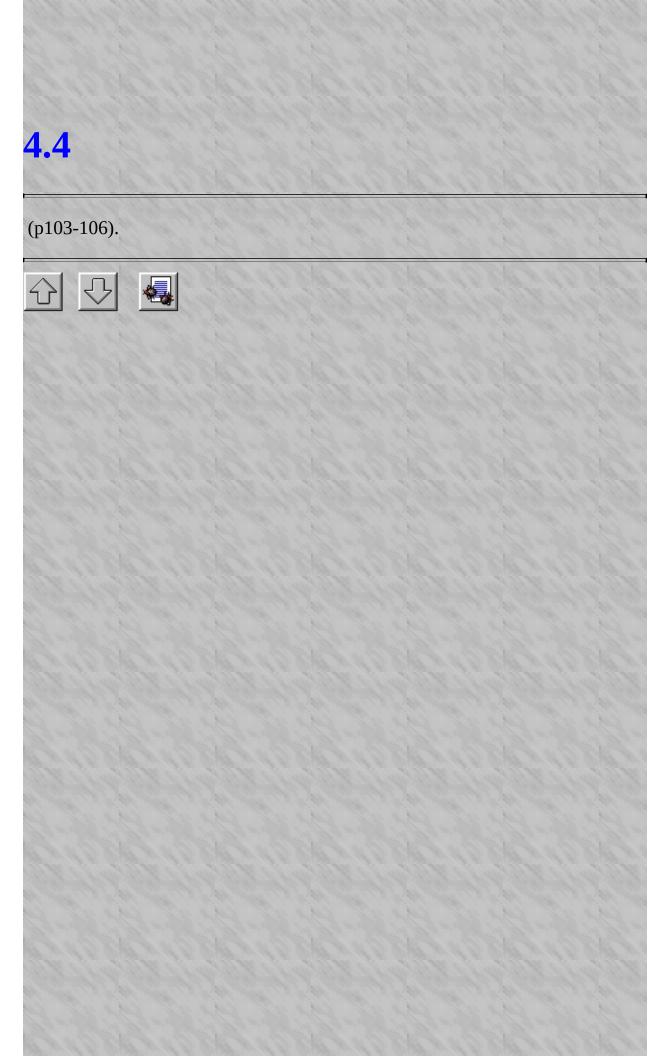
- >> plot(x,z)
- >> xlabel('x'),ylabel('z=f(x)')
- >> title('A discontinuous signal')
- >> hold off

xor(x,y), any(x), all(x), isnan(x), isinan(x)









4.5

```
M-file M-
file: cirarea.m
% M-file function, cirarea.m
% Calculate the area of a circle with raduis r
% r can be a scalar or an array
function c=cirarea(r)
c=pi*r.^2;
MATLABlinspace
function y = linspace(d1, d2, n)
% LINSPACE Linearly spaced vector.
% LINSPACE(x1, x2) generates a row vector of 100 linearly
% equally spaced points between x1 and x2.
% LINSPACE(x1, x2, N) generates N points between x1 and x2.
%
% See also LOGSPACE, :.
% Copyright (c) 1984-94 by The MathWorks, Inc.
if nargin == 2
n = 100;
```

```
end
```

y = [d1+(0:n-2)*(d2-d1)/(n-1) d2];

M-file

- 1. function
 in1 function [out1, out2]= serfun(in1, in2) [out1,out2]
 in2)
- 2.
- 3.
- 4. help cirarea

>> ar=cirarea(r) % cirarea.m

ar = 📗

3.1416 12.5664 28.2743

>> disp(ar) % disp

3.1416 12.5664 28.2743







4.6						
(normal)				(Gaussian)		
	REAL STATE	80000	REAL PROPERTY.	80000	REAL PROPERTY.	100
• 4.6						
	6.1					
	6.2					
10 11 11 11 11	OF THE PARTY	10 11 11 11 11	10 11 11 11 11	10 11 11 11 11	10 11 11 11 11	100
ما ما						
む ひ						
	61111111	61 (2)		61 (2) (4)		19
	111111111111111111111111111111111111111	111111111111111111111111111111111111111	FILL STATE	61111111	FILL STATE	
	Contract of the second	Contract of the second				
	1. 10 1. 1.	1000	1. 10			100

4.6.1

MATLAB nxn	rand [0, 1] [0, 1] mxn		seed	
>> rand(1,6) %				
ans =				
0.2190 0.0470 0.	6789 0.6793 0.934	7 0.3835		
>>hist(ans) %				
>>plot(ans) %				
>> rand(1,6) %				
ans =				
0.5194 0.8310 0.	0346 0.0535 0.529	7 0.6711		
>> rand('seed',0)	%			
>>rand('seed') %		=931316785	5	
ans =				
931316785				
>> rand(2,3) %		[0,1]		
ans =				

```
0.2190 0.6789 0.9347
0.0470 0.6793 0.3835
>> rand('seed') % seed=412659990
ans =
412659990
>> rand('seed',0)
>> rand(1,6)
ans =
0.2190 0.0470 0.6789 0.6793 0.9347 0.3835
>> rand('seed',100) % =100
>> rand('seed')
ans =
100
>> rand(2,5)
ans =
0.2909 0.0395 0.3671 0.5968 0.9253
0.0484 0.5046 0.9235 0.8085 0.3628
[0,1][0,1]
x=(b-a)*r+a,
```

```
>>data_1 = 2*rand(1,500)+2; %500
```

>>plot(data_1) %

>>axis([1 500 0 6]) %/

>>hist(data_1) %







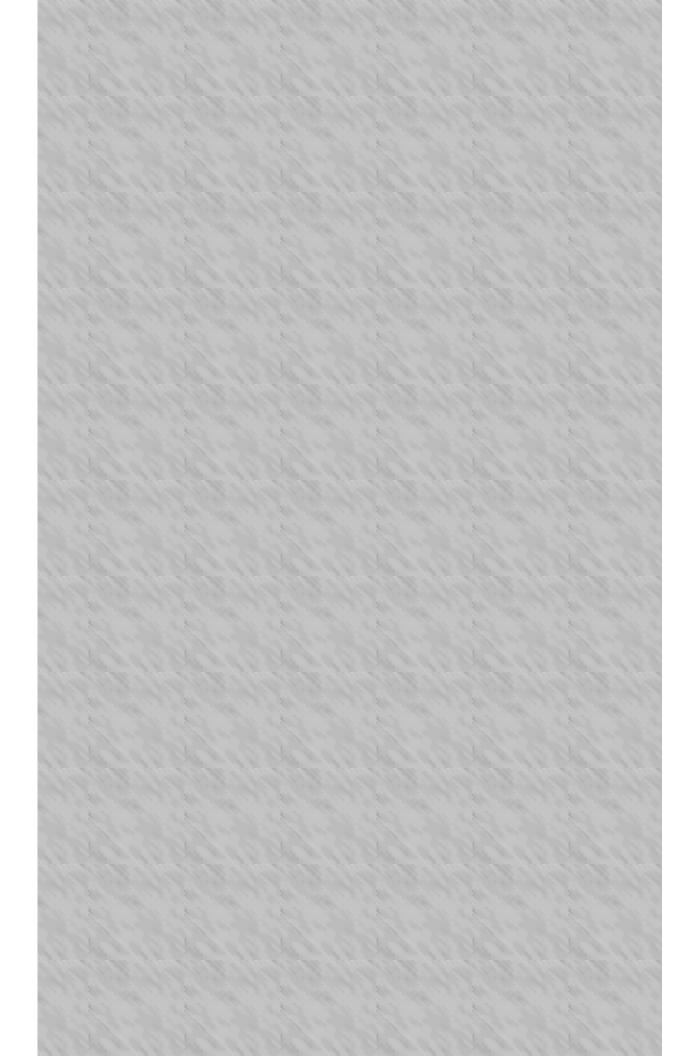
4.6.2

MATLAB randn randr	n(n)randn(n,m)	nxnmxn	01
>> x=-2.9:0.2:2.9; % hist			
>> y=randn(1,5000);			60000
>> hist(y,x)			
>> title('Histogram of Normal Ran	dom Data')		
>> y1=rand(1,5000);			(A11116)
>> hist(y1,x)			
>> title('Histogram of Uniform Ra	ndom Data')		
01			
x=a*r+b			10000
x			
>>data_2 = randn(1,500)+3 %500			
>>plot(data_2) %			
>>axis([1 500 0 6])			
>>hist(data_2) %			at litight









rot90, fliplr, flipud

>> A=[2 1 0; -2 5 -1; 3 4 6];

>> B=rot90(A) % A90

B =

0 -1 6

154

2 -2 3

>> A=[1 2; 4 8; -2 0];

>> B=fliplr(A); % A

>> C=flipud(A); % A

>> B, C

B =

2 1

84

0 -2

C =

-20

48

12

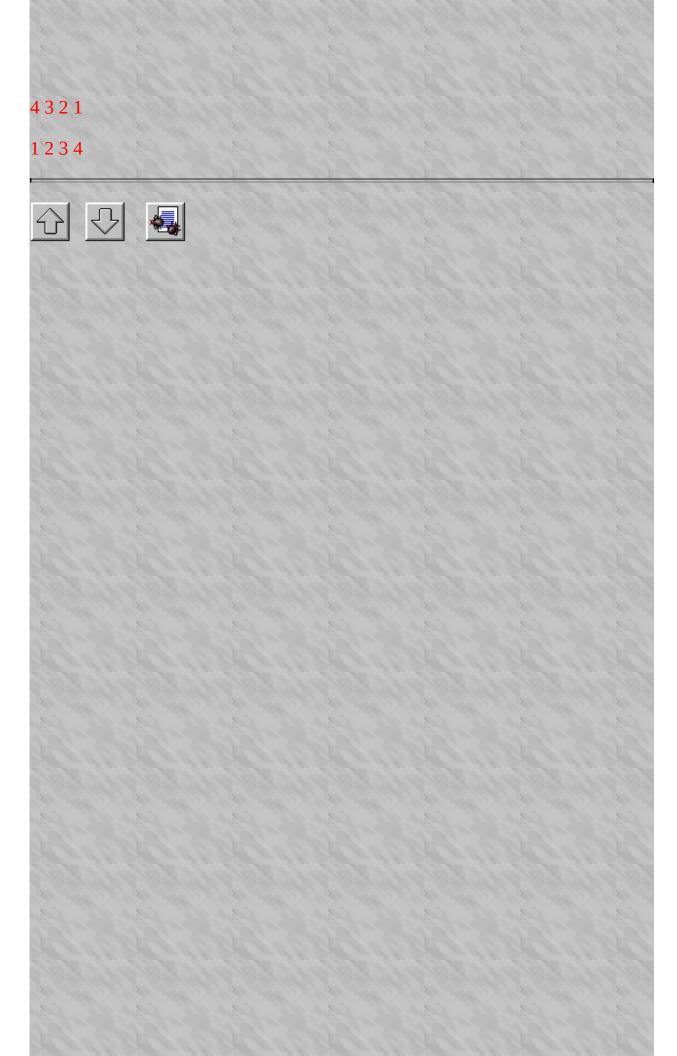
reshape

diag, tri

```
020
```

$$C =$$

D= >> B=tril(A) B = >> C=triu(A,-1) C =>> D=triu(A,3) D =3 6 9 12



5.1.1

MATLAB (array)

(matrix) MATLAB

+	+	
1111-1111	1163111	11/11/11
*	*	
./	/	166 1.3
	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	
·\	↑	
1	1	

>> A=[2 5 1; 7 3 8; 4 5 21; 16 13 0];

>> A' % A

A =

27416

5 3 5 13

18210

>> A=[4 -1 3]; B=[-2 5 2];

>> dot_prod = sum(A.*B) %

dot_prod =

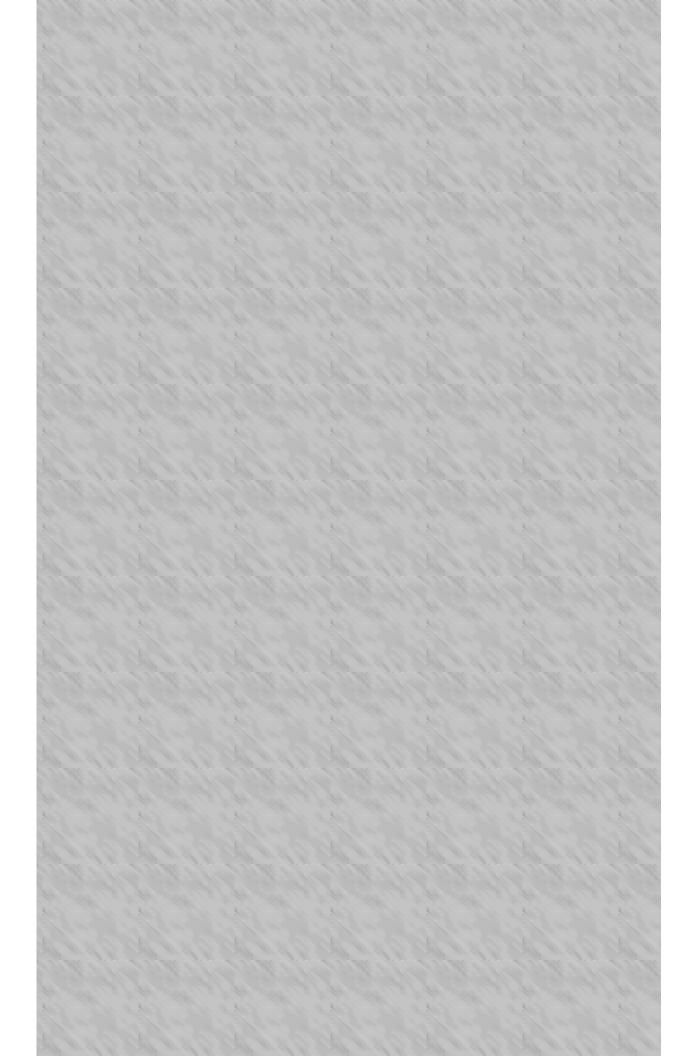
$$c =$$

$$C =$$









5.1.2

polyvalm polyval polyvalm(a,X)Xa

>> X=[1 1 1; 2 2 2; 3 3 3];

>> a=[1 1 1]; % a=X*X+X+I

>> f=polyvalm(a,X)

877

14 15 14

21 21 22







5.3.1

 $\mathbf{A} \mathbf{A}^{-1} \mathbf{A} \mathbf{A}^{-1} \mathbf{A}^{-1} \mathbf{A}$ (singular) (ill-con MATLAB inv(A), rank(A) >> A=[2 1; 4 3]; >> rank(A) 2 % A2 >> inv(A) % ans = 1.5000 -0.5000 -2.0000 1.0000 >> B=[2 1; 3 2; 4 5]; % B >> rank(B) ans = 2 % B23 >> inv(B) ??? Error using ==> inv Matrix must be square. **MATLAB** >> A=[1 3 0; -1 5 2; 1 2 1];

```
>> det(A) %
ans =
10
p MATLAB
                                    det(A)
>> A=[1 3 0; -1 5 2; 1 2 1];
>> det(A) %
ans =
10
```







5.3.2

$$\mathbf{A} n \times n \qquad \mathbf{X} \mathbf{n}$$

$$AX = \lambda X$$

 $X \longrightarrow A$ (eigenvalue)XA (eigenvector)(orthonormal) (normalization)

$$(A - \lambda I)X = 0$$

$$\mathbf{I} n \times n$$

$$A = \begin{bmatrix} 0.5 & 0.25 \\ 0.25 & 0.5 \end{bmatrix}$$

eigenvalue

$$|A - \lambda I| = \begin{vmatrix} 0.5 - \lambda & 0.25 \\ 0.25 & 0.5 - \lambda \end{vmatrix} = \lambda^2 - \lambda + 0.1875 = 0$$

$$\hat{\lambda} = 0.25, 0.75_{A}$$
 A

$$\begin{bmatrix} 0.5 - 0.25 & 0.25 \\ 0.25 & 0.5 - 0.25 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \implies \begin{bmatrix} 0.25 & 0.25 \\ 0.25 & 0.25 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \implies x_1 = -x_2$$

$$\lambda = 0.75$$
 $x_1 = x_2$

$$\begin{bmatrix} 1 \\ -1 \end{bmatrix} \begin{bmatrix} 3 \\ -3 \end{bmatrix} \begin{bmatrix} 0.1 \\ -0.1 \end{bmatrix} \dots, \begin{bmatrix} 2 \\ 2 \end{bmatrix} \begin{bmatrix} -1 \\ -1 \end{bmatrix} \begin{bmatrix} -0.4 \\ -0.4 \end{bmatrix} \dots$$

(orthonormal) $Q^{\mathbb{Q}\mathbb{Q}^T} = I$

$$QQ^{T} = \begin{bmatrix} c_{1} & c_{2} \\ -c_{1} & c_{2} \end{bmatrix} \begin{bmatrix} c_{1} & -c_{1} \\ c_{2} & c_{2} \end{bmatrix} = \begin{bmatrix} c_{1}^{2} + c_{2}^{2} & -c_{1}^{2} + c_{2}^{2} \\ -c_{1}^{2} + c_{2}^{2} & c_{1}^{2} + c_{2}^{2} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$c_1 = c_2 = \pm 1/\sqrt{2} \mathbf{Q}$$

$$Q = \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} \\ -1/\sqrt{2} & 1/\sqrt{2} \end{bmatrix}$$

 $A^{2\times2}$

MATLAB

$$>> A = [0.5 \ 0.25; \ 0.25 \ 0.5];$$

$$\gg$$
 [Q,d] = eig(A)

Q =

0.7071 0.7071

-0.7071 0.7071

d = %

0.25000

0 0.7500

>> Q*Q' % Q*Q'=I

ans=

10

01

>> $A*Q(:,1); 0.25*Q(:,1) \% A*X=\lambda X X=Q(:,1)$

ans = % A*X

0.1768 -0.1768 ans = $\% \lambda X$ 0.1768 -0.1768

5.3.3

0.5 1 1

(decomposition, factorization)(triangular matrix) Factorization)2)QR (QR Factorization)3) (Singular Value Decon (1) (square) (permuted) AB $A = [LA][UA] = \begin{bmatrix} 1 & 0 & 0 \\ -2 & 1 & 0 \\ -1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1 & 2 & -1 \\ 0 & -1 & 1 \\ 0 & 0 & -2 \end{bmatrix} \quad B = [LB][UB] \begin{bmatrix} 1 & 0 & 0 \\ -2 & 0 & 1 \\ 2 & 1 & 0 \end{bmatrix} \begin{bmatrix} 1 & 3 & 2 \\ 0 & -1 & 3 \\ 0 & 0 & 5 \end{bmatrix}$ B[LB] MATLABLU [L,U]=lu(A)LU >> A = [1 2 -1, -2 -5 3; -1 -3 0]; B=[1 3 2; -2 -6 1; 2 5 7];

MATLABLU [L,U]=lu(A)LU

>> A = [1 2 -1, -2 -5 3; -1 -3 0]; B=[1 3 2; -2 -6 1
>> [L1,U1] = lu(A); [L2,U2] = lu(B);

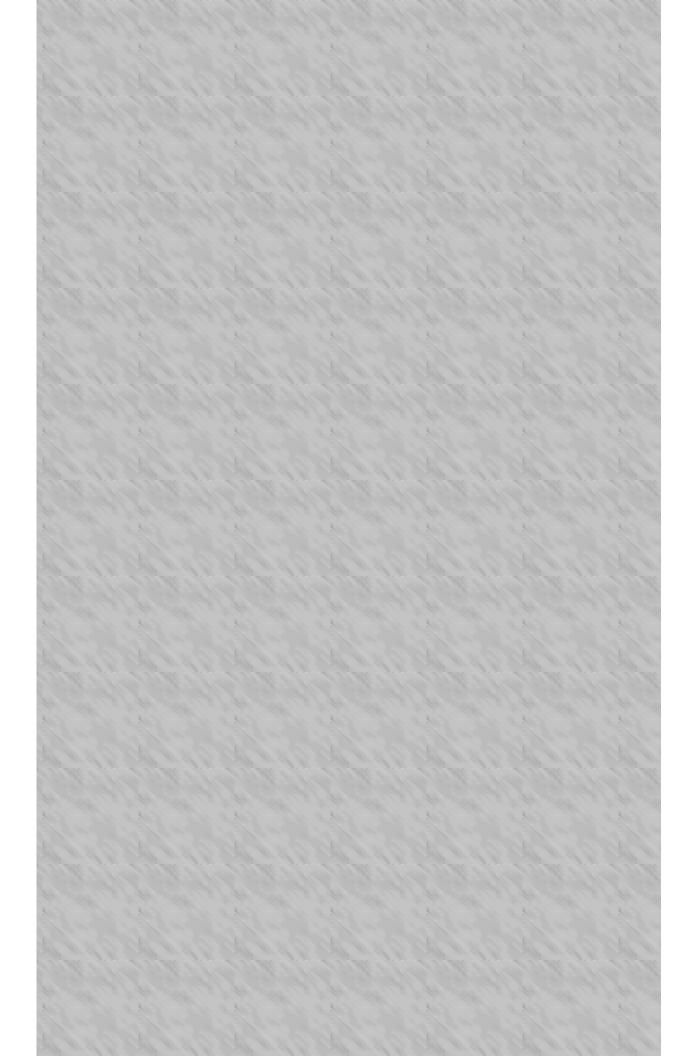
>> L1; U1

L1 = % L1[LA]

-0.5 1 0

1 0 0

```
U1 = \% U1[UA]
-2 -5 3
0 -0.5 0.5
0 0 -2
>> L2; U2
L2 = \% L2[LB]
-0.5 0 1
100
-110
U2 = \% U2[UB]
-2 -6 1
0 -1 8
0 0 2.5
(2) QR
QRQ
MATLAB qrQR
                           [Q,R]=qr(A)Q
(3)
         (sigular value decomposition, SVD)
                                           SVD
                                                   QR
             QR
   SVD
```



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11.00							
11/10							
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EV In	formatio				net/~futurev/		
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W. J.	· 6.2	11.00	2000				
					311/11/11	3111111	
Δ							
	<u> </u>						
	27 44			11 11 11 11 11 11			
18							
100							
	111.64						
18							

6.1

$$3x + 2y - z = 10$$
$$-x + 3y + 2z = 5$$
$$x - y - z = -1$$

AX=B

$$A = \begin{bmatrix} 3 & 2 & -1 \\ -1 & 3 & 2 \\ 1 & -1 & -1 \end{bmatrix}, \quad X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}, \quad B = \begin{bmatrix} 10 \\ 5 \\ -1 \end{bmatrix}$$

XA=B X, A B

$$X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}, \quad A = \begin{bmatrix} 3 & -1 & 1 \\ 2 & 3 & -1 \\ -1 & 2 & -1 \end{bmatrix}, \quad B = \begin{bmatrix} 10 \\ 5 \\ -1 \end{bmatrix}$$

$$AX=B, X=A^{-1}B X=inv(A)*B XA=B, X=BA^{-1} X=B*inv(A)$$

 $X=A\B$

$$X = \% X$$

$$C = \% C = B$$

10

-1

$$X = \% X$$

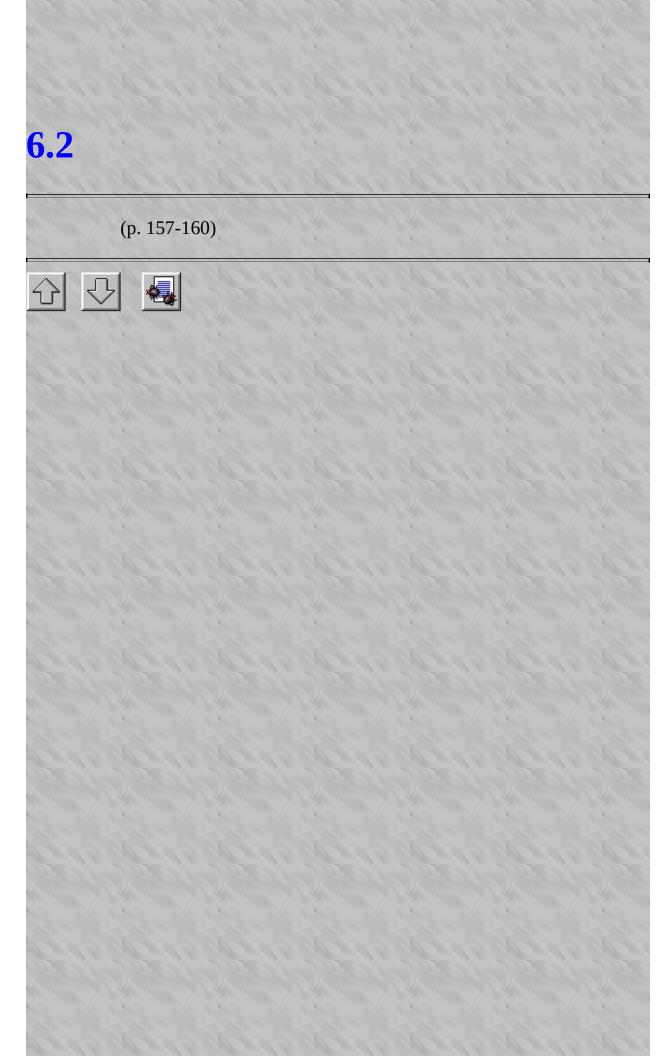
10 5 -1

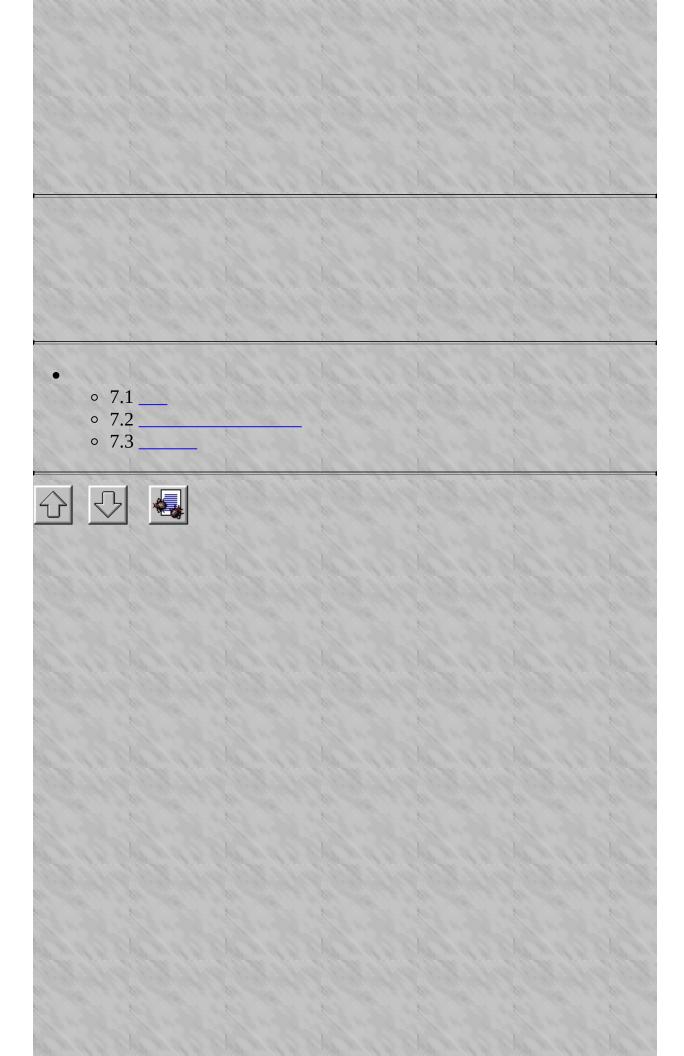
>> X=B*inv(A); %











$$f(x_k)$$
, $k = 1, 2, ...n$, $x_1 = a$, $x_n = c$

 x_i x_k $a \le x_i \le c \ f(x_i)$ (interpolation)

- 7.1
- 7.1.1 ____7.1.2 ____
- 7.1.3 <u>Spline</u>







a, *b*)

$$f(b) = f(a) + \frac{b-a}{c-a}(f(c) - f(a))$$

$$a < b < c \ b$$
 $f(b)$

\pcxfile[12cm,5cm]{fig9_1.pcx}

\caption{ spline }

 x,y xi method spline

sec

time	temp1	temp2	temp3
0	0	0	0
1	20	110	176
2	60	180	220
3	68	240	349
4	77	310	450
5	110	405	503

```
y1 = % 2.6 64.8
64.8
>> y1=interp1(x,y,[2.6 4.9]) % 2.6, 4.9[]
y1 =
64.8
106.7
>> y1=interp1(x,y,2.6,'cubic') % 2.6
y1 = % 2.6 66.264
66.264
>> y1=interp1(x,y,2.6,'spline') % spline 2.6
y1 = % 2.6 66.368
66.368
>> h=1:12;
>> temp=[5 8 9 15 25 29 31 30 22 25 27 24]; %
>> plot(h,temp,'--',h,temp,'+') %
>> h_3=1:0.1:12 % 0.1
>> t_3=interp1(h,temp,h_3,'cubic') %
>> t_s=interp1(h,temp,h_3,'spline') % spline
>> hold on
>> subplot(1,2,1)
```

>> plot(h,temp,'--',h,temp,'+',h_3,t_3) %

>> subplot(1,2,2)

>> plot(h,temp,'--',h,temp,'+',h_3,t_s) % spline

>> hold off







7.1.2 ¤G°û¤°′;

 $\Box G^{\circ}\hat{u}^{\circ}$ '; $\Box P^{\circ} = \partial^{\circ}\hat{u}^{\circ}$ '; \Box°

	-		
time	speed		13/1
0	2000	3000	4000
	rpm	rpm	rpm
1	20	110	176
2	60	180	220
3	68	240	349
4	77	310	450
5	110	405	503

"䤤·Å«×a°¼Æ¾Ú±q 20°CÅܤÆ"ì 503°C¡A¦paGn¦ôp¦bt=2.6, sec, rpm=2500 a°·Å«×¡A¥i¥H¤U¦C«ü¥Op°â

- >> d2(:,1)=[0 1 2 3 4 5]'; % ±N®É¶¡¿é¤J
- >> d2(:,2)=[2000 20 60 68 77 110]'; % ±N rpm=2000 ^{ao}·Å«×¿é¤J
- >> d2(:,3)=[3000 110 180 240 310 405]'; % ±N rpm=3000 ^{ao}·Å«×¿é¤J
- >> d2(:,4)=[4000 176 220 349 450 503]'; % ±N rpm=4000 ao·Å«×¿é¤J

```
>> t=d2(2:6,1); % ¿ï¾Ü°µ¤º′; aº®É¶;
```

>>_temp_i=interp2(rpm,t,temp,2500,2.6) % \{\frac{1}{2}u\circ\text{E}^o'; "M\circ\text{w} rpm=2500,t=2.6"} ao·Å«×

temp_i =

140.4000







¤W¤@¶¡@¤U¤@¶¡@Á¿¸q¤j°ĉ

7.1.3 Spline

```
spline7.1.1 interp1spline spline(x,y,xi) x,y,xiinter interp1(x,y,xi,'spline')MATLAB spline(x,y,xi) interp1

7.1.1 spline

>> x=[0 1 2 3 4 5]';

>> y=[0 20 60 68 77 110]';

>> y1=spline(x,y,2.6)

y1 =

67.3

>> y1=spline(x,y,[2.6,4.9])

y1 =

67.3 105.2
```







	Marie Contract		Marie Contract		
7.3					
2 1 1 1 1 2 1 2 1 1 1 1 1 1 1 1 1 1 1 1	10 7 10 10 10	Section 1	10 11 11 11 11	10 11 11 11 11 11	100
014101111111111111111111111111111111111	11/2/11	211411	271101011	10000	
(curve-fitting)					
	17.10.19.10.10	17.11.11.11.11.11	17.10.11.11.11	0.10.0000	17.18
7.0					
• 7.3					
o 7.3.1					
• 7.3.2					
o 7.3.3					
① 및					
13 311 6 60 311 6	11/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1	1000	13 37 11 15	1000	

7.3.1

```
y=y(x)
x=\{0, 1, 2, 3, 4, 5\}, y=\{0, 20, 60, 68, 77, 110\}
                                                 y = 20x
                                                                MATLAB
>> x=[0 1 2 3 4 5];
>> y=[0 20 60 68 77 110];
>> y1=20*x; % y1
>> sum_sq = sum(y-y1).^2); % 573
>> axis([-1,6,-20,120])
>> plot(x,y1,x,y,'o'), title('Linear estimate'), grid
                                                          polyfit
x,ynn=1
f(x) = a_n x^n + a_{n-1} x^{n-1} + \cdots + a_1 x^1 + a_0
\mathbf{polyfit}^{\mathcal{A}_0,\mathcal{A}_1,\cdots,\mathcal{A}_{n-1},\mathcal{A}_n} \mathbf{n} = 1 \quad \mathcal{A}_0,\mathcal{A}_1
                                                                      coef=polyfit(x,y,n)coef(1)=
,...,coef(n+1)= \frac{\partial}{\partial x}n
                                               n+1
>> x=[0 1 2 3 4 5];
>> y=[0 20 60 68 77 110];
>> coef=polyfit(x,y,1); % coef
```

```
>> a0=coef(1); a1=coef(2);
```

>> plot(x,ybest,x,y,'o'), title('Linear regression estimate'), grid







7.3.2					
1.5.4					
A CONTRACTOR OF THE PARTY OF TH	100 100 100 100	300	War was a second	TOP TO THE PARTY	100
polyfi	t <i>n</i> ≥ 2				
polyli	10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	21111111	21111111	2111111	
A1 01					
4					
ت ت					
		Marie Carlo	83 3318	43 1111 8	
		Wall of	63 311 3	63 111 6	
		The state of the s		A STATE OF THE STA	
		42 2111	100000	63 3311 6	

7.3.3

```
(a_0, a_1, \cdots, a_{\pi-1}, a_{\pi})
polyfit polyval polyfit
                                                              polyval
                                                                          polyval(
>> x=[0 1 2 3 4 5];
>> y=[0 20 60 68 77 110];
>> coef=polyfit(x,y,1); %
>> ybest=polyval(coef,x); % polyval
        polyval
>> coef=polyfit(x,y,5);
>> a0=coef(1);
>> a1=coef(2);
>> a2=coef(3);
>> a3=coef(4);
>> a4=coef(5);
>> a5=coef(6);
>> f=a0 + a1*x + a2*x.^2 + a3*x.^3 + a4*x.^4 + a5*x.^5;
>> x=[0 1 2 3 4 5];
>> y=[0 20 60 68 77 110];
```

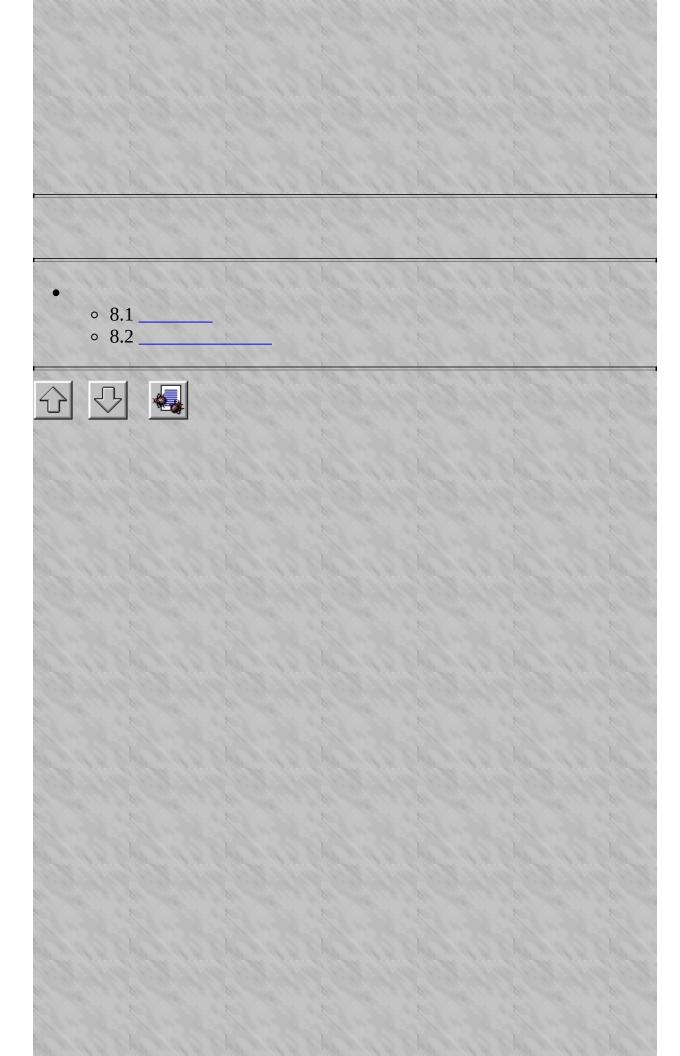
```
>> newx=0:0.05:5; %
>> for n=2:9
>> f(:,n)=polyval(polyfit(x,y,n),newx)';
>> plot(newx,f(:,n),x,y,'o')
>> title(['Poly. regression, deg=',int2str(n)])
>> xlabel('Time'), ylabel('Temp'), grid
>> pause %
>> end

    titlen int2str (integer) (string)title title [title, int2str, num2str
```





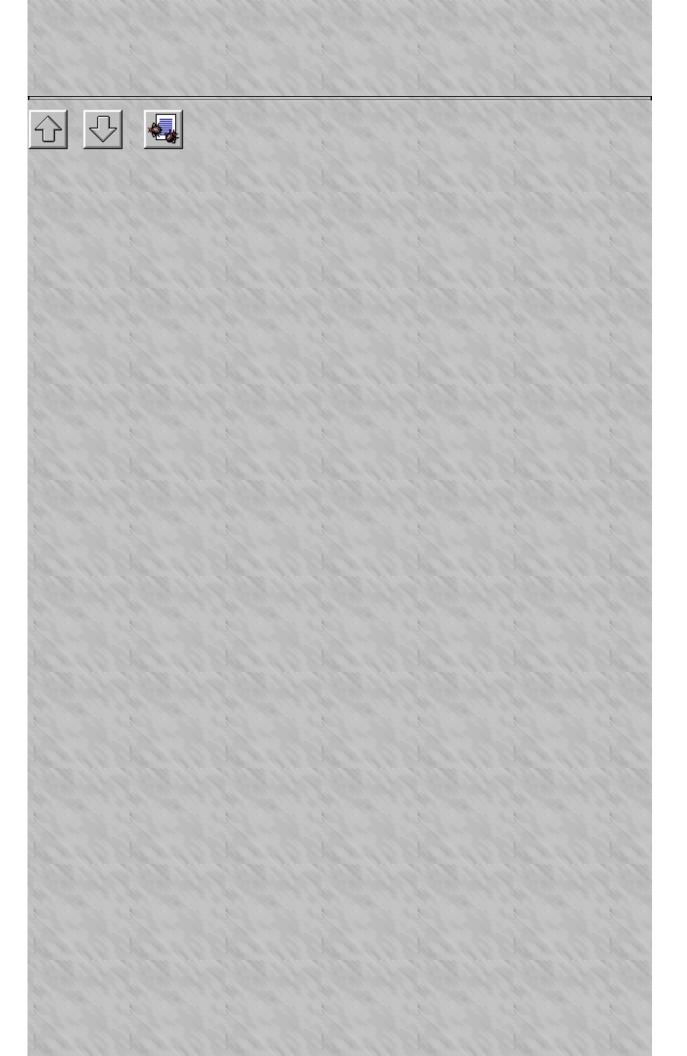




```
>> p=[1 3 2];
>> r=roots(p)
-1
>> p=[1 -12 0 25 116]; %
>> r=roots(p) %
11.7473
2.7028
-1.2251 + 1.4672i
-1.2251 - 1.4672i
roots poly, real
p(x) = (x-2)(x-1) = x^2 + 3x + 2
poly poly(r) r real
>> r=[-2 1];
>> pp=poly(r) % pp=(x+2)(x-1)=x^2+3x+2
```

```
pp =
132
>> p=[1 -4 6 -4];
>> r=roots(p)
2.0000 1.0000 + 1.0000i 1.0000 - 1.0000i
>> pp=poly(r) % p
pp =
1 -4 6 -4
>> pp=[1 7 12 9]; %
>> r=roots(pp)
-4.9395
-1.0303 + 0.8721i
-1.0303 - 0.8721i
>> pp=poly(r) %
pp =
1.0000 7.0000 12.0000 9.0000 + 0.0000i
>> pp=real(pp) % real
pp =
```

1.0000 7.0000 12.0000 9.0000



```
roots 'h
fzero
                                     x)=3 f(x)=\sin(x)-3 m-file
 1. 	 f(x)=0 \sin(
 2. \quad x, y(x)
 3. y(x)(x0) x fzerofzero('function',x0) x0 function
\sin(x)=0
                \pi,2\pi,3\pi,...
>> r=fzero('sin',3) % sin(x)sin
r = \% x = 3
3.1416
>> r=fzero('sin',6) % x=6
6.2832
MATLAB
                                      humps
>> x=linspace(-2,3);
>> y=humps(x);
```

```
>> plot(x,y), grid % 01
```

r =

1.2995

$$x^3 - 2x - 5 = 0$$

roots

% m-function, f_1.m

$$y=x.^3-2*x-5;$$

r =

2.0946

$$>> p=[1 0 -2 -5]$$

r =

-1.0473 - 1.1359i

 $x^2\sin(x)+\cos(x)=0$

% m-function, f_2.m

function $y=f_2(x) \% f_2.m$

 $y=x.^2.*sin(x)+cos(x);$

>> x=linspace(-3,3);

 $>> y=f_2(x);$

>> plot(x,y), grid % -13

>> r=fzero('f_2',-1); % -1

r =

-0.8952

>> r=fzero('f_2',3); % 3

r =

3.0333

 $2e^{-x}\sin(2\pi x) - 0.5 = 0$

% m-function, f_3.m

function $y=f_3(x) \% f_3.m$

```
y=2*exp(-x).*sin(2*pi*x)-0.5;
```

0.4368







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$$K = \int_{a}^{b} f(x) \, dx$$

a, b f(x) a, b f(x) MATLAB f(x) a, b [a,b] (discretized po

- 9.1
 - o 9.1.1 __
 - o 9.1.2







9.1.1

MATLABtrapztrapz(x,y)x,y

 $y=\sin(x)$ yx

$$k = \int_0^{\pi} \sin(x) dx = -\cos(x) \Big|_0^{\pi} = 2$$

MATLAB

>> x=0:pi/100:pi;

>> y=sin(x);

>> k=trapz(x,y)

k =







9.1.2

trapz, quad, quad8

quad('function

a, b trapz quad, quad8

$$k = \int_{a}^{b} \sqrt{x} dx = \frac{2}{3} (b^{3/2} - a^{3/2})$$

MATLAB

kq =

0.2357

>> kq8=quad8('sqrt',a,b)

kq8 =

0.2357

>> x=-1:0.17:2;

>> y=humps(x);

>> area=trapz(x,y)

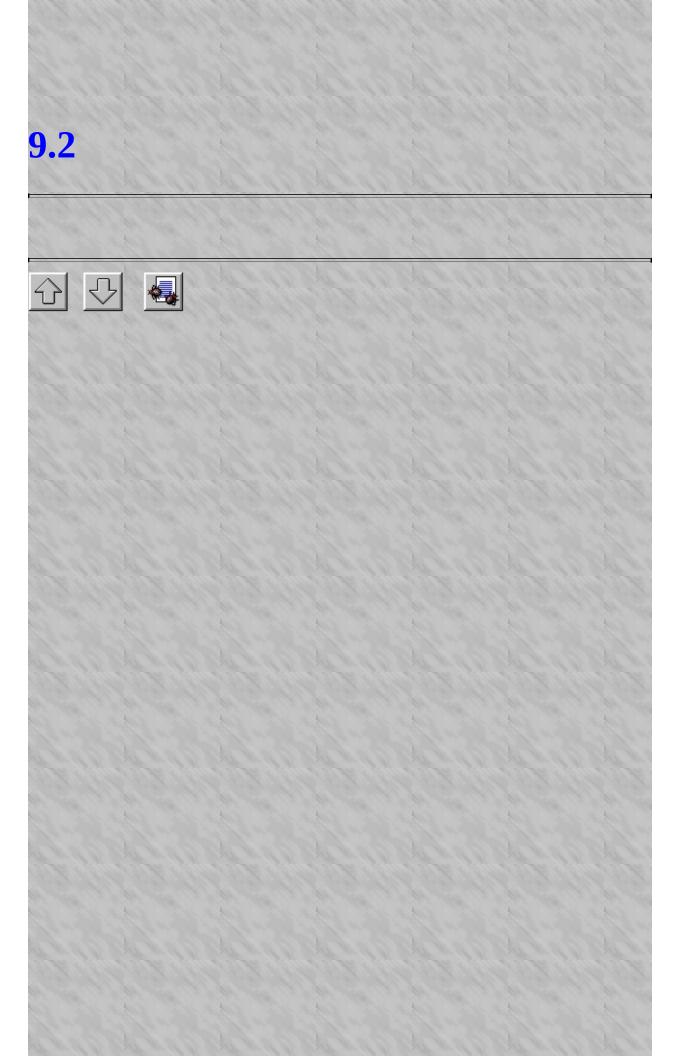
area =

```
25.9174
>> x=-1:0.07:2;
>> y=humps(x);
>> area=trapz(x,y)
area =
26.6243
>> area=quad('hump',-1,2)
area =
26.3450
>> area=quad8('hump',-1,2)
area =
26.3450
```









f(x) x=a

$$f'(z) = \frac{df(x)}{dx}\bigg|_{x=z}$$

x=a

- 9.3 9.3.1 ___ 9.3.2 ___







9.3.1

x+h x

$$f'(x) = \frac{df(x)}{dx} = \lim_{h \to 0} \frac{f(x+h) - f(x)}{(x+h) - x}$$

 X_0 , X_1 ,..., X_{k-1} , X_k , X_{k+1} ,...

$$f'(x_k) = \frac{f(x_{k+1}) - f(x_k)}{x_{k+1} - x_k}$$

$$h = x_{k+1} - x_k \qquad x_k \qquad x_{k+1}$$

 $f(x_{k+1}), f(x_k)_{x_k}$

後向差分
$$f'(x_k) = \frac{f(x_k) - f(x_{k-1})}{x_k - x_{k-1}}$$

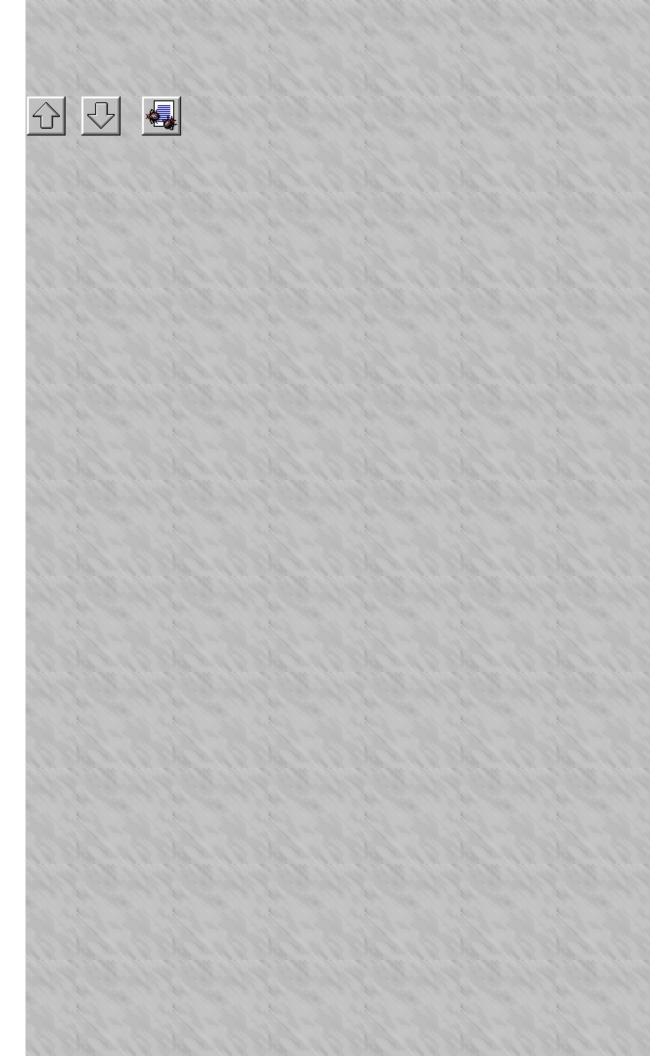
中央差分
$$f'(x_k) = \frac{f(x_{k+1}) - f(x_{k+1})}{x_{k+1} - x_{k+1}}$$

$$f''(x) = \frac{df'(x)}{dx}$$

前向差分
$$f''(x_k) = \frac{f'(x_{k+1}) - f'(x_k)}{x_{k+1} - x_k}$$

後向差分
$$f''(x_k) = \frac{f'(x_k) - f'(x_{k-1})}{x_k - x_{k-1}}$$

中央差分
$$f''(x_k) = \frac{f'(x_{k+1}) - f'(x_{k+1})}{x_{k+1} - x_{k+1}}$$



$$x_{k} - x_{k-1}, k = 1,...,n$$
 MATLAB diff $x = [1 \ 3 \ 5 \ 7 \ 9], y = [1 \ 4 \ 9 \ 16 \ 25]$

diff(x) = $[2 \ 2 \ 2 \ 2], \text{ diff}(y) = [3 \ 5 \ 7 \ 9] \ 4 \ 5$
 $[-4, 5]$
 $f(x) = x^{5} - 3x^{4} - 11x^{3} + 27x^{2} + 10x - 24$

>> $x = \text{linspace}(-4,5); \% \ 100x$

>> $p = [1 \ -3 \ -11 \ 27 \ 10 \ -24];$

>> f = polyval(p,x);

>> plot(x,f) %

>> title('Fifth-deg. equation')

>> $x = x(2 : \text{length}(x)); \% \ 99 \text{df} \qquad x2,x3,...,x100}$

>> plot(xd,dfb) %

>> title('Derivative of fifth-deg. equation')

(local critical value)

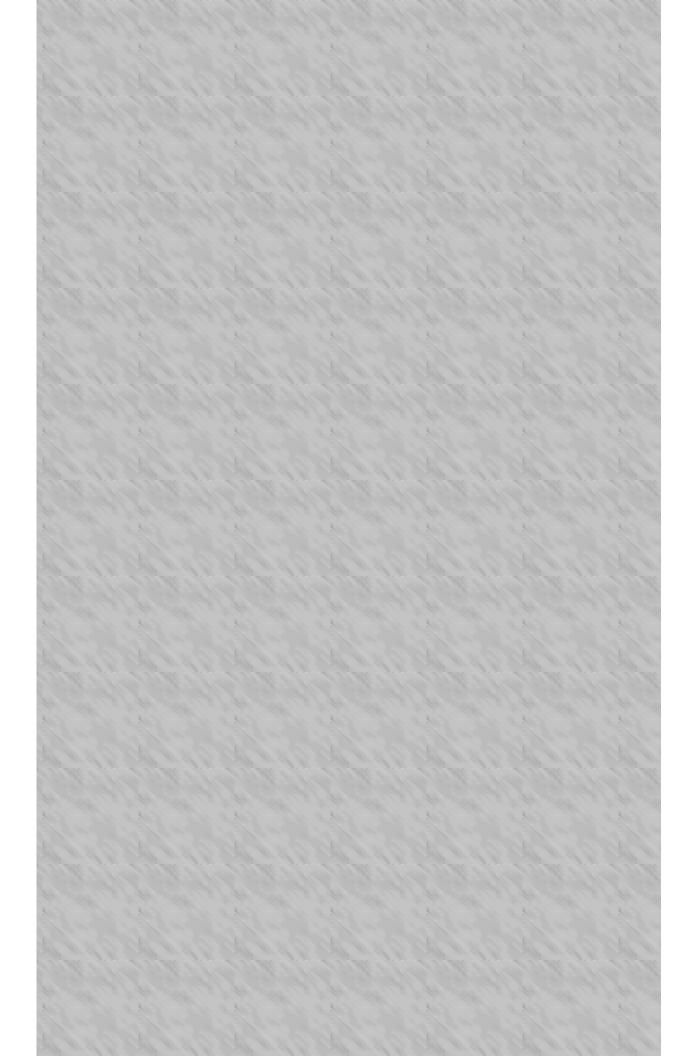
>> product=dfb(1:length(dfb)-1).*dfb(2:length(dfb)); %

```
>> crit=xd(find(product<0)) % find
                                                   diff
>> num=f(3:length(f))-f(1:length(f)-2); % f(k+1)-f(k-1)
>> deno=x(3:length(f))-x(1:length(f)-2); % x(k+1)-x(k-1)
>> df_c=num./deno;
>> xd=x(2:length(x)-1); % xd98
>> plot(xd,df_c)
>> title('Derivative of fifth-deg. polynomial')
>> x=0:0.1:1;
>> y=[-.447 1.978 3.28 6.16 7.08 7.34 7.66 9.56 9.48 9.30 11.2];
>> plot(x,y,'o',x,y)
>> title('y(x) data plot')
>> ylabel('y(x)'), xlabel('x')
>> dy=diff(y)./diff(x);
>> xd=x(1:length(x)-1);
>> plot(xd,dy)
>> title('Approximate derivative using diff')
>> ylabel('dy/dx'), xlabel('x')
```









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(ordinary differential equation, ODE)

$$y' = \frac{dy}{dx} = g(x, y)$$

x y x y(x) ODE ODE

$$y' = g_1(x,y) = 3x^2$$

 $y' = g_2(x,y) = -0.13y$
 $y' = g_3(x,y) = 2x\cos^2 y$

$$y' = g_4(x, y) = 3y + e^{2x}$$

ODE
$$y0=y(x0)$$
 $x=x0$ $y(x)=y0$

y(x)=y0 (analy

$$y = x^3 - 7.5$$
$$y = 4e^{-0.13x}$$
$$y = \tan^{-1}(x^2 + 1)$$
$$y = 4e^{3x} - e^{2x}$$

ODE
$$y(a) y(b) y(b)$$

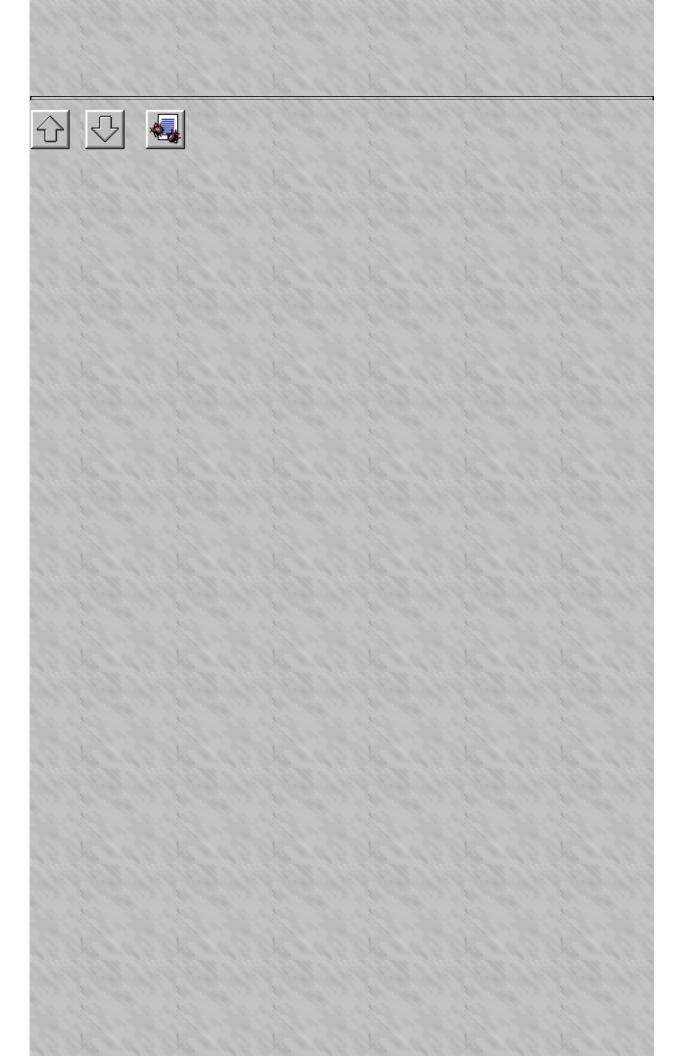
$$y(b) = y(a) + by'(a) + \frac{b^2}{2}y''(a) + \dots + \frac{h^n}{n!}y^n(a) + \dots$$

$$b=a+h$$

$$y(b) = y(a) + hy'(a)$$

$$y(b) = y(a) + by'(a) + \frac{b^2}{2}y''(a)$$

MATLAB ODE



10.2 -

- (Runge-Kutta) ODE

$$y_b = y_a + h y_a'$$

$$y(b) = y_b, y(a) = y_a, y'(a) = y'_a, -ODE$$

ode23, ode45ode23- ode45 -

 g_1, g_2, \dots x_0, x_n ODE [x_0, x_n]

MATLAB-

ODE

ode23

ODE

[2, 4] ODE

$$y' = g_1(x,y) = 3x^2$$
 起始値 $y(2) = 0.5$

% m-function, g1.m

function dy=g1(x,y)

 $dy=3*x.^2;$

>> [x,num_y]=ode23('g1',2,4,0.5);

>> anl_y= $x.^3-7.5$;

>> plot(x,num_y,x,anl_y,'o')

>> title('Solution of g1')

>> xlabel('x'), ylabel('y=f(x)'), grid

[0, 5] ODE

 $y' = g_2(x,y) = -0.131y$ 起始値 y(0) = 4

```
% m-function, g2.m
function dy=g2(x,y)
dy = -0.131*y;
>> [x,num_y]=ode23('g2',0,5,4);
>> anl_y=4*exp(-0.131*x);
>> plot(x,num_y,x,anl_y,'o')
>> title('Solution of g2')
>> xlabel('x'), ylabel('y=f(x)'), grid
[0, 2] ODE
y' = g_3(x,y) = 2x\cos y^2 起始値 y(0) = 0.25\pi
% m-function, g3.m
function dy=g3(x,y)
dy=2*x*cos(y)^2;
>> [x,num_y]=ode23('g3',0,2,pi/4);
\Rightarrow anl_y=atan(x.*x+1);
>> plot(x,num_y,x,anl_y,'o')
>> title('Solution of g3')
>> xlabel('x'), ylabel('y=f(x)'), grid
[0, 3] ODE
y' = g_4(x, y) = 3y + e^{2x} 起始値 y(0) = 3
% m-function, g4.m
```

```
function dy=g4(x,y)
dy=3*y+exp(2*x);
>> [x,num_y]=ode23('g4',0,3,3);
>> anl_y=4*exp(3*x)-exp(2*x);
>> plot(x,num_y,x,anl_y,'o')
>> title('Solution of g4')
>> xlabel('x'), ylabel('y=f(x)'), grid
                 ode45
                           ode23
                                                             ODE
% m-function, g1.m
function dy=g1(x,y)
dy=3*x.^2;
% m-file, odes1.m
% Solve an ode using ode23 and ode45
clg
[x1,num_y1]=ode23('g1',2,4,0.5);
anl y1=x1.^3-7.5;
error_1=abs(anl_y1-num_y1)./abs(anl_y1); % ode23
[x2,num_y2]=ode45('g1',2,4,0.5);
anl y2=x2.^3-7.5; % x2 x1
error_2=abs(anl_y2-num_y2)./abs(anl_y2); % ode45
hold on
```

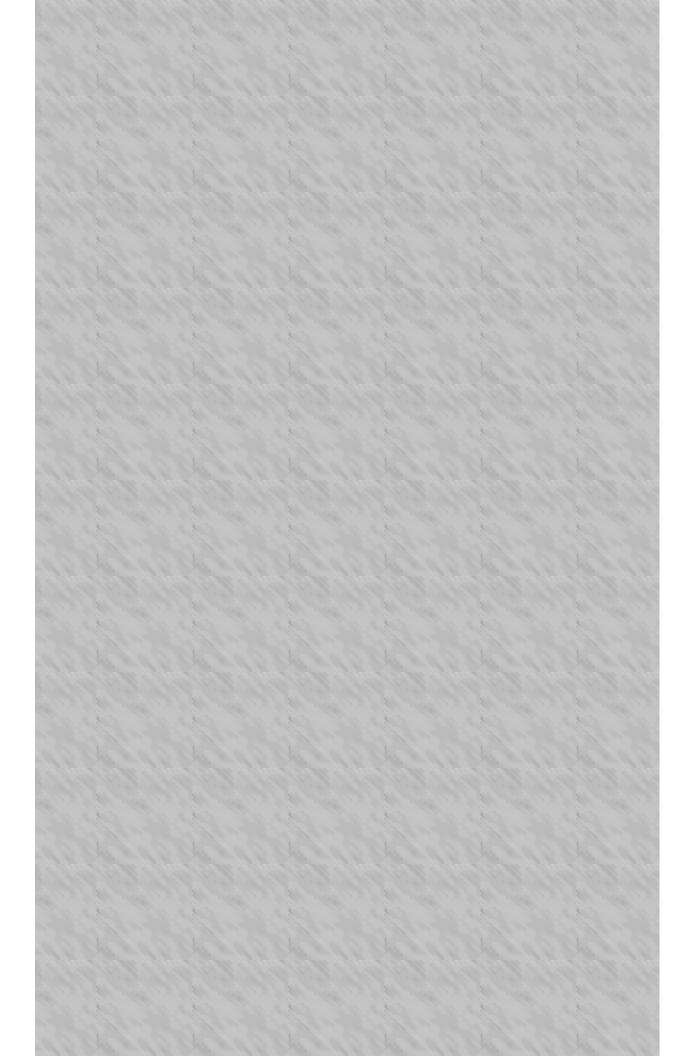
```
subplot(2,2,1)
plot(x1,num_y1,x1,anl_y1,'o')
title('ODE23 solution'), ylabel('y')
subplot(2,2,2)
plot(x1,error_y1) %
title('ODE23 error'), ylabel('y') % ode23 1.e-16
subplot(2,2,3)
plot(x2,num_y2,x2,anl_y2,'o')
title('ODE45 solution'), ylabel('y')
subplot(2,2,4)
plot(x1,error_y2)
title('ODE45 error'), ylabel('y') % ode45
hold off
% m-function, g5.m
function dy=g5(x,y)
dy = -y + 2*\cos(x);
% m-file, odes1.m
% Solve an ode using ode23 and ode45
clg
[x1,num_y1]=ode23('g5',0,5,1);
```

```
anl_y1=sin(x1)+cos(x1);
error_1=abs(anl_y1-num_y1)./abs(anl_y1);
[x2,num_y2]=ode45('g5',0,5,1);
anl_y2=sin(x2)+cos(x2);
error_2=abs(anl_y2-num_y2)./abs(anl_y2);
hold on
subplot(2,2,1)
plot(x1,num_y1,x1,anl_y1,'o')
title('ODE23 solution'), ylabel('y')
subplot(2,2,2)
plot(x1,error_y1) %
title('ODE23 error'), ylabel('y') % ode23 1.e-4
subplot(2,2,3)
plot(x2,num_y2,x2,anl_y2,'o')
title('ODE45 solution'), ylabel('y')
subplot(2,2,4)
plot(x1,error_y2)
title('ODE45 error'), ylabel('y') % ode45 1.e-6
hold off
```









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(change of variables)

$$y^{n} = g(x, y, y', y'', ..., y^{n-1})$$

$$n^{y,y',y'',\dots,y^{n-1}}$$

$$u_1(X) = \mathcal{Y}^{n-1}$$

$$u_2(X) = y^{n-2}$$

$$u_{n-1}(X) = y^t$$

$$u_n(X) = y$$

ODE

$$u_1' = y^n = g(x, u_n, u_{n-1}, ..., u_1)$$

$$u_2' = u_1$$

$$u_{n-2}'=u_{n-3}$$

$$u'_{n-1} = u_{n-2}$$

ODE

$$y'' = g(x, y, y') = y'(1-y^2) - y$$

$$u_1(x) = y^t \quad u_2(x) = y$$

ODE

$$u_1' = y'' = g(x, u_2, u_1) = u_1(1 - u_2^2) - u_2$$

 $u_2' = u_1$

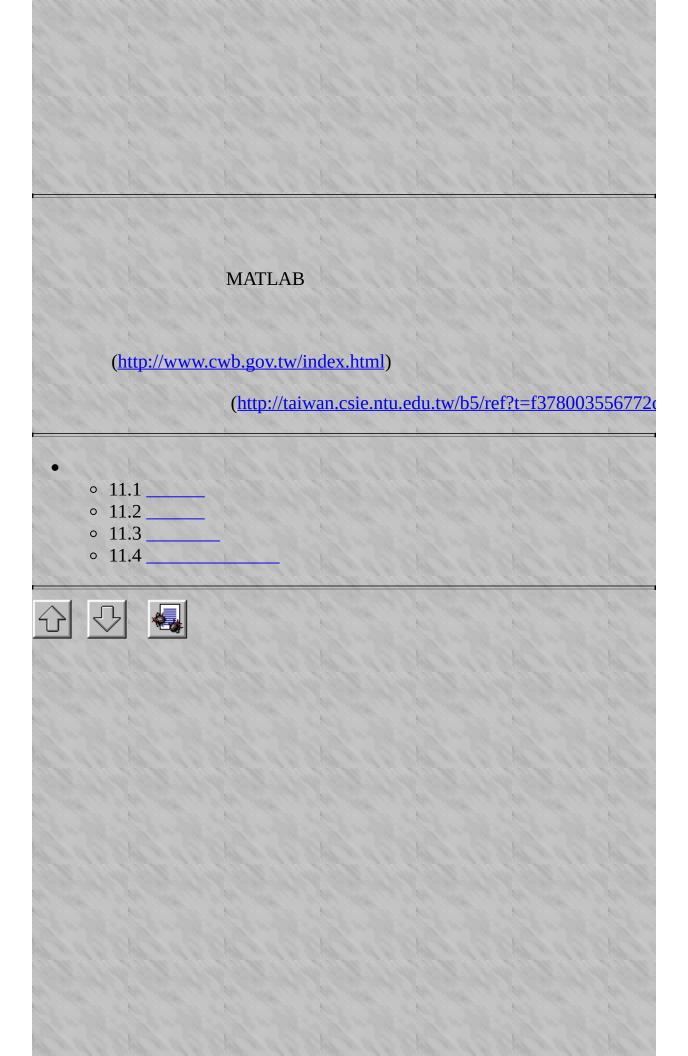
ODE

```
function u_prime =eqns2(x,u)
u_prime(1) = u(1)*(1-u(2)^2) - u(2);
u_prime(2) = u(1);
initial = [0 \ 0.25];
[x,num_y] = ode23('eqns2',0,20,initial);
subplot(2,1,1), plot(x,num_y(:,1))
title('1st derivative of y'), xlabel('x'), grid
subplot(2,1,2), plot(x,num_y(:,2))
title('y'), xlabel('x'), grid
```









11.1						
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				1-	+0.5=1.5	
sin(x)						
MATLABMa	iple					
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• 11.	1.3					
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11.1.1

MATLAB (character string) MATLA expression S symvar(S) 'tan(y/x)' x 'x^3-2*x^2+3' x '1/(cos(angle)+2)' x '3*a*b-6' b $[-2\pi,2\pi]$ ezplot(S), S ezplot ezplot(S,[xmin,xmax MATLAB







11.1.2

```
collect(S) S
collect(S,'v') S v
expand(S) S
factor(S) S(factorization)
simple(S)
simplify(S) MapleS
>> S1 = 'x^3-1';
>> S2 = '(x-3)^2 + (y-4)^2';
>> S3 = 'sqrt(a^4*b^7)'
>> S4 = '14*x^2/(22*x*y)';
>> factor(S1)
ans=
(x-1)*(x^2+x+1)
>> expand(S2)
ans=
x^2-6*x+25+y^2-8*y
```

```
>>collect(S2)
ans=
x^2-6*x+9+(y-4)^2
>>collect(S2,'y')
ans=
y^2-8*y+(x-3)62+16
>>simplify(S3)
ans=
a^2*b^(7/2)
>>simple(S4)
ans=
```



7/11*x/y





11.1.3

horner(S) S numden(S) S numeric(S) S(S) poly2sym(c) pretty(S) S sym2poly(S) S symadd(A,B) A+B symdiv(A,B) A+B symmul(A,B) A+B sympow(S,p) S^p symsub(A,B) A+B >>p1 = '1/(y-3)'; >> p2 = '3*y/(y+2)';>> p3 = '(y+4)*(y-3)*y';>> symmul(p1,p3) ans=

```
(y+4)*y
>> sympow(p2,3)
ans=
27*y^3/(y+2)^3
>> symadd(p1,p2)
ans=
1/(y-3)+3*y/(y+2)
>>[num,den] = numden(symadd(p1,p2))
ans=
[-8*y+2+3*y, (y-3)*(y+2)]
>> horner(symadd(p3,'1')
1+(-12+(1+y)*y)*y
```







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11.2.1

```
solve(f) f
solve(f1,,fn) f1,,fn
>>eq1 = 'x-3=4'; % ' eq1=x-7'
>>eq2 = 'x*2-x-6=0'; % ' eq2=x*2-x-6'
>> eq3 = 'x2+2*x+4=0';
>> eq4 = '3*x+2*y-z=10';
>>eq5 = '-x+3*y+2*z=5';
>>eq6 = 'x-y-z=-1';
>>solve(eq1)
ans=
>>solve(eq2)
ans=
[[3],[-2]]' % 3, -2
>>solve(eq3)
ans=
```

>>solve(eq4,eq5,eq6) %

ans=

$$x = -2$$
, $y = 5$, $z = -6$







11.2.2

(first-order ordinary differential equation, ODE)

ans=

 $-\exp(2^*x)+4^*\exp(3^*x)$







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11.3						
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	.3.1					
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			Marie Contraction	6 6 6	61 12 11 11	
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11.3.1

```
diff 4
diff(f) f
diff(f,'t') ft
diff(f,n) fn
diff(f,'t',n) ftn
                                      diff
>> S1 = '6*x^3-4*x^2+b*x-5';
>>S2 = 'sin(a)';
>>S3 = '(1 - t^3)/(1 + t^4)';
>>diff(S1)
ans=
18*x^2-8*x+b
>>diff(S1,2)
ans=
36*x-8
>>diff(S1,'b')
ans=
```

```
>>diff(S2)
ans=
cos(a)
>>diff(S3)
ans=
-3*t^2/(1+t^4)-4*(1-t^3)/(1+t^4)^2*t^3
>>simplify(diff(S3))
ans=
t^2*(-3+t^4-4*t)/(1+t^4)^2
```







11.3.2

```
int F diff(F)=f (analytical form, closed form) MATLAB
int(f) f
int(f,'t') ft
int(f,a,b) f [a,b]ab
int(f,'t',a,b) ft [a,b]ab
int(f,'m','n') f [m,n]mn
>>S1 = '6*x^3-4*x^2+b*x-5';
>>S2 = 'sin(a)';
>>S3 = 'sqrt(x)';
>>int(S1)
ans=
3/2*x^4-4/3*x^3+1/2*b*x^2-5*x
>>int(S2)
ans=
-cos(a)
>>int(S3)
ans=
```

2/3*x^(3/2)

>>int(\$3,'a','b')

ans=

2/3*b^(3/2)- 2/3*a^(3/2)

>>int(S3,0.5,0.6)

ans=

2/25*15^(1/2)-1/6*2^(1/2)

>>numeric(int(S3,0.5,0.6)) % numeric

ans=

0.0741







