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```
%%%% Differential Equations Homework 3 - Romeo Perlstein %%%%

%%%% -- Problem D3 --- %%%%

close all
close all force
```

a)

```
% Given general solution:
% Theta = @(t) A*cos(t-delta);
% Theta" + sin(theta) = 0
% Theta" = -sin(theta)

%finding numerical solution of given equation D.3
theta_2_prime  = @(t, theta) [theta(2); -sin(theta(1))];

theta_zero = [.1 .7 1.5 3];
theta_p_zero = 0;

%%%& Didn't work, but had a rather interesting result
% for i = 1:1:length(theta_zero)
%     [tA, thetaA] = ode45(theta_2_prime, [-10 10], [theta_zero(i),
 theta_p_zero]);
% end

[tA1, thetaA1] = ode45(theta_2_prime, [-10 10], [theta_zero(1) theta_p_zero]);
[tA2, thetaA2] = ode45(theta_2_prime, [-10 10], [theta_zero(2) theta_p_zero]);
[tA3, thetaA3] = ode45(theta_2_prime, [-10 10], [theta_zero(3) theta_p_zero]);
[tA4, thetaA4] = ode45(theta_2_prime, [-10 10], [theta_zero(4) theta_p_zero]);
figure
plot(tA1, thetaA1);
title("graph 1");
figure
plot(tA2, thetaA2);
title("graph 2");
figure
plot(tA3, thetaA3);
title("graph 3");
figure
plot(tA4, thetaA4);
title("graph 4");
figure
```

```
hold on
plot(tA1, thetaA1, "r");
plot(tA2, thetaA2, "b");
plot(tA3, thetaA3, "g");
plot(tA4, thetaA4, "m");
title("graph 1-4 overlay")

%%%% estimated periods:
% first amplitude T = ~6.2, or ~2pi
% second amtplitude T = ~6.6 or ~2.1pi
% third amplitude T = ~ 7.5 or (12/5)pi
% fourth amplitude T = ~8 or (5/2)pi


%%%% analyze the graph x an y values, see when the y values repeat, and see
%%%% the delta x when it does:
period_look_1 = [tA1(:,1) thetaA1(:,1)]
period_look_2 = [tA2(:,1) thetaA2(:,1)]
period_look_3 = [tA3(:,1) thetaA3(:,1)]
period_look_4 = [tA4(:,1) thetaA4(:,1)]

%%%% Looks good on the interval [1:50] for the first 3 graphs, 1:100 for the
%%%% 4th graph, so display the interval:

period_look_1_but_better = [tA1(1:50,1) thetaA1(1:50,1)]
period_look_2_but_better = [tA2(1:50,1) thetaA2(1:50,1)]
period_look_3_but_better = [tA3(1:50,1) thetaA3(1:50,1)]
period_look_4_but_better = [tA4(1:100,1) thetaA4(1:100,1)]

period_guesstamate1 = string((tA1(50) - tA1(1))/pi) + "pi"
period_guesstamate2 = string((tA2(50) - tA1(1))/pi) + "pi"
period_guesstamate3 = string((tA3(50) - tA1(1))/pi) + "pi"
period_guesstamate4 = string((tA4(100) - tA1(1))/pi) + "pi"


period_look_1 =

  -10.0000    0.1000
   -9.9995    0.1000
   -9.9990    0.1000
   -9.9985    0.1000
   -9.9980    0.1000
   -9.9955    0.1000
   -9.9930    0.1000
   -9.9904    0.1000
   -9.9879    0.1000
   -9.9753    0.1000
   -9.9628    0.0999
   -9.9502    0.0999
   -9.9376    0.0998
   -9.8747    0.0992
   -9.8118    0.0982
   -9.7489    0.0969
```

```
-9.6860    0.0951
-9.5207    0.0888
-9.3555    0.0800
-9.1902    0.0690
-9.0249    0.0562
-8.8242    0.0385
-8.6234    0.0194
-8.4226   -0.0006
-8.2219   -0.0205
-8.0171   -0.0400
-7.8124   -0.0578
-7.6076   -0.0731
-7.4029   -0.0855
-7.2010   -0.0941
-6.9991   -0.0990
-6.7972   -0.0998
-6.5952   -0.0966
-6.3960   -0.0896
-6.1967   -0.0790
-5.9974   -0.0653
-5.7981   -0.0491
-5.5955   -0.0305
-5.3929   -0.0108
-5.1903    0.0095
-4.9877    0.0293
-4.7922    0.0473
-4.5968    0.0635
-4.4014    0.0773
-4.2060    0.0881
-4.0030    0.0958
-3.8001    0.0996
-3.5971    0.0993
-3.3942    0.0949
-3.2009    0.0872
-3.0076    0.0761
-2.8143    0.0623
-2.6210    0.0461
-2.4177    0.0272
-2.2144    0.0072
-2.0110   -0.0130
-1.8077   -0.0328
-1.6161   -0.0502
-1.4244   -0.0657
-1.2328   -0.0789
-1.0412   -0.0891
-0.8377   -0.0964
-0.6343   -0.0998
-0.4308   -0.0990
-0.2273   -0.0942
-0.0365   -0.0861
 0.1544   -0.0749
 0.3453   -0.0610
 0.5361   -0.0448
 0.7398   -0.0258
```

```
    0.9434   -0.0058
    1.1471    0.0145
    1.3508    0.0342
    1.5408    0.0513
    1.7309    0.0666
    1.9210    0.0795
    2.1110    0.0895
    2.3147    0.0967
    2.5184    0.0998
    2.7221    0.0989
    2.9258    0.0938
    3.1156    0.0856
    3.3055    0.0744
    3.4953    0.0604
    3.6852    0.0443
    3.8890    0.0253
    4.0928    0.0052
    4.2966   -0.0151
    4.5004   -0.0348
    4.6898   -0.0518
    4.8792   -0.0670
    5.0686   -0.0798
    5.2580   -0.0897
    5.4618   -0.0968
    5.6656   -0.0998
    5.8694   -0.0988
    6.0732   -0.0937
    6.2626   -0.0854
    6.4520   -0.0741
    6.6414   -0.0602
    6.8309   -0.0441
    7.0347   -0.0250
    7.2386   -0.0049
    7.4425    0.0154
    7.6464    0.0351
    7.8355    0.0520
    8.0246    0.0671
    8.2137    0.0799
    8.4029    0.0897
    8.6067    0.0968
    8.8105    0.0998
    9.0143    0.0988
    9.2182    0.0936
    9.4136    0.0850
    9.6091    0.0732
    9.8045    0.0586
   10.0000    0.0417


period_look_2 =

  -10.0000    0.7000
   -9.9999    0.7000
   -9.9998    0.7000
```

```
-9.9998    0.7000
-9.9997    0.7000
-9.9993    0.7000
-9.9989    0.7000
-9.9985    0.7000
-9.9981    0.7000
-9.9962    0.7000
-9.9942    0.7000
-9.9923    0.7000
-9.9903    0.7000
-9.9806    0.6999
-9.9708    0.6997
-9.9611    0.6995
-9.9513    0.6992
-9.9026    0.6969
-9.8539    0.6931
-9.8051    0.6878
-9.7564    0.6810
-9.5830    0.6446
-9.4097    0.5903
-9.2363    0.5192
-9.0630    0.4333
-8.8479    0.3095
-8.6328    0.1717
-8.4177    0.0260
-8.2027   -0.1209
-7.9877   -0.2622
-7.7727   -0.3916
-7.5577   -0.5033
-7.3428   -0.5928
-7.1332   -0.6554
-6.9237   -0.6913
-6.7142   -0.6991
-6.5047   -0.6788
-6.2920   -0.6302
-6.0792   -0.5549
-5.8665   -0.4559
-5.6538   -0.3370
-5.4360   -0.1999
-5.2182   -0.0534
-5.0004    0.0955
-4.7826    0.2400
-4.5860    0.3610
-4.3894    0.4683
-4.1929    0.5582
-3.9963    0.6277
-3.7813    0.6778
-3.5663    0.6990
-3.3514    0.6904
-3.1364    0.6525
-2.9360    0.5920
-2.7355    0.5091
-2.5351    0.4067
-2.3346    0.2884
```

```
-2.1159    0.1466
-1.8972   -0.0022
-1.6785   -0.1509
-1.4597   -0.2924
-1.2718   -0.4033
-1.0838   -0.5004
-0.8959   -0.5805
-0.7079   -0.6413
-0.4898   -0.6854
-0.2717   -0.6995
-0.0536   -0.6829
 0.1645   -0.6364
 0.3608   -0.5704
 0.5572   -0.4837
 0.7536   -0.3791
 0.9499   -0.2602
 1.1691   -0.1161
 1.3882    0.0335
 1.6074    0.1815
 1.8265    0.3209
 2.0165    0.4297
 2.2065    0.5236
 2.3965    0.5994
 2.5865    0.6549
 2.8069    0.6918
 3.0273    0.6979
 3.2477    0.6726
 3.4681    0.6172
 3.6680    0.5427
 3.8679    0.4477
 4.0677    0.3354
 4.2676    0.2100
 4.4870    0.0630
 4.7064   -0.0870
 4.9257   -0.2328
 5.1451   -0.3676
 5.3382   -0.4721
 5.5312   -0.5598
 5.7243   -0.6276
 5.9173   -0.6736
 6.1414   -0.6980
 6.3656   -0.6902
 6.5897   -0.6504
 6.8138   -0.5802
 7.0187   -0.4921
 7.2235   -0.3842
 7.4283   -0.2607
 7.6331   -0.1264
 7.8522    0.0230
 8.0712    0.1712
 8.2903    0.3113
 8.5094    0.4367
 8.7068    0.5326
 8.9042    0.6088
```

```
    9.1016    0.6626
    9.2990    0.6925
    9.4743    0.6984
    9.6495    0.6845
    9.8248    0.6512
   10.0000    0.5993


period_look_3 =

  -10.0000    1.5000
   -9.9999    1.5000
   -9.9999    1.5000
   -9.9998    1.5000
   -9.9998    1.5000
   -9.9995    1.5000
   -9.9993    1.5000
   -9.9990    1.5000
   -9.9988    1.5000
   -9.9975    1.5000
   -9.9963    1.5000
   -9.9950    1.5000
   -9.9938    1.5000
   -9.9875    1.4999
   -9.9812    1.4998
   -9.9749    1.4997
   -9.9686    1.4995
   -9.9371    1.4980
   -9.9056    1.4956
   -9.8741    1.4921
   -9.8427    1.4877
   -9.6853    1.4506
   -9.5279    1.3890
   -9.3705    1.3031
   -9.2131    1.1933
   -8.9650    0.9740
   -8.7169    0.7042
   -8.4688    0.3950
   -8.2207    0.0623
   -8.0249   -0.2038
   -7.8291   -0.4622
   -7.6333   -0.7037
   -7.4375   -0.9205
   -7.2418   -1.1068
   -7.0460   -1.2590
   -6.8502   -1.3748
   -6.6544   -1.4529
   -6.3656   -1.4990
   -6.0768   -1.4617
   -5.7880   -1.3413
   -5.4992   -1.1403
   -5.2614   -0.9178
   -5.0237   -0.6508
   -4.7860   -0.3500
```

```
-4.5482   -0.0299
-4.3105    0.2918
-4.0727    0.5973
-3.8350    0.8714
-3.5973    1.1023
-3.4002    1.2554
-3.2032    1.3717
-3.0062    1.4501
-2.8091    1.4898
-2.4616    1.4664
-2.1141    1.3222
-1.7665    1.0612
-1.4190    0.6970
-1.2237    0.4560
-1.0284    0.1985
-0.8331   -0.0665
-0.6378   -0.3291
-0.4424   -0.5794
-0.2471   -0.8089
-0.0518   -1.0110
 0.1435   -1.1808
 0.3553   -1.3250
 0.5671   -1.4259
 0.7789   -1.4824
 0.9906   -1.4941
 1.3343   -1.4190
 1.6780   -1.2264
 2.0216   -0.9235
 2.3653   -0.5286
 2.5574   -0.2791
 2.7495   -0.0197
 2.9416    0.2405
 3.1337    0.4920
 3.3258    0.7262
 3.5180    0.9360
 3.7101    1.1162
 3.9022    1.2633
 4.1244    1.3895
 4.3466    1.4673
 4.5688    1.4959
 4.7909    1.4753
 5.0931    1.3689
 5.3952    1.1730
 5.6974    0.8934
 5.9995    0.5440
 6.1921    0.2949
 6.3846    0.0353
 6.5771   -0.2256
 6.7696   -0.4784
 6.9621   -0.7141
 7.1547   -0.9257
 7.3472   -1.1079
 7.5397   -1.2569
 7.7609   -1.3846
```

```
    7.9821   -1.4643
    8.2032   -1.4953
    8.4244   -1.4775
    8.7286   -1.3741
    9.0329   -1.1796
    9.3371   -0.9001
    9.6413   -0.5495
    9.7310   -0.4357
    9.8207   -0.3185
    9.9103   -0.1987
   10.0000   -0.0774


period_look_4 =

  -10.0000    3.0000
   -9.9996    3.0000
   -9.9993    3.0000
   -9.9989    3.0000
   -9.9986    3.0000
   -9.9968    3.0000
   -9.9950    3.0000
   -9.9932    3.0000
   -9.9915    3.0000
   -9.9826    3.0000
   -9.9737    3.0000
   -9.9648    2.9999
   -9.9559    2.9999
   -9.9114    2.9994
   -9.8669    2.9987
   -9.8224    2.9978
   -9.7779    2.9965
   -9.6225    2.9898
   -9.4672    2.9795
   -9.3118    2.9653
   -9.1565    2.9468
   -8.9485    2.9146
   -8.7406    2.8727
   -8.5327    2.8193
   -8.3247    2.7521
   -8.0777    2.6507
   -7.8306    2.5204
   -7.5836    2.3543
   -7.3365    2.1450
   -7.0771    1.8706
   -6.8177    1.5318
   -6.5584    1.1264
   -6.2990    0.6615
   -6.1153    0.3058
   -5.9317   -0.0597
   -5.7480   -0.4233
   -5.5643   -0.7734
   -5.3807   -1.0999
   -5.1970   -1.3967
```

```
-5.0133   -1.6606
-4.8297   -1.8909
-4.6280   -2.1070
-4.4264   -2.2883
-4.2248   -2.4388
-4.0231   -2.5630
-3.8217   -2.6649
-3.6203   -2.7481
-3.4190   -2.8156
-3.2176   -2.8701
-3.0162   -2.9138
-2.8148   -2.9483
-2.6134   -2.9749
-2.4120   -2.9947
-2.2170   -3.0083
-2.0221   -3.0168
-1.8271   -3.0206
-1.6321   -3.0197
-1.4519   -3.0148
-1.2716   -3.0058
-1.0914   -2.9924
-0.9112   -2.9741
-0.7031   -2.9462
-0.4951   -2.9099
-0.2871   -2.8636
-0.0790   -2.8054
 0.1683   -2.7174
 0.4156   -2.6041
 0.6629   -2.4593
 0.9102   -2.2758
 1.1710   -2.0325
 1.4318   -1.7278
 1.6926   -1.3561
 1.9534   -0.9192
 2.1471   -0.5586
 2.3409   -0.1786
 2.5347    0.2079
 2.7285    0.5872
 2.9222    0.9454
 3.1160    1.2737
 3.3098    1.5666
 3.5036    1.8220
 3.6966    2.0401
 3.8896    2.2251
 4.0826    2.3804
 4.2756    2.5100
 4.4781    2.6225
 4.6806    2.7146
 4.8831    2.7895
 5.0856    2.8502
 5.2882    2.8993
 5.4907    2.9384
 5.6932    2.9692
 5.8957    2.9929
```

```
    6.0919    3.0101
    6.2881    3.0222
    6.4844    3.0297
    6.6806    3.0329
    6.8664    3.0321
    7.0521    3.0275
    7.2379    3.0190
    7.4237    3.0062
    7.6194    2.9877
    7.8152    2.9632
    8.0109    2.9320
    8.2067    2.8927
    8.4460    2.8318
    8.6853    2.7532
    8.9246    2.6529
    9.1640    2.5256
    9.3730    2.3877
    9.5820    2.2197
    9.7910    2.0168
   10.0000    1.7747


period_look_1_but_better =

  -10.0000    0.1000
   -9.9995    0.1000
   -9.9990    0.1000
   -9.9985    0.1000
   -9.9980    0.1000
   -9.9955    0.1000
   -9.9930    0.1000
   -9.9904    0.1000
   -9.9879    0.1000
   -9.9753    0.1000
   -9.9628    0.0999
   -9.9502    0.0999
   -9.9376    0.0998
   -9.8747    0.0992
   -9.8118    0.0982
   -9.7489    0.0969
   -9.6860    0.0951
   -9.5207    0.0888
   -9.3555    0.0800
   -9.1902    0.0690
   -9.0249    0.0562
   -8.8242    0.0385
   -8.6234    0.0194
   -8.4226   -0.0006
   -8.2219   -0.0205
   -8.0171   -0.0400
   -7.8124   -0.0578
   -7.6076   -0.0731
   -7.4029   -0.0855
   -7.2010   -0.0941
```

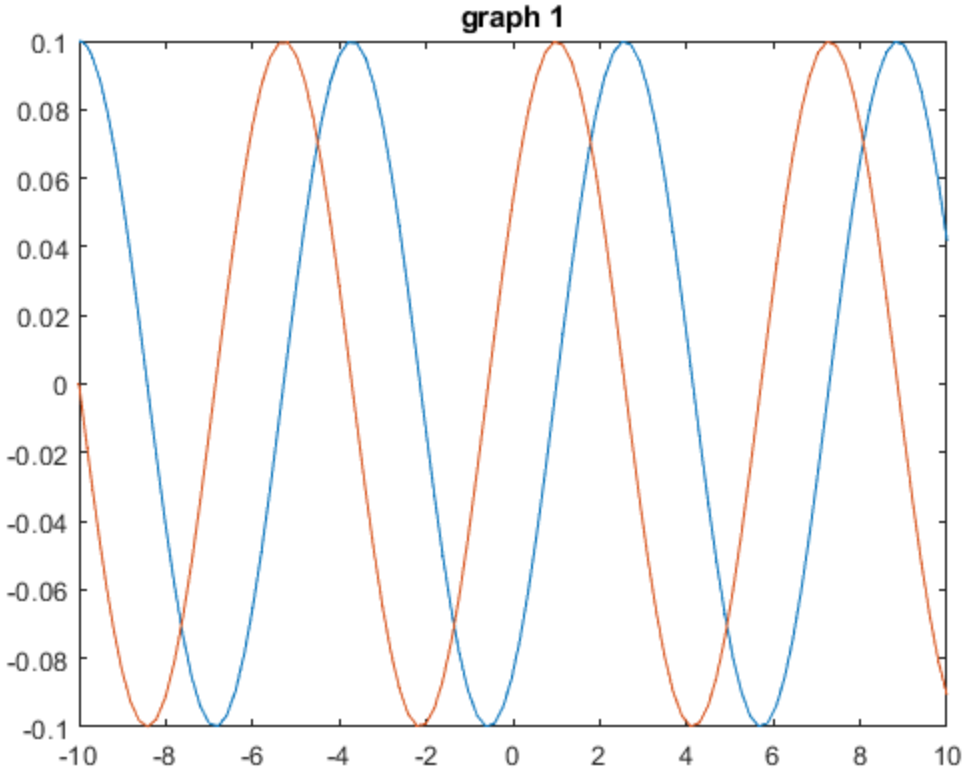
```
   -6.9991   -0.0990
   -6.7972   -0.0998
   -6.5952   -0.0966
   -6.3960   -0.0896
   -6.1967   -0.0790
   -5.9974   -0.0653
   -5.7981   -0.0491
   -5.5955   -0.0305
   -5.3929   -0.0108
   -5.1903    0.0095
   -4.9877    0.0293
   -4.7922    0.0473
   -4.5968    0.0635
   -4.4014    0.0773
   -4.2060    0.0881
   -4.0030    0.0958
   -3.8001    0.0996
   -3.5971    0.0993
   -3.3942    0.0949
   -3.2009    0.0872


period_look_2_but_better =

  -10.0000    0.7000
   -9.9999    0.7000
   -9.9998    0.7000
   -9.9998    0.7000
   -9.9997    0.7000
   -9.9993    0.7000
   -9.9989    0.7000
   -9.9985    0.7000
   -9.9981    0.7000
   -9.9962    0.7000
   -9.9942    0.7000
   -9.9923    0.7000
   -9.9903    0.7000
   -9.9806    0.6999
   -9.9708    0.6997
   -9.9611    0.6995
   -9.9513    0.6992
   -9.9026    0.6969
   -9.8539    0.6931
   -9.8051    0.6878
   -9.7564    0.6810
   -9.5830    0.6446
   -9.4097    0.5903
   -9.2363    0.5192
   -9.0630    0.4333
   -8.8479    0.3095
   -8.6328    0.1717
   -8.4177    0.0260
   -8.2027   -0.1209
   -7.9877   -0.2622
```

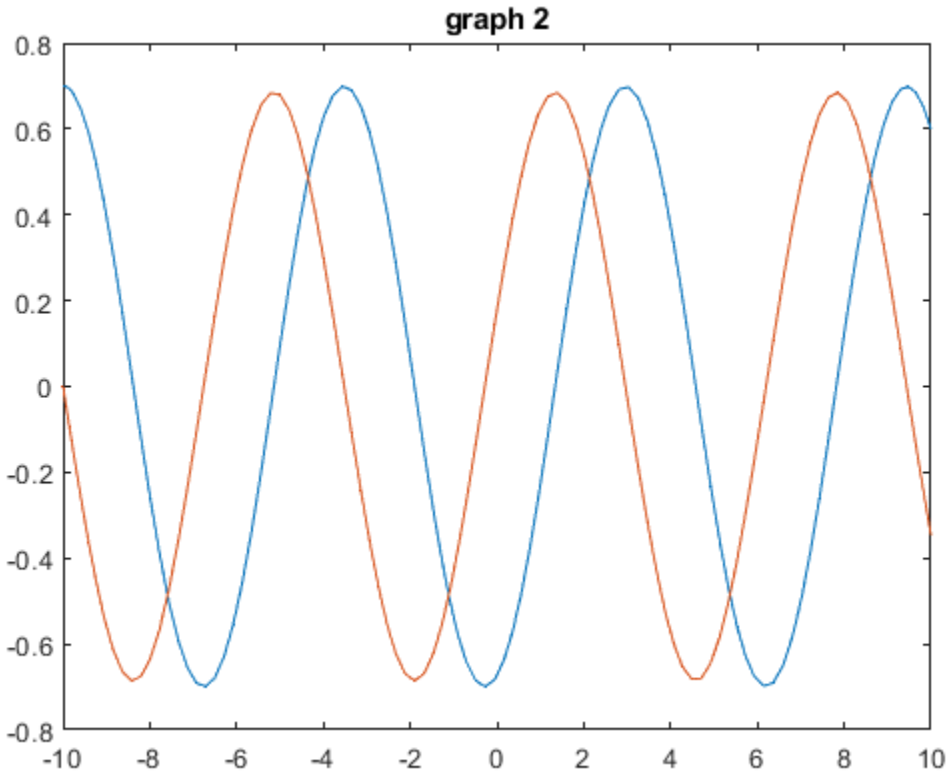
```
   -7.7727   -0.3916
   -7.5577   -0.5033
   -7.3428   -0.5928
   -7.1332   -0.6554
   -6.9237   -0.6913
   -6.7142   -0.6991
   -6.5047   -0.6788
   -6.2920   -0.6302
   -6.0792   -0.5549
   -5.8665   -0.4559
   -5.6538   -0.3370
   -5.4360   -0.1999
   -5.2182   -0.0534
   -5.0004    0.0955
   -4.7826    0.2400
   -4.5860    0.3610
   -4.3894    0.4683
   -4.1929    0.5582
   -3.9963    0.6277
   -3.7813    0.6778


period_look_3_but_better =

  -10.0000    1.5000
   -9.9999    1.5000
   -9.9999    1.5000
   -9.9998    1.5000
   -9.9998    1.5000
   -9.9995    1.5000
   -9.9993    1.5000
   -9.9990    1.5000
   -9.9988    1.5000
   -9.9975    1.5000
   -9.9963    1.5000
   -9.9950    1.5000
   -9.9938    1.5000
   -9.9875    1.4999
   -9.9812    1.4998
   -9.9749    1.4997
   -9.9686    1.4995
   -9.9371    1.4980
   -9.9056    1.4956
   -9.8741    1.4921
   -9.8427    1.4877
   -9.6853    1.4506
   -9.5279    1.3890
   -9.3705    1.3031
   -9.2131    1.1933
   -8.9650    0.9740
   -8.7169    0.7042
   -8.4688    0.3950
   -8.2207    0.0623
   -8.0249   -0.2038
```

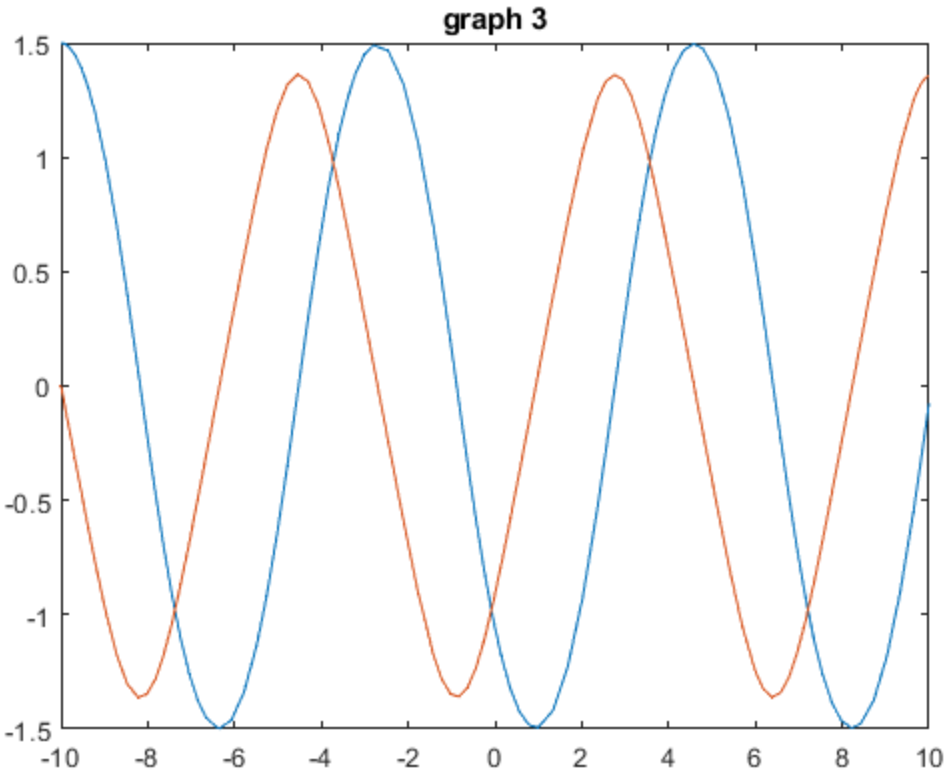
```
   -7.8291   -0.4622
   -7.6333   -0.7037
   -7.4375   -0.9205
   -7.2418   -1.1068
   -7.0460   -1.2590
   -6.8502   -1.3748
   -6.6544   -1.4529
   -6.3656   -1.4990
   -6.0768   -1.4617
   -5.7880   -1.3413
   -5.4992   -1.1403
   -5.2614   -0.9178
   -5.0237   -0.6508
   -4.7860   -0.3500
   -4.5482   -0.0299
   -4.3105    0.2918
   -4.0727    0.5973
   -3.8350    0.8714
   -3.5973    1.1023
   -3.4002    1.2554


period_look_4_but_better =

  -10.0000    3.0000
   -9.9996    3.0000
   -9.9993    3.0000
   -9.9989    3.0000
   -9.9986    3.0000
   -9.9968    3.0000
   -9.9950    3.0000
   -9.9932    3.0000
   -9.9915    3.0000
   -9.9826    3.0000
   -9.9737    3.0000
   -9.9648    2.9999
   -9.9559    2.9999
   -9.9114    2.9994
   -9.8669    2.9987
   -9.8224    2.9978
   -9.7779    2.9965
   -9.6225    2.9898
   -9.4672    2.9795
   -9.3118    2.9653
   -9.1565    2.9468
   -8.9485    2.9146
   -8.7406    2.8727
   -8.5327    2.8193
   -8.3247    2.7521
   -8.0777    2.6507
   -7.8306    2.5204
   -7.5836    2.3543
   -7.3365    2.1450
   -7.0771    1.8706
```

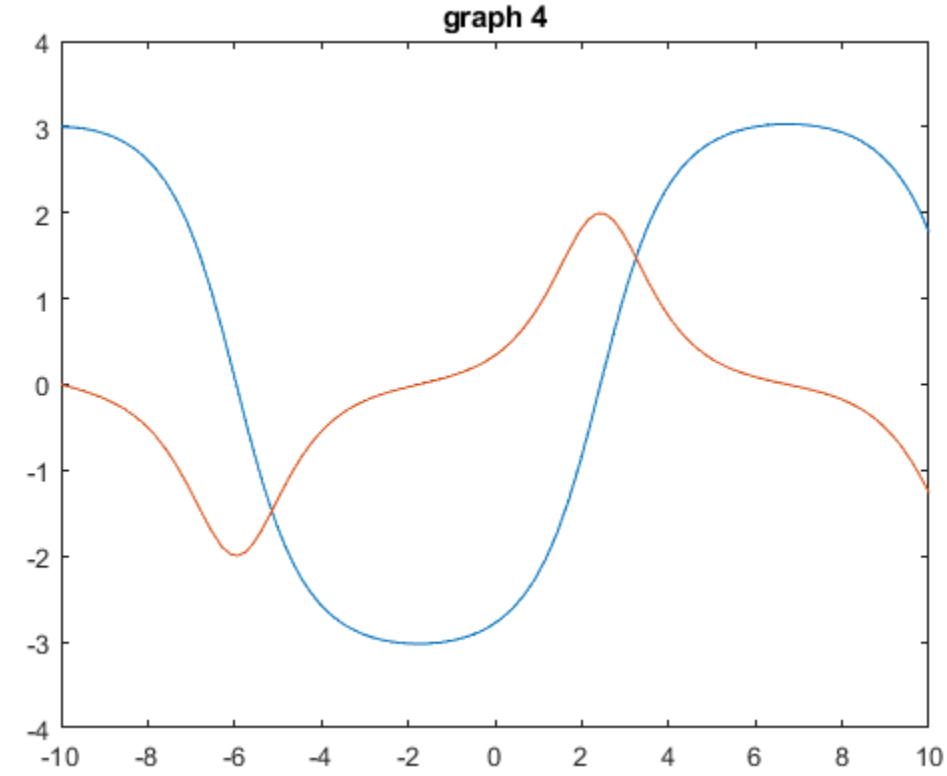
```
-6.8177    1.5318
-6.5584    1.1264
-6.2990    0.6615
-6.1153    0.3058
-5.9317   -0.0597
-5.7480   -0.4233
-5.5643   -0.7734
-5.3807   -1.0999
-5.1970   -1.3967
-5.0133   -1.6606
-4.8297   -1.8909
-4.6280   -2.1070
-4.4264   -2.2883
-4.2248   -2.4388
-4.0231   -2.5630
-3.8217   -2.6649
-3.6203   -2.7481
-3.4190   -2.8156
-3.2176   -2.8701
-3.0162   -2.9138
-2.8148   -2.9483
-2.6134   -2.9749
-2.4120   -2.9947
-2.2170   -3.0083
-2.0221   -3.0168
-1.8271   -3.0206
-1.6321   -3.0197
-1.4519   -3.0148
-1.2716   -3.0058
-1.0914   -2.9924
-0.9112   -2.9741
-0.7031   -2.9462
-0.4951   -2.9099
-0.2871   -2.8636
-0.0790   -2.8054
 0.1683   -2.7174
 0.4156   -2.6041
 0.6629   -2.4593
 0.9102   -2.2758
 1.1710   -2.0325
 1.4318   -1.7278
 1.6926   -1.3561
 1.9534   -0.9192
 2.1471   -0.5586
 2.3409   -0.1786
 2.5347    0.2079
 2.7285    0.5872
 2.9222    0.9454
 3.1160    1.2737
 3.3098    1.5666
 3.5036    1.8220
 3.6966    2.0401
 3.8896    2.2251
 4.0826    2.3804
```

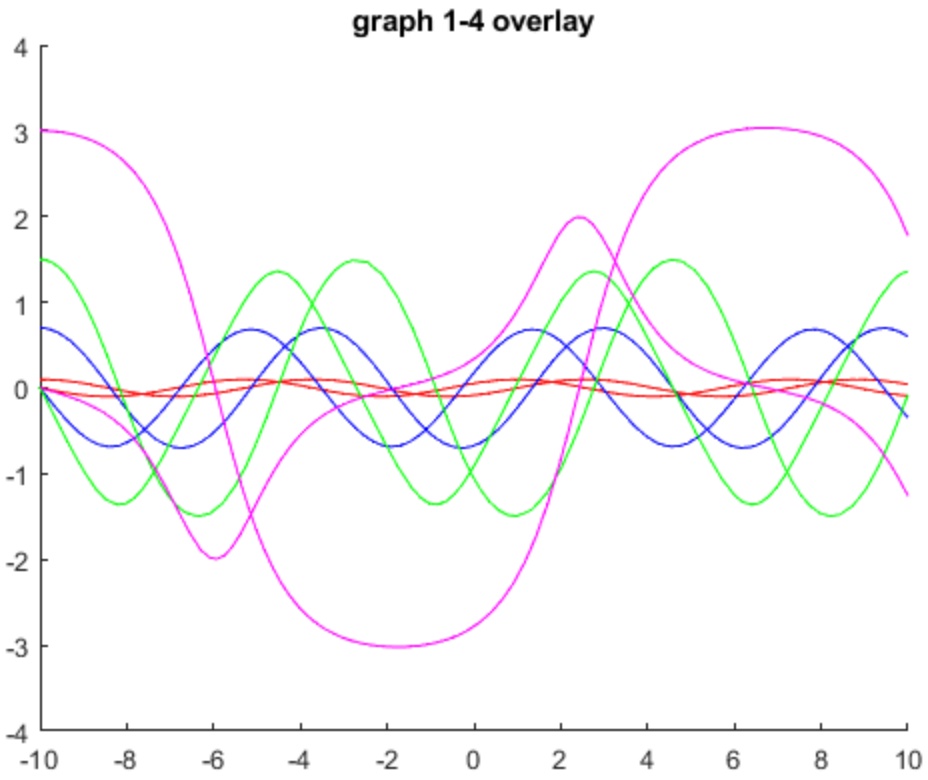
```
    4.2756    2.5100
    4.4781    2.6225
    4.6806    2.7146
    4.8831    2.7895
    5.0856    2.8502
    5.2882    2.8993
    5.4907    2.9384
    5.6932    2.9692
    5.8957    2.9929
    6.0919    3.0101
    6.2881    3.0222
    6.4844    3.0297
    6.6806    3.0329
    6.8664    3.0321
    7.0521    3.0275
    7.2379    3.0190


period_guesstamate1 =

    "2.1642pi"


period_guesstamate2 =

    "1.9795pi"


period_guesstamate3 =

    "2.1008pi"


period_guesstamate4 =

    "5.487pi"
```


graph 1
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-10
-8
-6
-4
-2
0
2
4
6
8
10


graph 2
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-10
-8
-6
-4
-2
0
2
4
6
8
10


graph 3
1.5
1
0.5
0
-0.5
-1
-1.5
-10
-8
-6
-4
-2
0
2
4
6
8
10


graph 4
4
3
2
1
0
-1
-2
-3
-4
-10
-8
-6
-4
-2
0
2
4
6
8
10



b)

```
A1 = 0.1;
A2 = 0.7;
A3 = 1.5;
A4 = 3.0;
k1 = sin(A1/2);
k2 = sin(A2/2);
k3 = sin(A3/2);
k4 = sin(A4/2);
func1 = @(phi) 4./(sqrt(1-(k1.^2).*(sin(phi)).^2));
func2 = @(phi) 4./(sqrt(1-(k2.^2).*(sin(phi)).^2));
func3 = @(phi) 4./(sqrt(1-(k3.^2).*(sin(phi)).^2));
func4 = @(phi) 4./(sqrt(1-(k4.^2).*(sin(phi)).^2));

T1 = integral(func1, 0, (pi()/2));
T2 = integral(func2, 0, (pi()/2));
T3 = integral(func3, 0, (pi()/2));
T4 = integral(func4, 0, (pi()/2));
T_actual = [string(T1/pi())+"pi" string(T2/pi())+"pi" string(T3/pi())+"pi"
 string(T4/pi())+"pi"]

% yes! the values I had found for my periods are rather close to what
% the integral function using the actual time peiod function outputted.
% This may be because I tried to make my values as accurate as possible,
```

```
% however.
```

```
T_actual =

  1×4 string array

    "2.0013pi"    "2.063pi"    "2.3239pi"    "5.1425pi"
```

c)

```
%%%% Show it by using the values in the graph, and better parameters

for i = 2:1:50
    if (thetaA1(i,1) <= thetaA1(1,1)+.005 && thetaA1(i,1) >= thetaA1(1,1)
 - .005)
        temp_period1 = tA1(i) - tA1(1);
        period1 = string(temp_period1/pi()) + "pi";
    end
end

for i = 2:1:53
    if (thetaA2(i,1) <= thetaA2(1,1)+.001 && thetaA2(i,1) >= thetaA2(1,1)
 - .001)
        temp_period2 = tA2(i) - tA2(1);
        period2 = string(temp_period2/pi()) + "pi";
    end
end

for i = 2:1:54
    if (thetaA3(i,1) <= thetaA3(1,1) + .05 && thetaA3(i,1) >= thetaA3(1,1)
 - .05)
        temp_period3 = tA3(i) - tA3(1);
        period3 = string(temp_period3/pi()) + "pi";
    end
end

for i = 2:1:110
    if (thetaA4(i,1) >= thetaA4(1,1) && thetaA4(i,1) >= thetaA4(i-1,1))
        temp_period4 = tA4(i) - tA4(1);
        period4 = string(temp_period4/pi()) + "pi";
    end
end

%%%% display the solved for values of the time period, using the plots
period1
period2
period3
period4
```

```
period1 =
```

```
    "2.0381pi"

period2 =

    "2.0479pi"

period3 =

    "2.3995pi"

period4 =

    "5.3096pi"
```

d)

```
%%%% Providing an answer through a written response
% amazingly, the prediction made by the book was correct, and while A is
% relatively small, (seemingly 0-1.5), the period of the function remains
% roughly around 2pi. As A increases though, the period starts to also
% increase, and it seems to reach a point where the described movement of
% the pendulum becomes "weird" or at least incorrect. This is also
% corroberated in the output of the graph, where you can see that for a
% larger amplitude of 3, the graph is no longer a sinusoidal wave, but has
% two different graphs, which are not just simple phase shifts of the same
% graph.

% the period seems to increase as the amplitude increases, which is also
% demonstrated with the output of the graphs. If I were to guess, because
% I'm not exactly sure what's happening, I would assume the linear
% approximnation of the differential equation starts to "explode" as the
% amplitude get's bigger. If I'm thinking about it correctly, it kind of
% does make senes, since if the displacement of the pendulum becomes larger
% and larger, the behavior of the pendulum wont follow simply harmonic
% motion anymore (I think). As such, the approximation becomes less and
% less accurate, because it wasn't meant to model the behavior of an
% erratic pendulum.

% This is speculation on my end, after reviewing the behavior, however.
```

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