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9	Solve by variation of parameters $D^2y + 4y = sec(x)$		
10	Determine the characteristic polynomial of a matrix by evaluating the polynomial $P(\lambda)$ at $n + 1$ points. Then fit the polynomial to these points		

Experiment - 1

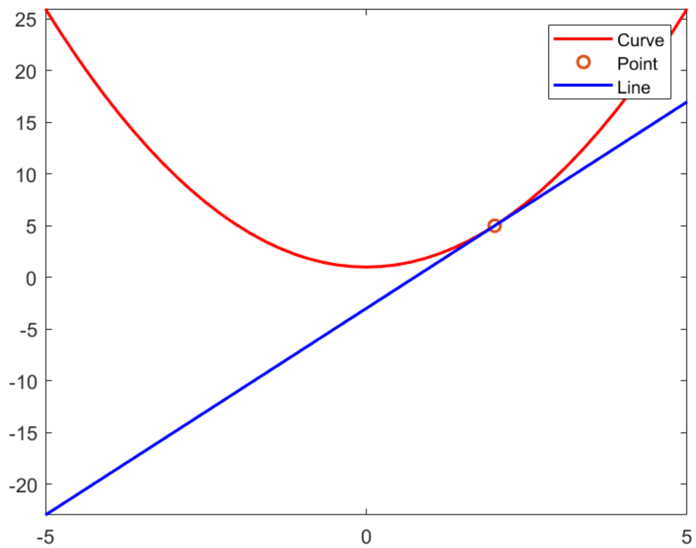
Write a program to draw a tangent line at point on a given curve y=1+x^2 at (2,5) and find the radius of curvature

CODE

```
disp("-------------------")

disp("Experiment - 1")

disp("Name -> M K Lino Roshaan")

disp("Roll No -> 2K22/MC/87")

disp("-------------------")

syms x

eqn = x^2 + 1;

fplot(eqn, '-r','linewidth', 1.5)

hold on

x1 = 2;

y1 = 5;

plot(x1, y1, 'o', 'linewidth', 1.5)

f = @(x) 1+x^2 ;

f1 = eval(['@(x)' char(diff(f(x)))]);

f2 = eval(['@(x)' char(diff(f1(x)))]);

slope_of_tangent = f1(2);

offset = y1 - slope_of_tangent*x1;

tangent_eqn = slope_of_tangent*x + offset;

fplot(tangent_eqn, '-b','linewidth', 1.5)

legend Curve Point Line

radius_of_curvature = ((1+(f1(x1))^2)^(1.5))/f2(x);

disp("Radius Of Curvature->")

disp(radius_of_curvature)
```

OUTPUT

```
>> radius_and_tangent
-------------------
Experiment - 1
Name -> M K Lino Roshaan
Roll No -> 2K22/MC/87
-------------------
Radius Of Curvature->
   35.0464

>>
```



Experiment - 2

Write a program to show consistency and inconsistency of a given system of linear equation

CODE

```
disp("------------------")

disp("Experiment - 2")

disp("Name -> M K Lino Roshaan")

disp("Roll No -> 2K22/MC/87")

disp("------------------")

syms x y z

eqn1 = 2*x + y + z == 2

eqn2 = -x + y - z == 3

eqn3 = x + 2*y + 3*z == -10

%eqn1 = x + y + z == 1

%eqn2 = 2*x + 2*y + 2*z == 2

%eqn3 = 3*x + 3*y + 3*z == 3

[A,B] = equationsToMatrix([eqn1, eqn2, eqn3], [x, y, z]);

M = [A B];

R = rref(M);

if rank(R) == rank(A) && rank(A) == 3

    disp("The System Of Linear Equations Is Consistent")

    X = linsolve(A, B);

    disp(X)

elseif rank(R) == rank(A) && rank(A) < 3

     disp("The System Of Linear Equations Is Consistent")

     disp("The System has Infinite Many Solutions")

else
```

```
    fprint("The System Of Linear Equations Is Inconsistent")
end
```

OUTPUT

```
>> consistency_inconsistency
-------------------
Experiment - 2
Name -> M K Lino Roshaan
Roll No -> 2K22/MC/87
-------------------

eqn1 =

2*x + y + z == 2


eqn2 =

y - x - z == 3


eqn3 =

x + 2*y + 3*z == -10

The System Of Linear Equations Is Consistent
 3
 1
-5

fx >>
>> consistency_inconsistency

eqn1 =

x + y + z == 1


eqn2 =

2*x + 2*y + 2*z == 2


eqn3 =

3*x + 3*y + 3*z == 3

The System Of Linear Equations Is Consistent
The System has Infinite Many Solutions
fx >>
```

Experiment - 3

Write a program to determine the largest of two eigenvalues of a matrix

CODE

```
disp("-------------------")
disp("Experiment - 3")
disp("Name -> M K Lino Roshaan")
disp("Roll No -> 2K22/MC/87")
disp("-------------------")
A = magic(3);
e = eig(A);
max_eigenvalue = maxk(e,1);
disp("The Eigenvalues are: ")
disp(e)
fprintf("The Maximum Eigenvalue is: %f ", max_eigenvalue)
```

OUTPUT

```
>> largest_eingenvalue
-------------------
Experiment - 3
Name -> M K Lino Roshaan
Roll No -> 2K22/MC/87
-------------------
The Eigenvalues are:
   15.0000
    4.8990
   -4.8990

fx The Maximum Eigenvalue is: 15.000000 >>
```

Experiment - 4

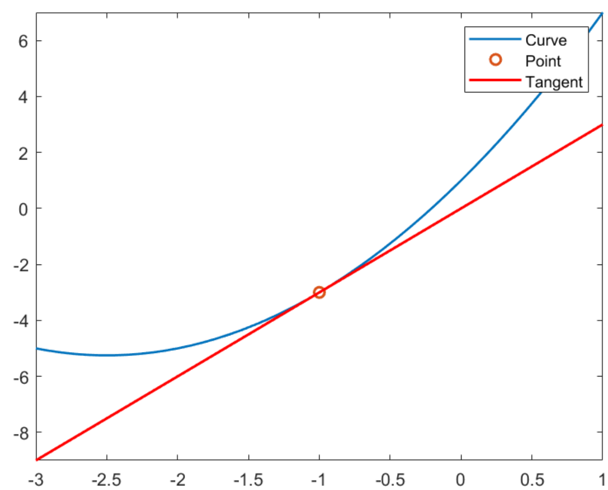
Write a program to draw a tangent at (-1, 5) to the curve $x^2 + 5x + 1$ and find radius of curvature

CODE

```
disp("-------------------")
disp("Experiment - 4")
disp("Name -> M K Lino Roshaan")
disp("Roll No -> 2K22/MC/87")
disp("-------------------")
syms x
x1 = -1;
% y1 = -5;
f = x^2+5*x+1;
y1 = subs(f,x1);
f_x = diff(f,x);
slope = subs(f_x, x1);
f_xx = diff(f,x,2);
tangent_eq = slope*(x-x1) + y1;
fplot(f,[x1-2,x1+2],'linewidth', 1.3);
hold on
plot(x1, y1, 'o', 'linewidth', 1.5)
fplot(tangent_eq, [x1-2,x1+2],'-r','linewidth', 1.5)
legend Curve Point Tangent
radius_of_curvature = ((1+(subs(f_x, x, x1))^2)^(1.5))/subs(f_xx, x, x1);
disp("Radius Of Curvature->")
disp(double(radius_of_curvature))
```

OUTPUT

```
>> radius_and_tangent_2
-------------------
Experiment - 4
Name -> M K Lino Roshaan
Roll No -> 2K22/MC/87
-------------------
Radius Of Curvature->
   15.8114

fx >>
```



Experiment - 5

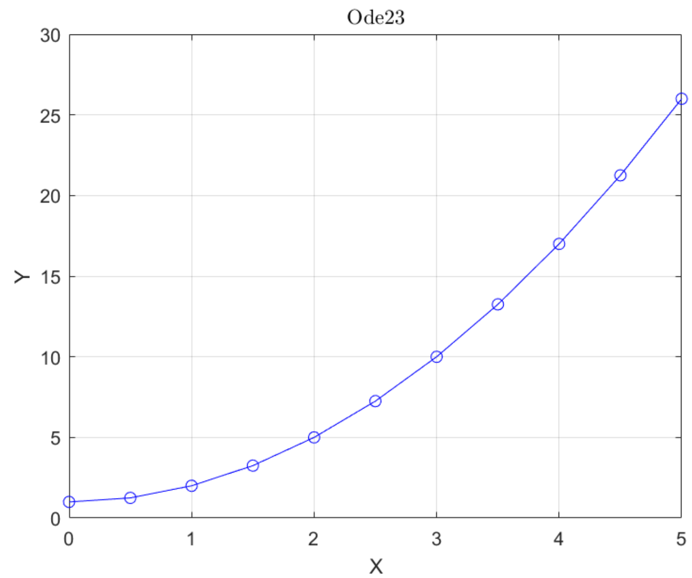
Using the inbuilt ode solvers ode23 and ode45 to find y(3) where y is the solution of the initial value problem and compare the value with actual answer

CODE (Ode23)

```
disp("-------------------")
disp("Experiment - 6(A)")
disp("Name -> M K Lino Roshaan")
disp("Roll No -> 2K22/MC/87")
disp("-------------------")
xspan = [0 5];
y0 = 1;
[X, Y] = ode23(@(x,y) 2*x, xspan, y0);
plot(X,Y, '-ob')
x_val = 3;
ind = interp1(X,1:length(X),x_val,'nearest');
predicted_answer = Y(ind)
% Actually solving answer y = x^2 + 1 => y(3) = 10
actual_answer = 10
xlabel X
ylabel Y
grid
title('Ode23','Interpreter','latex')
```

OUTPUT

```
>> mc203_exp_6_a
-------------------
Experiment - 6(A)
Name -> M K Lino Roshaan
Roll No -> 2K22/MC/87
-------------------

predicted_answer =

    10


actual_answer =

    10

fx >> 
```



CODE (Ode45)

```
disp("-------------------")
disp("Experiment - 6(B)")
disp("Name -> M K Lino Roshaan")
disp("Roll No -> 2K22/MC/87")
disp("-------------------")
xspan = [0 5];
y0 = 1;
[X, Y] = ode45(@(x,y) 3*x^2, xspan, y0);
plot(X,Y, '-ob')
x_val = 3;
ind = interp1(X,1:length(X),x_val,'nearest');
predicted_answer = Y(ind)
% Actually solving answer y = x^3 + 1 => y(3) = 28
```

actual_answer = 28

xlabel X

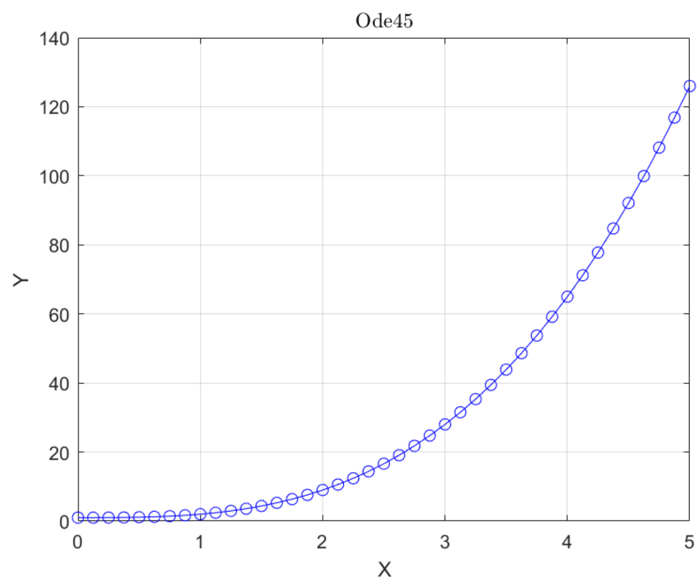
ylabel Y

grid

title('Ode45','Interpreter','latex')

OUTPUT

```
>> mc203_exp_6_b
-------------------
Experiment - 6(B)
Name -> M K Lino Roshaan
Roll No -> 2K22/MC/87
-------------------

predicted_answer =

    28


actual_answer =

    28

fx >>
```



Experiment - 6

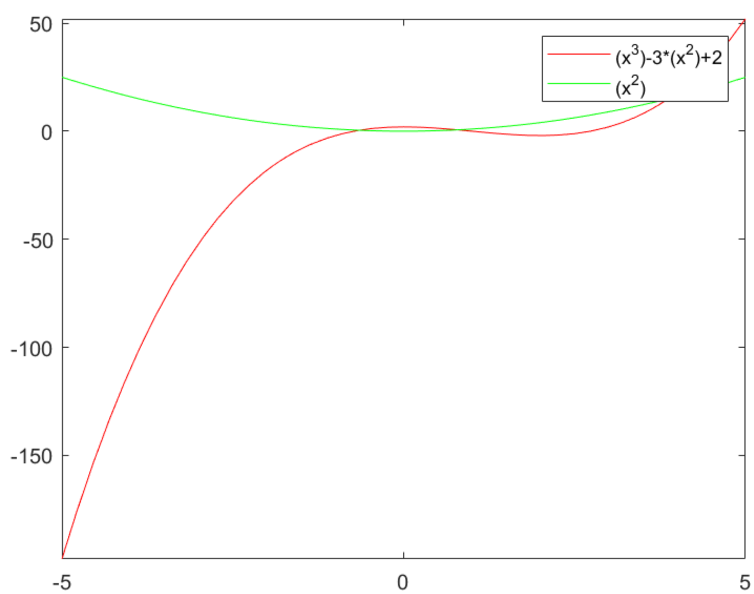
Write a program to find the are enclosed by $x^3 - 3x^2 + 2$ and x^2

CODE

```
disp("-------------------")
disp("Experiment - 6")
disp("Name -> M K Lino Roshaan")
disp("Roll No -> 2K22/MC/87")
disp("-------------------")
syms x
fplot((x^3)-3*(x^2)+2, '-r')
hold on
fplot((x^2), '-g')
legend '(x^3)-3*(x^2)+2' '(x^2)'
%fun = @(x) exp(-x.^2).*log(x).^2;
fun = @(x) (x.^3)-(4*(x.^2))+2;
eqn_t = coeffs(fun, x, 'All')
rts = double(roots(eqn_t));
area_1 = integral(fun, rts(3), rts(2));
area_2 = integral(fun, rts(2), rts(1));
t_Area = area_1 + abs(area_2);
disp("Inersection Points = ")
disp(rts)
disp("Total Area = ")
disp(t_Area)
```

OUTPUT

```
>> area_between_curves
-------------------
Experiment - 6
Name -> M K Lino Roshaan
Roll No -> 2K22/MC/87
-------------------

eqn_t =

[1, -4, 0, 2]

Inersection Points =
    3.8662
   -0.6554
    0.7892

Total Area =
   10.6654

fx >>
```



Experiment - 7

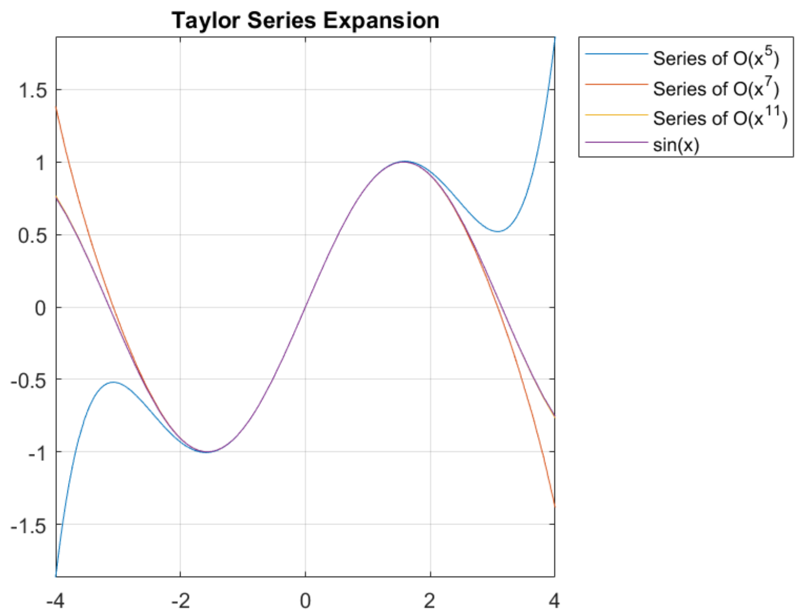
Graphically compare sin(x) and its Taylor series expansion (up to degree 10) in neighborhood of 1

CODE

```
disp("-------------------")
disp("Experiment - 7")
disp("Name -> M K Lino Roshaan")
disp("Roll No -> 2K22/MC/87")
disp("-------------------")
disp("Graphically Compare sin(x) and Taylor Series Expansion")
syms x x1 y1
f = sin(x);
T_5 = taylor(f, x, 'Order', 6); % Order = 5
T_7 = taylor(f, x, 'Order', 8); % Order = 7
T_11 = taylor(f, x, 'Order', 12); % Order = 11
sympref('PolynomialDisplayStyle','ascend');
% To display taylor series in ascending order
fplot([T_5 T_7 T_11 f])
xlim([-4 4])
grid on
legend('Series of O(x^5)', ...
    'Series of O(x^7)', ...
    'Series of O(x^{11})', ...
    'sin(x)','Location','bestoutside')
title('Taylor Series Expansion')
```

OUTPUT

```
>> mc203_exp_7
-------------------
Experiment - 7
Name -> M K Lino Roshaan
Roll No -> 2K22/MC/87
-------------------
Graphically Compare sin(x) and Taylor Series Expansion
fx >>
```



Experiment - 8

If $f = 15x^3 - 7x^2 + 2x + 4$ and $g = 9x^3 - 17x + 3$ then

1. Find product of f and g
2. Find quotient and remainder of f and g
3. Find roots of f and g
4. Find value of f at x=3 and g at x=2i

CODE

```
disp("-------------------")

disp("Experiment - 8")

disp("Name -> M K Lino Roshaan")

disp("Roll No -> 2K22/MC/87")

disp("-------------------")

syms x

f = 15*x^3-7*x^2+4;

g = 9*x^3-17*x+3;

% (i)

mult = expand(f*g);

disp(mult)

% (ii)

[q, r] = quorem(f, g, x)

% (iii)

f_c = coeffs(f ,'All');

g_c = coeffs(g ,'All');

f_roots = round(roots(f_c), 3)

g_roots = round(roots(g_c), 3)

% (iv)

fs = subs(f, x, 3);
```

gs = subs(g, x, 2*1i); % Imaginary 'i' or 'j' should be displayed by '1i'

disp("f(3) = ")

disp(fs)

disp("g(2i) = ")

disp(gs)

OUTPUT

```
>> mc203_exp_8
-------------------
Experiment - 8
Name -> M K Lino Roshaan
Roll No -> 2K22/MC/87
-------------------
12 - 68*x - 21*x^2 + 200*x^3 - 255*x^4 - 63*x^5 + 135*x^6


q =

5/3


r =

- 1 + (85*x)/3 - 7*x^2


f_roots =

         -0.52
0.493 - 0.519i
0.493 + 0.519i


g_roots =

 1.276
-1.455
  0.18

f(3) =
346

g(2i) =
3 - 106i

fx >>
```

Experiment - 9

Solve by variation of parameters $D^2y + 4y = sec(x)$

CODE

```
disp("-------------------")
disp("Experiment - 9")
disp("Name -> M K Lino Roshaan")
disp("Roll No -> 2K22/MC/87")
disp("-------------------")
disp("Variation Of Parameters")
disp("-> (D^2)y + 4y = sec(x)")
syms D x y e c1 c2
lhs = (D^2)*y + 4*y ;
rhs = sec(x);
sols = solve(lhs==0, D);
a = sols(1);
b = sols(2);
if isreal(sols)
    if a == b
        y1 = c1*(e^(a*x));
        y2 = c1*x*(e^(b*x));
    else
        y1 = c1*(e^(a*x));
        y2 = c2*(e^(b*x));
    end
else
    y1 = c1*cos((b/1i)*x);
```

```
    y2 = c2*sin((b/1i)*x);
end
W = [y1/c1 y2/c2; diff(y1,x)/c1 diff(y2,x)/c2];
den = det(W);
u = int((y2/c2)*rhs/den, x);
v = int((y1/c1)*rhs/den, x);
yc = y1 + y2
yp = -(y1/c1)*u +  (y2/c2)*v
y_complete = yc + yp
```

OUTPUT

```
>> variation_of_parameters
--------------------
Experiment - 9
Name -> M K Lino Roshaan
Roll No -> 2K22/MC/87
--------------------
Variation Of Parameters
-> (D^2)y + 4y = sec(x)

yc =

sin(2*x)*c2 + cos(2*x)*c1


yp =

cos(2*x)*cos(x) - sin(2*x)*(atanh(sin(x))/2 - sin(x))


y_complete =

c2*sin(2*x) - sin(2*x)*(atanh(sin(x))/2 - sin(x)) + cos(2*x)*cos(x) + c1*cos(2*x)

fx >>
```

Experiment - 10

Determine the characteristic polynomial of a matrix by evaluating the polynomial $P(\lambda)$ at $n + 1$ points. Then fit the polynomial to these points

CODE

```
disp("-------------------")
disp("Experiment - 10")
disp("Name -> M K Lino Roshaan")
disp("Roll No -> 2K22/MC/87")
disp("-------------------")
A = [3 4 5; 5 8 7; 11 10 6]
n = length(A);
ind_mat = eye(n);
syms lambda
ch_mat = A - lambda*ind_mat;
disp("Actual Characteristic Equation")
P(lambda) = det(ch_mat) % Actual Characteristic Equation

%X = randi([-25,25],1,n+1);
X = linspace(-25,25,n+1); % n+1 = 4
disp("4 Equally Spaced Points Chosen")
X
Y = double(P(X));
disp("Coefficients of Fitted Characteristic Equation")
curve_fitted = polyfit(X,Y, 3)
disp("Coefficients of Actual Characteristic Equation")
[coefficients] = coeffs(P, lambda, 'All')
```

OUTPUT

```
>> mc203_exp_10
-------------------
Experiment - 10
Name -> M K Lino Roshaan
Roll No -> 2K22/MC/87
-------------------

A =

     3     4     5
     5     8     7
    11    10     6

Actual Characteristic Equation

P(lambda) =

- 68 + 55*lambda + 17*lambda^2 - lambda^3

4 Equally Spaced Points Chosen

X =

  -25.0000   -8.3333    8.3333   25.0000

Coefficients of Fitted Characteristic Equation

curve_fitted =

   -1.0000   17.0000   55.0000  -68.0000

Coefficients of Actual Characteristic Equation

coefficients(lambda) =

[-1, 17, 55, -68]

fx >>
```