

```
> with(student): with(vec_calc): vc_aliases;
```

```
Warning, new definition for D
```

```
Warning, new definition for norm
```

```
Warning, new definition for trace
```

```
Package:   vec_calc   Version 4.3
```

```
For all HELP, execute: ?vec_calc
```

```
To use aliases, execute:   vc_aliases;
```

```
I, Point, MF, Cv, Ca, Cj, CT, CN, CB, Ck, Ct, CL, CaT, CaN, Cforget, d2r, r2d, p2r, r2p, c2r, r2c, s2r,
```

```
r2s, s2c, c2s, Muint, muint, LPMD, Lis, lis, Liv, liv, Sis, sis, Siv, siv
```

Exam I Solutions

Form A #1, Form B #9 D

```
> a:=[3,-4]; b:=[-2,1];
```

```
three_a_plus_2b:=3*a+2*b;
```

```
unit_vector:="/len("; expand(");
```

```
a := [3, -4]
```

```
b := [-2, 1]
```

```
three_a_plus_2b := [5, -10]
```

```
unit_vector :=  $\frac{1}{25} [5, -10] \sqrt{5}$ 
```

```
 $\left[ \frac{1}{5} \sqrt{5}, -\frac{2}{5} \sqrt{5} \right]$ 
```

Form A #2, Form B #6 A

```
> P:=[0,1]; Q:=[2,1]; R:=[5,4];
```

```
RP:=P-R; RQ:=Q-R;
```

```
cos_theta:=dot(RP,RQ)/(len(RP)*len(RQ));
```

```
P := [0, 1]
```

```
Q := [2, 1]
```

```
R := [5, 4]
```

```
RP := [-5, -3]
```

```
RQ := [-3, -3]
```

```
cos_theta :=  $\frac{2}{17} \sqrt{34} \sqrt{2}$ 
```

Form A #3, Form B #8 C

```
> a:=[1,2]; b:=[3,-1];
```

```
scalar_proj:=dot(a,b)/len(a);
```

```
vector_proj:=scalar_proj*a/len(a);
```

```
a := [1, 2]
```

```
b := [3, -1]
```

```
scalar_proj :=  $\frac{1}{5} \sqrt{5}$ 
```

```
vector_proj :=  $\left[ \frac{1}{5}, \frac{2}{5} \right]$ 
```

Form A #4, Form B #7 B

```
> A:=[a+2,3]; B:=[a,-(2+a)];
eqn:=dot(A,B)=0;
solve(eqn,a);
```

$$A := [a + 2, 3]$$

$$B := [a, -a - 2]$$

$$eqn := a^2 - a - 6 = 0$$

$$-2, 3$$

Form A #5, Form B #1 C

```
> f:=1/sqrt(4-x^2); #radical must be positive
domain:=solve(4-x^2>0,x);
```

$$f := \frac{1}{\sqrt{4 - x^2}}$$

$$domain := \text{RealRange}(\text{Open}(-2), \text{Open}(2))$$

Form A #8, Form B #2 D

```
> Limit(abs(x-4)/(x-4),x=4); value("");
>
```

$$\lim_{x \rightarrow 4} \frac{|x - 4|}{x - 4}$$

undefined

Form A #7, Form B #3 C

```
> Limit((x^2-x-2)/(x^2+3*x+2),x=-1); value("");
```

$$\lim_{x \rightarrow (-1)} \frac{x^2 - x - 2}{x^2 + 3x + 2}$$

$$-3$$

Form A #9, Form B #4 A

```
> Limit((2*x^2-x+1)/(sqrt(25*x^4-12*x)),x=-infinity);
value("");
```

$$\lim_{x \rightarrow (-\infty)} \frac{2x^2 - x + 1}{\sqrt{25x^4 - 12x}}$$

$$\frac{2}{5}$$

Form A #6, Form B #5 D

```
> r:=MF(t,[5*t+3,2*t-16*t^2+3]);
avg_vel:=(r(3)-r(1))/(3-1);
```

$$r := [t \rightarrow 5t + 3, t \rightarrow 2t - 16t^2 + 3]$$

$$avg_vel := [5, -62]$$

Form A #10, Form B #13 D

```
> f:=x->6/sqrt(x)-6/x+6*x-6;
D(f)(x);
```

$$f := x \rightarrow \frac{6}{\sqrt{x}} - \frac{6}{x} + 6x - 6$$

$$-\frac{3}{x^{3/2}} + \frac{6}{x^2} + 6$$

Form A #11, Form B #12 B

```
> f:=t->(2*t^3+1)*(7-3*t);
  expand(f(t));
  diff(",t);
```

$$f := t \rightarrow (2t^3 + 1)(7 - 3t)$$

$$14t^3 - 6t^4 + 7 - 3t$$

$$42t^2 - 24t^3 - 3$$

Form A #12, Form B #11 A

```
> h:=x->f(x)/g(x);
  D(h)(x);
  D(h)(2);
  subs(f(2)=1,D(f)(2)=-1,g(2)=3,D(g)(2)=5,");
```

$$h := x \rightarrow \frac{f(x)}{g(x)}$$

$$\frac{D(f)(x)}{g(x)} - \frac{f(x) D(g)(x)}{g(x)^2}$$

$$\frac{D(f)(2)}{g(2)} - \frac{f(2) D(g)(2)}{g(2)^2}$$

$$-\frac{8}{9}$$

Form A #13, Form B #10 C

```
> f:=x->2+x-x^3;
  f_at_1:=f(1),greater_than_0;
  f_at_2:=f(2),less_than_0;
```

$$f := x \rightarrow 2 + x - x^3$$

$$f_{at_1} := 2, greater_than_0$$

$$f_{at_2} := -4, less_than_0$$

Form A #14, Form B #18

```
> f:=x->1/(2*x-1);
  defn:=Limit((f(x+h)-f(x))/h,h=0);
  value("");
  Diff(f(x),x)=diff(f(x),x);
```

$$f := x \rightarrow \frac{1}{2x - 1}$$

$$defn := \lim_{h \rightarrow 0} \frac{\frac{1}{2x + 2h - 1} - \frac{1}{2x - 1}}{h}$$

$$-\frac{2}{(2x - 1)^2}$$

$$\frac{\partial}{\partial x} \frac{1}{2x-1} = -\frac{2}{(2x-1)^2}$$

Form A #15, Form B #19

```
> r:=MF(t,[(sqrt(4+t)-2)/t,t^2*cos(1/t)+(t^2+8)^(4/3)]);
map(Limit,r(t),t=0);
value("),use_squeeze_thm_on_j;
[1/4,16];
```

$$r := \left[t \rightarrow \frac{\sqrt{4+t}-2}{t}, t \rightarrow t^2 \cos\left(\frac{1}{t}\right) + (t^2+8)^{4/3} \right]$$

$$\left[\lim_{t \rightarrow 0} \frac{\sqrt{4+t}-2}{t}, \lim_{t \rightarrow 0} t^2 \cos\left(\frac{1}{t}\right) + (t^2+8)^{4/3} \right]$$

$$\left[\frac{1}{4}, 8 \cdot 8^{1/3} \right], use_squeeze_thm_on_j$$

$$\left[\frac{1}{4}, 16 \right]$$

Form A #16, Form B #14

```
> fleft:=x->a*x+b; fright:=x->2*b*x^2-2*a*x+3;
f_cts:=fleft(1)=fright(1);
f_diff:=D(fleft)(1)=D(fright)(1);
solve({f_cts,f_diff},{a,b});
```

$$fleft := x \rightarrow a x + b$$

$$fright := x \rightarrow 2 b x^2 - 2 a x + 3$$

$$f_cts := a + b = 2 b - 2 a + 3$$

$$f_diff := a = 4 b - 2 a$$

$$\{b = 1, a = \frac{4}{3}\}$$

Form A #17, Form B #15

```
> f:=x->2*x^3-3*x^2-6*x+87;
horiz_tanline:=D(f)(x)=0;
solve(",x);
```

$$f := x \rightarrow 2 x^3 - 3 x^2 - 6 x + 87$$

$$horiz_tanline := 6 x^2 - 6 x - 6 = 0$$

$$\frac{1}{2} \sqrt{5} + \frac{1}{2}, \frac{1}{2} - \frac{1}{2} \sqrt{5}$$

Form A #18, Form B #16

```
> L1:=[5+3*t,2+t]; v1:=[3,1];
L2:=[6-5*s,3-s]; v2:=[-5,-1];
not_parallel;
dot_prod:=dot(v1,v2),not_perpendicular;
eq1:=L1[1]=L2[1];
eq2:=L1[2]=L2[2];
solve({eq1,eq2},{t,s});
point_of_intersection:=subs("[1],L1);
```

```

L1 := [5 + 3 t, 2 + t]
v1 := [3, 1]
L2 := [6 - 5 s, 3 - s]
v2 := [-5, -1]
not_parallel
dot_prod := -16, not_perpendicular
eq1 := 5 + 3 t = 6 - 5 s
eq2 := 2 + t = 3 - s
{ t = 2, s = -1 }
point_of_intersection := [11, 4]

```

```

> p1 := [2, -1]; p2 := [5, 3];
Cartesian;
m := (3 - (-1)) / (5 - 2);
y - (-1) = m * (x - 2);
Vector;
v := p2 - p1;
r_of_t := p1 + t * v;
Parametric;
expand(r_of_t);
x = " [1], y = " [2];

```

```

p1 := [2, -1]
p2 := [5, 3]

```

Cartesian

$$m := \frac{4}{3}$$

$$y + 1 = \frac{4}{3}x - \frac{8}{3}$$

Vector

```
v := [3, 4]
```

```
r_of_t := [2, -1] + t [3, 4]
```

Parametric

```
[3 t + 2, 4 t - 1]
```

```
x = 3 t + 2, y = 4 t - 1
```

Form A #19, Form B #17

```

> F := 25; d := 12; theta := 60; #angle with horizontal is 30
work := F * d * cos(d2r(theta)) * ft_lbs;

```

```
F := 25
```

```
d := 12
```

```
θ := 60
```

```
work := 150 ft_lbs
```

[>