PES University, Bangalore

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Department of Science & Humanities

Maxima Lab

Session: Jan-May 2020

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Semester & Section : **2nd &D SECTION**

To be filled by the teacher-in-charge:

Marks : / 5 + / 5 = /10

Faculty :

Signature with date :_____

Q1 . Find gradient of 3* x^2+5*y^2+z^2 and cos(x)^3*sin(y)^3.

```
→    /·Find gradient of 3· x^2+5·y^2+z^2 and  cos(x)^3·sin(y)^3.;
(%i1) load(vect);
(%i4) f:3·x^2+5·y^2+z^2;
      grad(f);
      express(%);
(f)   z^2+5 y^2+3 x^2
(%o3) grad(z^2+5 y^2+3 x^2)
(%o4) [d/dx (z^2+5 y^2+3 x^2), d/dy (z^2+5 y^2+3 x^2), d/dz (z^2+5 y^2+3 x^2)]
(%i5) ev(%,diff);

(%o5) [6 x,10 y,2 z]
(%i6) load(vect);
      vect: warning: removing existing rule or rules for ".".
(%o6) C:/maxima-5.43.0/share/maxima/5.43.0/share/vector/vect.mac
(%i9) f1:cos(x)^3·sin(y)^3;
      grad(f1);
      express(%);
(f1)  cos(x)^3 sin(y)^3
(%o8) grad(cos(x)^3 sin(y)^3)
(%o9) [d/dx (cos(x)^3 sin(y)^3), d/dy (cos(x)^3 sin(y)^3), d/dz (cos(x)^3 sin(y)^3)]
(%i10) ev(%,diff);
(%o10) [-3 cos(x)^2 sin(x) sin(y)^3,3 cos(x)^3 cos(y) sin(y)^2,0]
```

Q2. Find the Divergence and curl of i) x*y^2i+4*x^2*y*zj-6*y*z^2 ii)(z^2+4*x+5*y)i+(3*x+2*y+z)j+(2*y+4*z*x)k

```
→   /· Find the Divergence and curl of i) x·y^2i+4·x^2·y·zj−6·y·z^2  ii)(z^2+4·x+5·y)i+(3·x+2·y+z)j+(2·y+4·z·x)k;
(%i1) load(vect);
(%o1) C:/maxima−5.43.0/share/maxima/5.43.0/share/vector/vect.mac
(%i5) F:([x·y^2,4·x^2·y·z,−6·y·z^2]);
      div(F);
      express(%);
      ev(%,diff);
(F)   [x y^2,4 x^2 y z,−6 y z^2]
(%o3) div([x y^2,4 x^2 y z,−6 y z^2])
(%o4) d/dz (−6 y z^2)+d/dy (4 x^2 y z)+d/dx (x y^2)
(%o5) −12 y z+4 x^2 z+y^2
(%i8) curl(F);
      express(%);
      ev(%,diff);
(%o6) curl([x y^2,4 x^2 y z,−6 y z^2])
(%o7) [d/dy (−6 y z^2)−d/dz (4 x^2 y z),d/dz (x y^2)−d/dx (−6 y z^2),d/dx (4 x^2 y z)−d/dy (x y^2)]
(%o8) [−6 z^2−4 x^2 y,0,8 x y z−2 x y]
(%i9) load(vect);
      vect: warning: removing existing rule or rules for ".".
(%o9) C:/maxima−5.43.0/share/maxima/5.43.0/share/vector/vect.mac
(%i13) F1:([z^2+4·x+5·y,3·x+2·y+z,2·y+4·z·x]);
       div(F1);
       express(%);
       ev(%,diff);
(F1)   [z^2+5 y+4 x,z+2 y+3 x,4 x z+2 y]
(%o11) div([z^2+5 y+4 x,z+2 y+3 x,4 x z+2 y])
(%o12) d/dx (z^2+5 y+4 x)+d/dz (4 x z+2 y)+d/dy (z+2 y+3 x)
(%o13) 4 x+6
(%i16) curl(F1);
       express(%);
       ev(%,diff);
(%o14) curl([z^2+5 y+4 x,z+2 y+3 x,4 x z+2 y])
(%o15) [d/dy (4 x z+2 y)−d/dz (z+2 y+3 x),d/dz (z^2+5 y+4 x)−d/dx (4 x z+2 y),d/dx (z+2 y+3 x)−d/dy (z^2+5 y+4 x)]
(%o16) [1,−2 z,−2]
```

Q3. Find the Directional derivative of x^2+y^2-z^2 at (1,1,-4) in the direction of the vector i+ j + 4k

```
→   /· Find the Directional derivative of x^2+y^2−z^2 at (1,1,−4) in the direction of the vector i+ j + 4k;
(%i1) load(vect);
(%o1) C:/maxima−5.43.0/share/maxima/5.43.0/share/vector/vect.mac
(%i5) f:x^2+y^2−z^2;
      a:[1,1,4];
      b:grad(f);
      express(%);
(f)   −z^2+y^2+x^2
(a)   [1,1,4]
(b)   grad(−z^2+y^2+x^2)
(%o5) [d/dx (−z^2+y^2+x^2), d/dy (−z^2+y^2+x^2), d/dz (−z^2+y^2+x^2)]
(%i6) ev(%,diff);
(%o6) [2 x,2 y,−2 z]
(%i7) define(b(x,y,z),%);
(%o7) b(x,y,z):=[2 x,2 y,−2 z]
(%i8) (b(1,1,−4).a)/sqrt(a.a);
(%o8) 3 2^(3/2)
```

Q4. Find the Gamma of 6,9,11,5/2,4/5,8/3

```
→   /·Find the Gamma of 6,9,11,5/2,4/5,8/3
    ;
(%i1) gamma(n);
(%o1) Γ(n)
(%i2)   map('gamma,[6,9,11,5/2,4/5,8/3]);
(%o2) [120,40320,3628800, 3√π/4, Γ(4/5), 10 Γ(2/3)/9]
```

Q5. Find the i)Beta(8,9) ii)beta(4,3/2) iii)beta(3/2,5/2) iv)beta(4/3,-1/3)

```
→ /·Find the  i)Beta(8,9) ii)beta(4,3/2) iii)beta(3/2,5/2)  iv)beta(4/3,−1/3)
  ;
(%i1) beta(8,9);
```

$$(\%o1)\quad \frac{1}{102960}$$

```
(%i2) beta(4,3/2);
```

$$(\%o2)\quad \frac{32}{315}$$

```
(%i3) beta(3/2,5/2);
```

$$(\%o3)\quad \frac{\pi}{16}$$

```
(%i4) beta(4/3,−1/3);
```

$$(\%o4)\quad -\frac{2\,\pi}{\sqrt{3}}$$

```
→ ;
→ ;
```

Q6. Find Bessel functions of orders 7/2, 5/2,-7/2,9/2

```
→ /· Find Bessel functions of orders 7/2, 5/2,−7/2,9/2;
(%i2) besselexpand:true$
      bessel_j(7/2,x);
```

$$(\%o2)\quad \frac{\sqrt{2}\sqrt{x}\left(\left(\frac{15}{x^4}-\frac{6}{x^2}\right)\sin(x)+\left(\frac{1}{x}-\frac{15}{x^3}\right)\cos(x)\right)}{\sqrt{\pi}}$$

```
(%i3) bessel_j(5/2,x);
```

$$(\%o3)\quad \frac{\sqrt{2}\sqrt{x}\left(\left(\frac{3}{x^3}-\frac{1}{x}\right)\sin(x)-\frac{3\cos(x)}{x^2}\right)}{\sqrt{\pi}}$$

```
(%i4) bessel_j(−7/2,x);
```

$$(\%o4)\quad \frac{\sqrt{2}\sqrt{x}\left(\left(\frac{1}{x}-\frac{15}{x^3}\right)\sin(x)-\left(\frac{15}{x^4}-\frac{6}{x^2}\right)\cos(x)\right)}{\sqrt{\pi}}$$

```
(%i5) bessel_j(9/2,x);
```

$$(\%o5)\quad \frac{\sqrt{2}\sqrt{x}\left(\left(\frac{1}{x}-\frac{45}{x^3}+\frac{105}{x^5}\right)\sin(x)-\left(\frac{105}{x^4}-\frac{10}{x^2}\right)\cos(x)\right)}{\sqrt{\pi}}$$

Q7. Find the Laplace transforms of cos(t)^3*sin(t)^2,sin(2*t)+cos(2*t)^3,sin(t)^2*cos(t)/t,e^(4*t)*sin(3*t)^2

```
→  /·Find the Laplace transforms of cos(t)^3·sin(t)^2,sin(2·t)+cos(2·t)^3,sin(t)^2·cos(t)/t,e^(4·t)·sin(3·t)^2;
(%i1)  laplace(cos(t)^3·sin(t)^2,t,s);
```

$$(\%o1)\quad \frac{2\,s^3+26\,s}{s^6+35\,s^4+259\,s^2+225}$$

```
(%i2)  laplace(sin(2·t)+cos(2·t)^3,t,s);
```

$$(\%o2)\quad \frac{s^3+28\,s}{s^4+40\,s^2+144}+\frac{2}{s^2+4}$$

```
(%i3)  laplace(sin(t)^2·cos(t)/t,t,s);
```

$$(\%o3)\quad 2\left(\frac{\log\left(s^2+9\right)}{16}-\frac{\log\left(s^2+1\right)}{16}\right)$$

```
(%i4)  laplace(e^(4·t)·sin(3·t)^2,t,s);
```

$$(\%o4)\quad \frac{18}{s^3-12\log(e)\,s^2+\left(48\log(e)^2+36\right)s-64\log(e)^3-144\log(e)}$$

```
(%i5)  laplace(t^2·cos(t)^2,t,s);
```

$$(\%o5)\quad \frac{2}{s^3+4\,s}-\frac{4\,s\left(3\,s^2+4\right)}{\left(s^3+4\,s\right)^2}-\frac{6\,s\left(s^2+2\right)}{\left(s^3+4\,s\right)^2}+\frac{2\left(s^2+2\right)\left(3\,s^2+4\right)^2}{\left(s^3+4\,s\right)^3}$$

Q8. Find Inverse Laplace Transforms of 1/(s-4),s/(s^2+49),s/(s^2-64),1/(s^2-64),1/(s^2+64)

```
→  /· Find Inverse Laplace Transforms of 1/(s−4),s/(s^2+49),s/(s^2−64),1/(s^2−64),1/(s^2+64);
(%i1)  ilt(1/(s−4),s,t);
```

$$(\%o1)\quad \%e^{4\,t}$$

```
(%i2)  ilt(s/(s^2+49),s,t);
```

$$(\%o2)\quad \cos\left(7\,t\right)$$

```
(%i3)  ilt(s/(s^2−64),s,t);
```

$$(\%o3)\quad \frac{\%e^{8\,t}}{2}+\frac{\%e^{-8\,t}}{2}$$

```
(%i4)  ilt(1/(s^2−64),s,t);
```

$$(\%o4)\quad \frac{\%e^{8\,t}}{16}-\frac{\%e^{-8\,t}}{16}$$

```
(%i5)  ilt(1/(s^2+64),s,t);
```

$$(\%o5)\quad \frac{\sin\left(8\,t\right)}{8}$$

Q9. Inverse laplace transforms by convulation theorem 1/s*(s+49)^2 and s/(s^2+81)^2

```
→   /· Inverse laplace transforms by convulation theorem  1/s·(s+49)^2  and s/(s^2+81)^2·/;
(%i1) F:1/(s+49)^2;
```

$$(F)\quad \frac{1}{(s+49)^2}$$

```
(%i2) G:1/(s);
```

$$(G)\quad \frac{1}{s}$$

```
(%i3) ilt(F·G,s,t);
```

$$(\%o3)\quad -\frac{t\,\%e^{-49\,t}}{49}-\frac{\%e^{-49\,t}}{2401}+\frac{1}{2401}$$

```
(%i6) F1:s/(s^2+81);
      G1:1/(s^2+9^2);
      ilt(F1·G1,s,t);
```

$$(F1)\quad \frac{s}{s^2+81}$$

$$(G1)\quad \frac{1}{s^2+81}$$

$$(\%o6)\quad \frac{t\sin(9\,t)}{18}$$

Q10. solve the differential equatin using laplace transformations y^111+2y^11-y1-2y = 0 ;y(0)=y^1(0)=0 and y^11(0) =6

```
→   /·solve the differential equatin using laplace transformations y^111+2y^11−y1−2y = 0 ;y(0)=y^1(0)=0 and y^11(0) =6·/
(%i1) ode:'diff(y(t),t,3)+2·'diff(y(t),t,2)−'diff(y(t),t)−2·y(t)=0;
```

$$(ode)\quad \frac{d^3}{dt^3}y(t)+2\left(\frac{d^2}{dt^2}y(t)\right)-\frac{d}{dt}y(t)-2\,y(t)=0$$

```
(%i2) atvalue(y(t),t=0,0);
(%o2) 0
(%i3) atvalue('diff(y(t),t),t=0,0);
(%o3) 0
(%i4) atvalue('diff(y(t),t,2),t=0,6);
(%o4) 6
(%i5) lap−ode:laplace(ode,t,s);
```

$$(\%o5)\quad -s^3\,\text{laplace}(y(t),t,s)-2\,s^2\,\text{laplace}(y(t),t,s)+s\,\text{laplace}(y(t),t,s)+2\,\text{laplace}(y(t),t,s)+lap+6=lap$$

```
(%i6) sol:solve(%,'laplace(y(t),t,s));
```

$$(sol)\quad \left[\text{laplace}(y(t),t,s)=\frac{6}{s^3+2\,s^2-s-2}\right]$$

```
(%i7) map(lambda([eq],ilt(eq,s,t)),sol);
```

$$(\%o7)\quad [y(t)=\%e^{t}-3\,\%e^{-t}+2\,\%e^{-2\,t}]$$

Q11. Find the Fourier series of the function f(x)=e^(-5x) in (-%pi,%pi)

```
/·Find the Fourier series of the function f(x)=e^(−5x)  in (−%pi,%pi)·/
load(fourie);
l:fourier(e^(−5·x),x,%pi);
```

(%o1) C:/maxima−5.43.0/share/maxima/5.43.0/share/calculus/fourie.mac

$$a_0=\frac{\frac{e^{5\,\pi}}{5\log(e)}-\frac{1}{5\,e^{5\,\pi}\log(e)}}{2\,\pi}$$

$$a_n=\frac{-\frac{5\log(e)\cos(\pi\,n)}{\%e^{5\,\pi\log(e)}\,n^2+25\,\%e^{5\,\pi\log(e)}\log(e)^2}+\frac{5\,\%e^{5\,\pi\log(e)}\log(e)\cos(\pi\,n)}{n^2+25\log(e)^2}}{\pi}$$

$$b_n=\frac{-\frac{n\cos(\pi\,n)}{\%e^{5\,\pi\log(e)}\,n^2+25\,\%e^{5\,\pi\log(e)}\log(e)^2}+\frac{\%e^{5\,\pi\log(e)}\,n\cos(\pi\,n)}{n^2+25\log(e)^2}}{\pi}$$

[%t2,%t3,%t4]

```
fourexpand(l,x,%pi,4);
```

(%o5)

$$\frac{\left(\frac{4\,\%e^{5\,\pi\log(e)}}{25\log(e)^2+16}-\frac{4}{25\,\%e^{5\,\pi\log(e)}\log(e)^2+16\,\%e^{5\,\pi\log(e)}}\right)\sin(4\,x)}{\pi}+$$

$$\frac{\left(\frac{5\,\%e^{5\,\pi\log(e)}\log(e)}{25\log(e)^2+16}-\frac{5\log(e)}{25\,\%e^{5\,\pi\log(e)}\log(e)^2+16\,\%e^{5\,\pi\log(e)}}\right)\cos(4\,x)}{\pi}+$$

$$\frac{\left(\frac{3}{25\,\%e^{5\,\pi\log(e)}\log(e)^2+9\,\%e^{5\,\pi\log(e)}}-\frac{3\,\%e^{5\,\pi\log(e)}}{25\log(e)^2+9}\right)\sin(3\,x)}{\pi}+$$

$$\frac{\left(\frac{5\log(e)}{25\,\%e^{5\,\pi\log(e)}\log(e)^2+9\,\%e^{5\,\pi\log(e)}}-\frac{5\,\%e^{5\,\pi\log(e)}\log(e)}{25\log(e)^2+9}\right)\cos(3\,x)}{\pi}+$$

$$\frac{\left(\frac{2\,\%e^{5\,\pi\log(e)}}{25\log(e)^2+4}-\frac{2}{25\,\%e^{5\,\pi\log(e)}\log(e)^2+4\,\%e^{5\,\pi\log(e)}}\right)\sin(2\,x)}{\pi}+$$

$$\frac{\left(\frac{5\,\%e^{5\,\pi\log(e)}\log(e)}{25\log(e)^2+4}-\frac{5\log(e)}{25\,\%e^{5\,\pi\log(e)}\log(e)^2+4\,\%e^{5\,\pi\log(e)}}\right)\cos(2\,x)}{\pi}+\frac{\left(\frac{1}{25\,\%e^{5\,\pi\log(e)}\log(e)^2+\%e^{5\,\pi\log(e)}}-\frac{\%e^{5\,\pi\log(e)}}{25\log(e)^2+1}\right)\sin(x)}{\pi}$$

$$+\frac{\left(\frac{5\log(e)}{25\,\%e^{5\,\pi\log(e)}\log(e)^2+\%e^{5\,\pi\log(e)}}-\frac{5\,\%e^{5\,\pi\log(e)}\log(e)}{25\log(e)^2+1}\right)\cos(x)}{\pi}+\frac{\frac{e^{5\,\pi}}{5\log(e)}-\frac{1}{5\,e^{5\,\pi}\log(e)}}{2\,\pi}$$

Q12. Find the Fourier sine series of f(x)=x^2+x, in (0,%pi);

```
load(fourie);
foursin(x^2+x,x,%pi);
```

(%o1) C:/maxima−5.43.0/share/maxima/5.43.0/share/calculus/fourie.mac

(%t2)
$$b_n=\frac{2\left(\frac{2\,\pi\sin(\pi\,n)}{n^2}+\frac{\sin(\pi\,n)}{n^2}-\frac{\pi^2\cos(\pi\,n)}{n}-\frac{\pi\cos(\pi\,n)}{n}+\frac{2\cos(\pi\,n)}{n^3}-\frac{2}{n^3}\right)}{\pi}$$

(%o2) [%t2]

Q13. Find the Fourier cosine series of f(x)=1-x^2 in (0,4)

```
/· Find the Fourier cosine series of f(x)=1−x^2 in (0,4)
(%i2) load(fourie);
      fourcos(1−x^2,x,4);
(%o1) C:/maxima−5.43.0/share/maxima/5.43.0/share/calculus/fourie.mac
```

(%t2) $a_0 = -\frac{13}{3}$

(%t3) $a_n = \frac{-\frac{60\sin(\pi n)}{\pi n} + \frac{128\sin(\pi n)}{\pi^3 n^3} - \frac{128\cos(\pi n)}{\pi^2 n^2}}{2}$

```
(%o3) [%t2,%t3]
(%i4) fourexpand(%,x,4,6);
```

(%o4) $-\frac{16\cos\left(\frac{3\pi x}{2}\right)}{9\pi^2} + \frac{64\cos\left(\frac{5\pi x}{4}\right)}{25\pi^2} - \frac{4\cos(\pi x)}{\pi^2} + \frac{64\cos\left(\frac{3\pi x}{4}\right)}{9\pi^2} - \frac{16\cos\left(\frac{\pi x}{2}\right)}{\pi^2} + \frac{64\cos\left(\frac{\pi x}{4}\right)}{\pi^2} - \frac{13}{3}$