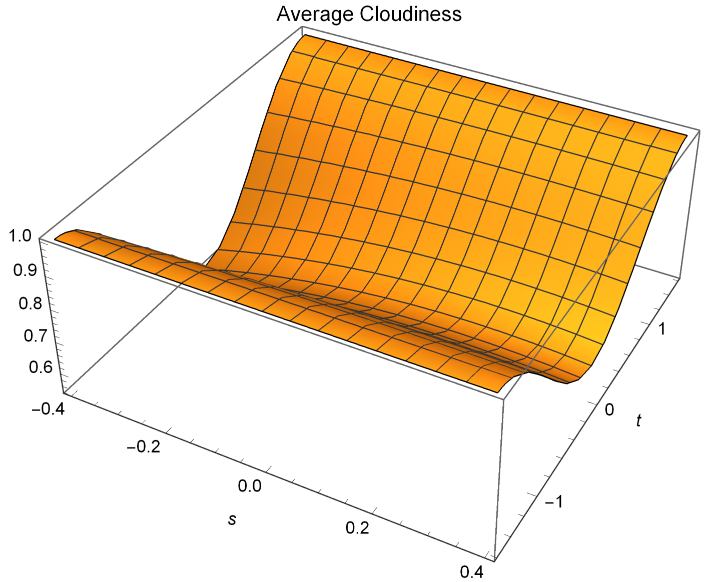
Cloudiness

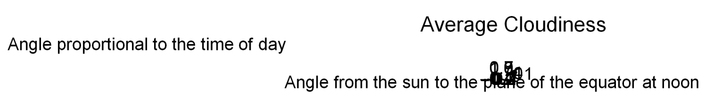
In[1]:=
```
F[s_, t_] = (3 - (1 + (s - 0.2)^2) * Cos[t]^2) / 3
```

Out[1]= $\frac{1}{3}\left(3-\left(1+(-0.2+s)^{2}\right)\mathrm{Cos}[t]^{2}\right)$

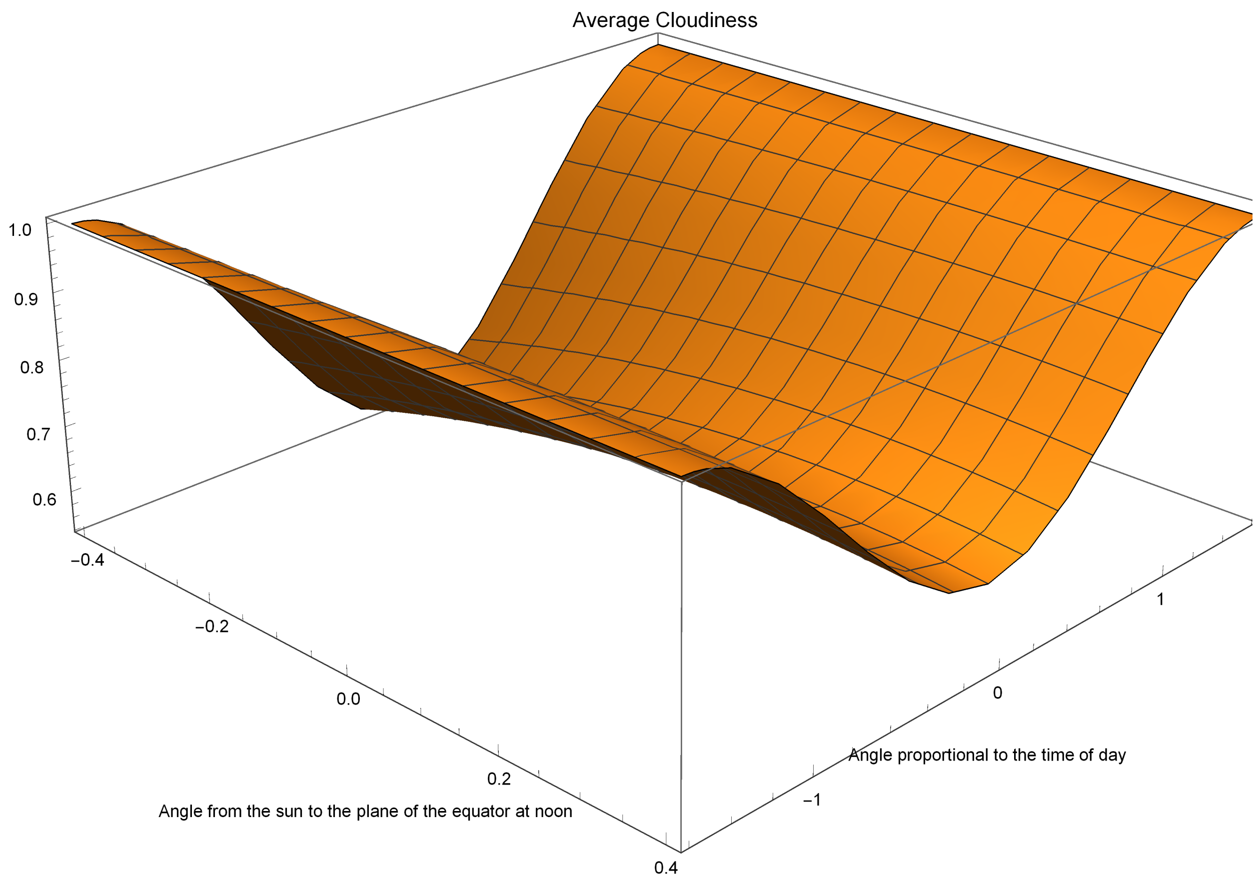
In[2]:=
```
Plot3D[F[s, t], {s, -0.4, 0.4}, {t, -π/2, π/2},
 PlotLabel → "Average Cloudiness", AxesLabel → {s, t}]
```

Out[2]=


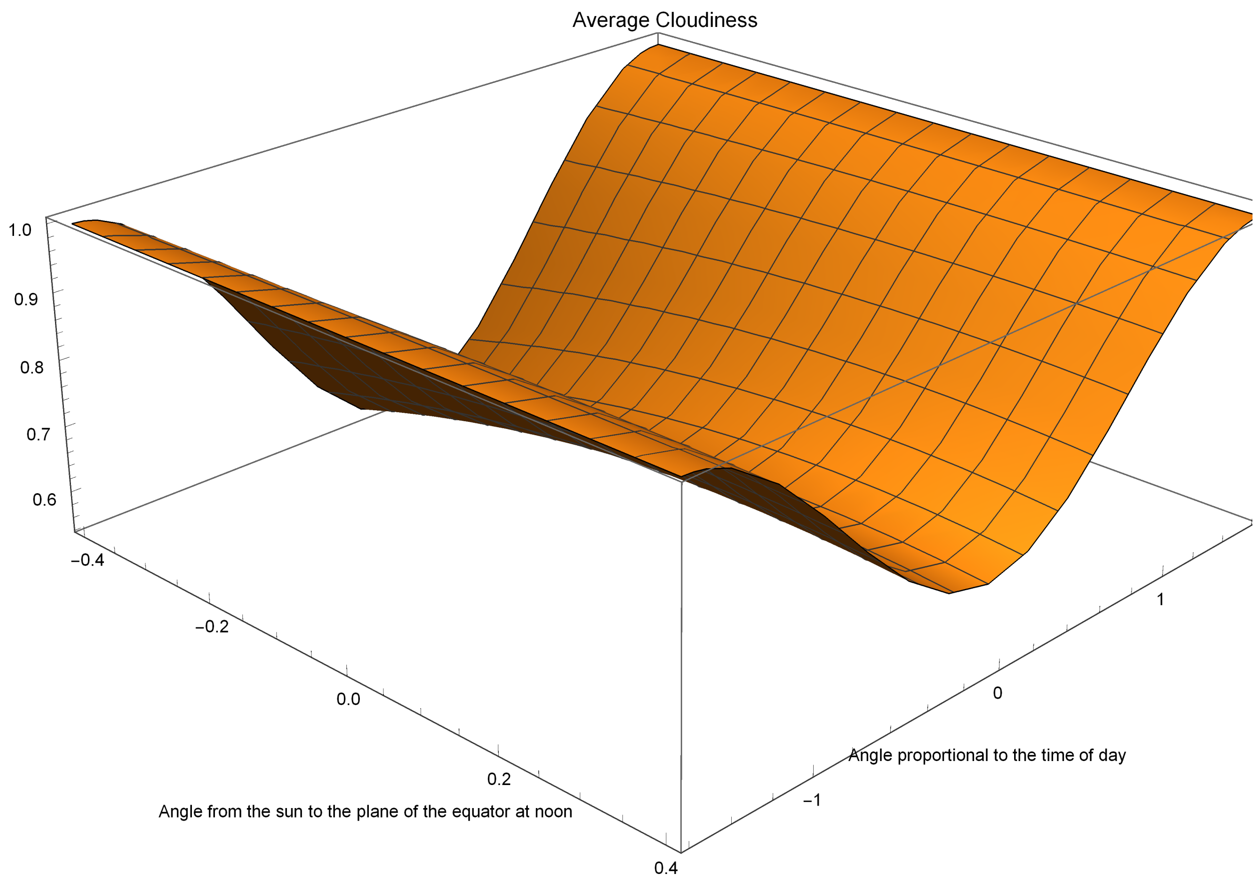

In[3]:=
```
Plot3D[F[s, t], {s, -0.4`, 0.4`}, {t, -π/2, π/2}, PlotLabel → "Average Cloudiness",
 AxesLabel → {"Angle from the sun to the plane of the equator at noon",
   "Angle proportional to the time of day"}]
```

Out[3]=


In[4]:=


Average Cloudiness
1.0
0.9
0.8
0.7
0.6
−0.4
−0.2
0.0
0.2
0.4
Angle from the sun to the plane of the equator at noon
1
0
−1
Angle proportional to the time of day

Out[4]=

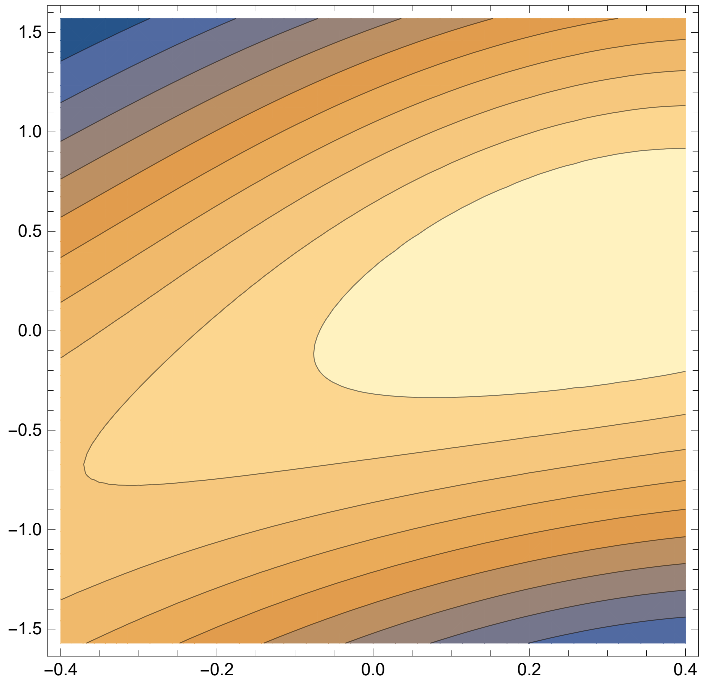


Average Cloudiness
1.0
0.9
0.8
0.7
0.6
-0.4
-0.2
0.0
0.2
0.4
Angle from the sun to the plane of the equator at noon
-1
0
1
Angle proportional to the time of day


2

In[5]:=
```
W[s_, u_] = 1 + (1 + 0.65 s - 1.2 s^2 - 0.4 s^3 + 0.35 s^4) * Cos[u] +
    (1.4 s - 0.4 s^2 - 1.5 s^3 - 0.35 s^4) * Sin[u];
WContours = ContourPlot[W[s, u], {s, -0.4, 0.4}, {u, -π/2, π/2}, Contours → 10]
```

Out[6]=




In[7]:=
```
D[W[s, u], s]
```

Out[7]= $(0.65 - 2.4\,s - 1.2\,s^2 + 1.4\,s^3)\,\mathrm{Cos}[u] + (1.4 - 0.8\,s - 4.5\,s^2 - 1.4\,s^3)\,\mathrm{Sin}[u]$

In[8]:=
```
Du = D[W[s, u], u];
FindRoot[D[W[s, u], s], {{s, 0.3}, {u, 0}}]
```

... FindRoot: The number of equations does not match the number of variables in FindRoot[$\partial_s$ W[s, u], {{s, 0.3}, {u, 0}}].

Out[9]= FindRoot[$\partial_s$W[s, u], {{s, 0.3}, {u, 0}}]

In[10]:=
```
GW[s_, u_] = Grad[W[s, u], {s, u}]
```

Out[10]= $\{(0.65 - 2.4\,s - 1.2\,s^2 + 1.4\,s^3)\,\mathrm{Cos}[u] + (1.4 - 0.8\,s - 4.5\,s^2 - 1.4\,s^3)\,\mathrm{Sin}[u],$
$(1.4\,s - 0.4\,s^2 - 1.5\,s^3 - 0.35\,s^4)\,\mathrm{Cos}[u] - (1 + 0.65\,s - 1.2\,s^2 - 0.4\,s^3 + 0.35\,s^4)\,\mathrm{Sin}[u]\}$

In[11]:=
```
FindRoot[GW[s, u], {{s, 0.3}, {u, 0}}]
```

Out[11]= {s → 0.32402, u → 0.320456}

In[12]:=
```
DSS[s_, u_] = D[D[W[s, u], s], s];
DUU[s_, u_] = D[D[W[s, u], u], u];
DSU[s_, u_] = D[D[W[s, u], s], u];
Diff[s_, u_] = DSS[s, u] * DUU[s, u] - DSU[s, u]^2;
Diff[0.32402, 0.320456]
DSS[0.32402, 0.320456]
```

Out[16]= 3.99694

Out[17]= -3.90687

In[18]:=
```
-3.906868907086583`
W[0.32402, 0.320456]
```

Out[18]= -3.90687

Out[19]= 2.13253

Crit Point = {s→0.32402,u→0.320456},

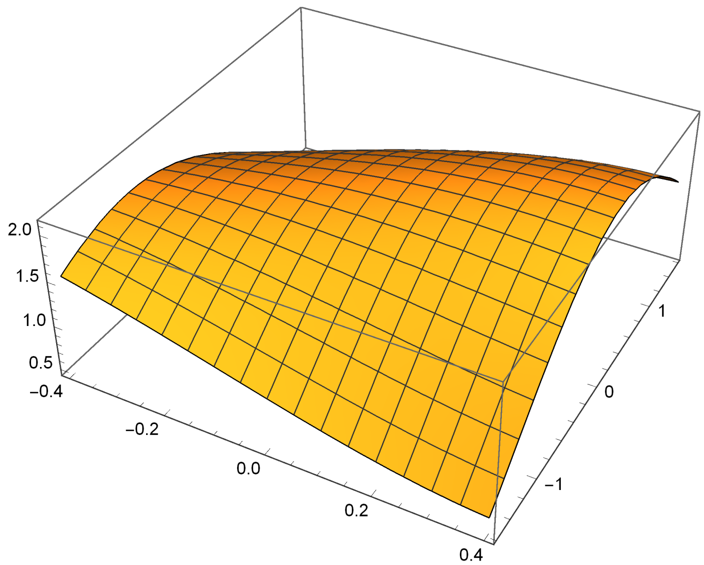
Differential at point = 3.99694

DXX at point = -3.9068689

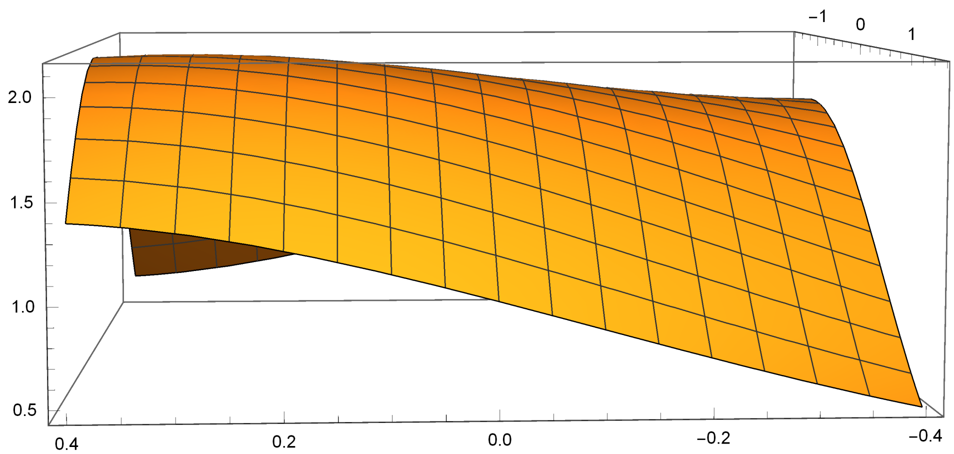
Power Generated = 2.13253

In[20]:=
```
Plot3D[W[s, u], {s, -.4, .4}, {u, -π/2, π/2}]
```

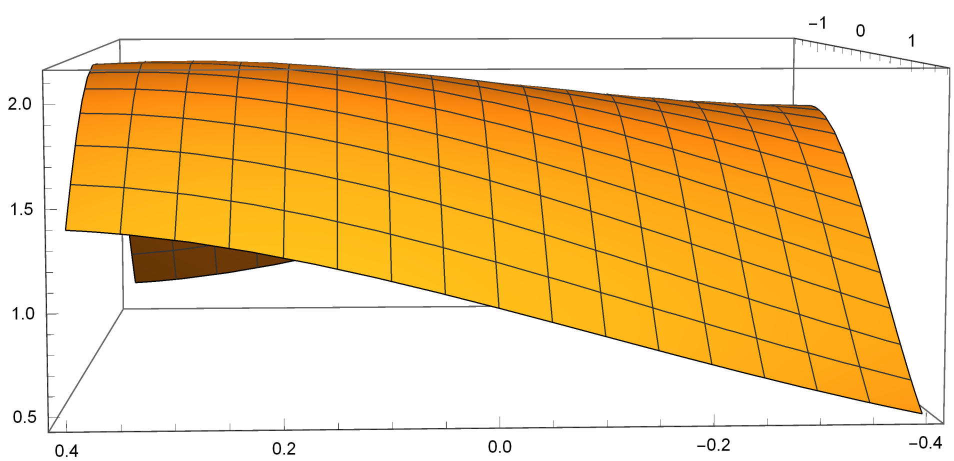
Out[20]=



In[21]:=




Out[21]=



In[22]:=
```
d1[u_] = D[W[0.4, u], u];
d2[u_] = D[W[-0.4, u], u];
d3[s_] = D[W[s, π/2], s];
d4[s_] = D[W[s, -π/2], s]
```

Out[25]= $-1.4 + 0.8\, s + 4.5\, s^2 + 1.4\, s^3$

In[26]:=
```
FindRoot[{d1[u]}, {u, 0}]
```

Out[26]= {u → 0.356083}

^^ is a maximum ?????

In[27]:=
```
FindRoot[{d2[u]}, {u, 0}]
```

Out[27]= {u → −0.744689}

^^ is a maximum ?????

In[28]:=
```
FindRoot[{d3[s]}, {s, 0}]
```

Out[28]= {s → 0.450206}

^^ Out of domain

In[29]:=
```
FindRoot[{d4[s]}, {s, 0.5}]
```

Out[29]= {s → 0.450206}

^^ Out of domain

# Part 4

## A

Point (0.4 , 0.356083)

In[30]:=
```
W[0.4, 0.356083]
```

Out[30]= 2.12173

Point (-0.4 , -0.744689)

In[31]:=
```
W[-0.4, -0.744689]
```

Out[31]= 1.79228

Point(-0.4, -$\pi$/2)

In[32]:=
```
W[-0.4, -π/2]
```

Out[32]= 1.53696

Point(-0.4, $\pi$/2)     GLOBAL MINIMUM for the given domain

In[33]:=
```
W[-0.4, π/2]
```
Out[33]=
```
0.46304
```

Point(0.4, -π/2)

In[34]:=
```
W[0.4, -π/2]
```
Out[34]=
```
0.60896
```

Point(0.4, π/2)

In[35]:=
```
W[0.4, π/2]
```
Out[35]=
```
1.39104
```

### B

The critical point from part 2 is the global maximum

## Part 5

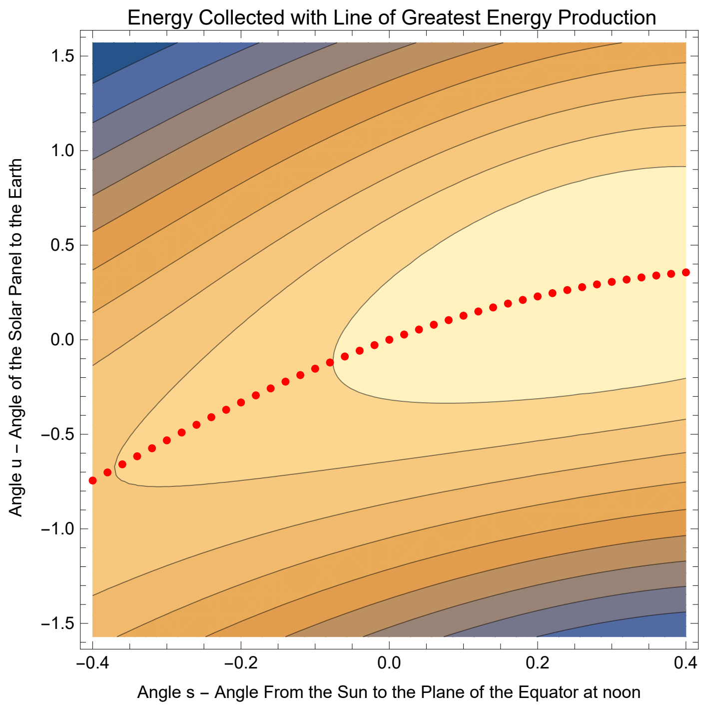
The panel will absorb the most light when s = 0.32402 rad ~= 18.56 Degrees
there for the season that will collect the most solar energy is the summer, the days that collect the most energy are when s is 4.5 degrees off of the 23 at the summer solstice( before the solstice AND after the solstice)

## Part 6

In[36]:=
```
svals = Table[s, {s, -0.4, 0.4, 0.02}];
```
In[37]:=
```
uvals = Table[FindRoot[D[W[s, u], u], {u, 0}], {s, -.4, 0.4, 0.02}];
```
In[38]:=
```
coords = Table[{svals[[i]], u} /. uvals[[i]], {i, Length[svals]}];
```
In[39]:=
```
IdealPointsPlot = ListPlot[coords, PlotStyle → Red];
```

In[40]:=
```
Show[{WContours, IdealPointsPlot},
 FrameLabel → {"Angle s - Angle From the Sun to the Plane of the Equator at noon",
   " Angle u - Angle of the Solar Panel to the Earth"},
 PlotLabel → " Energy Collected with Line of Greatest Energy Production"]
```

Out[40]=




Makes sense because it follows the ride and probably something about gradient

## Part 7

If the solar panels need to be replaced then they should be replaced about the winter solstice because the greatest energy production around s = -0.4 is the least of the entire year.  One should start the replacements before the winter solstice and finish after the solstice making the time before and after equal to minimize the amount of energy lost.