

# Team Update 5

April 5, 2024

## 1 Team Update 5

For this assignment, you'll be creating a complete version of your design system from start to finish. Modify the code cells below to reflect your design choices.

```
[ ]: import os
      from pathlib import Path

      import sys
      ISST_DIR = str(Path(os.getcwd()).parent.parent.parent)
      sys.path.append(ISST_DIR)

      import numpy as np
      import arviz as az
      import pymc as pm

      import ISST
```

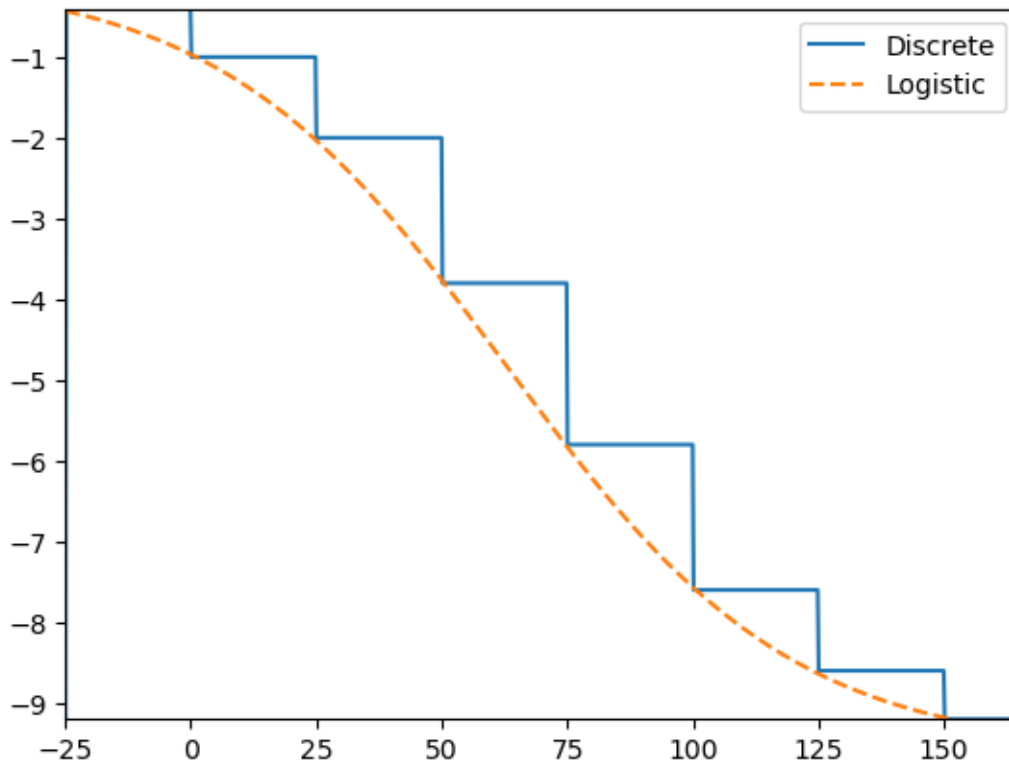
## 2 Cost Risk Table

First, create your overall cost Risk Table by completing the inputs for the Risk Table. Adjust your breakpoints and utility levels to obtain a satisfactory utility function.

```
[ ]: Cost_Risk_Table = ISST.RiskTable(name='Cost',
                                     units = 'euros',
                                     utility_breakpoints=[-25, 0, 25, 50, 75, 100, ↵
                                     ↵125, 150]),
                                     utilities=[-0.4, -1., -2., -3.8, -5.8, -7.6, ↵
                                     ↵-8.6, -9.2],
                                     utility_names=['-25M Euros',
                                                    '0M Euros',
                                                    '25M Euros',
                                                    '50M Euros',
                                                    '75M Euros',
                                                    '100M Euros',
                                                    '125M Euros',
                                                    '150M Euros']
```

```
)
```

```
Cost_Risk_Table.plot_utilities()
```



### 3 Schedule Risk Table

Next, the same for your schedule risk table:

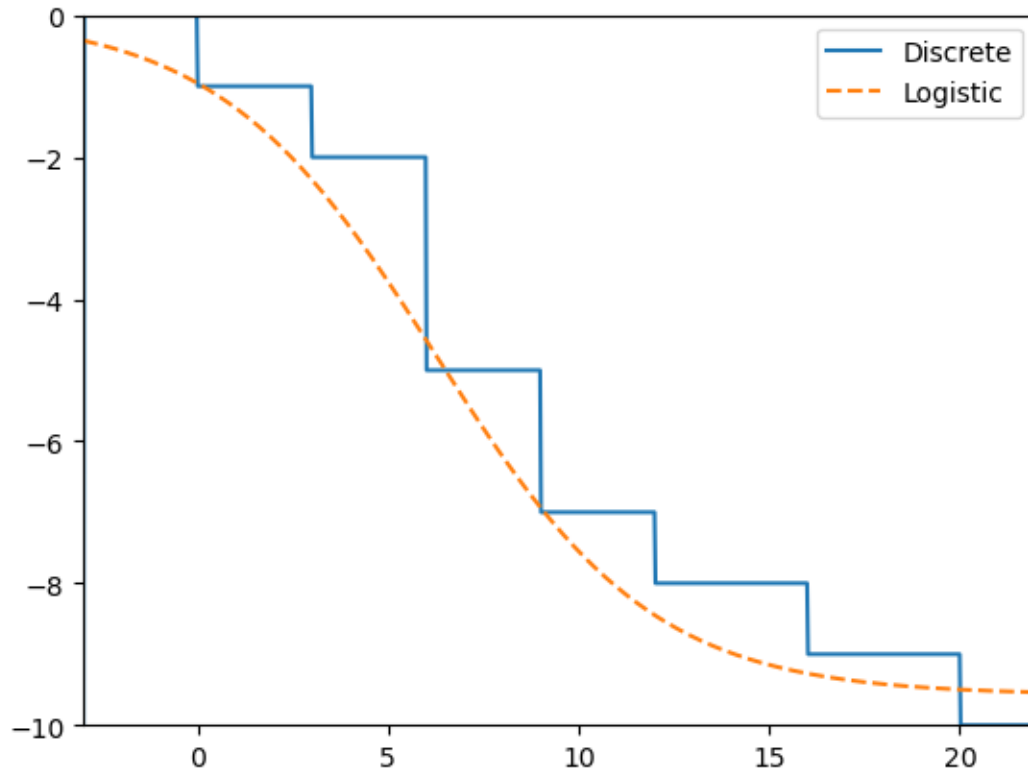
```
[ ]: Schedule_Risk_Table = ISST.RiskTable(name='Schedule',
                                         units = 'months',
                                         utility_breakpoints=[-3., 0, 3., 6., 9., 12., 16., 20.],
                                         utilities=[0., -1., -2., -5., -7, -8., -9., -10.],
                                         utility_names=['-3 Months',
                                                         '0 Months',
                                                         '3 Month',
                                                         '6 Months',
                                                         '9 Months',
                                                         '12 Months',
                                                         '16 Months',
```

```

)
'20 Months']

Schedule_Risk_Table.plot_utilities()

```



## 4 Technical Risk Tables

Next, your Technical Risk Tables. Identify the key technical parameters for each sub team, and assemble risk tables for each. There should be at minimum one risk table per sub-team, but not more than three. Copy and paste the code below as necessary, changing the variable names and the `name` parameter of the Risk Table.

```

[ ]: Payload_Power = ISST.RiskTable(name='Power',
                                   units = 'W',
                                   utility_breakpoints=[0., 750., 800.],
                                   utilities=[0., 5., 10.],
                                   utility_names=['Under Spec', 'Near Spec', 'At_
↳Spec'])

Payload_Power.L = 10

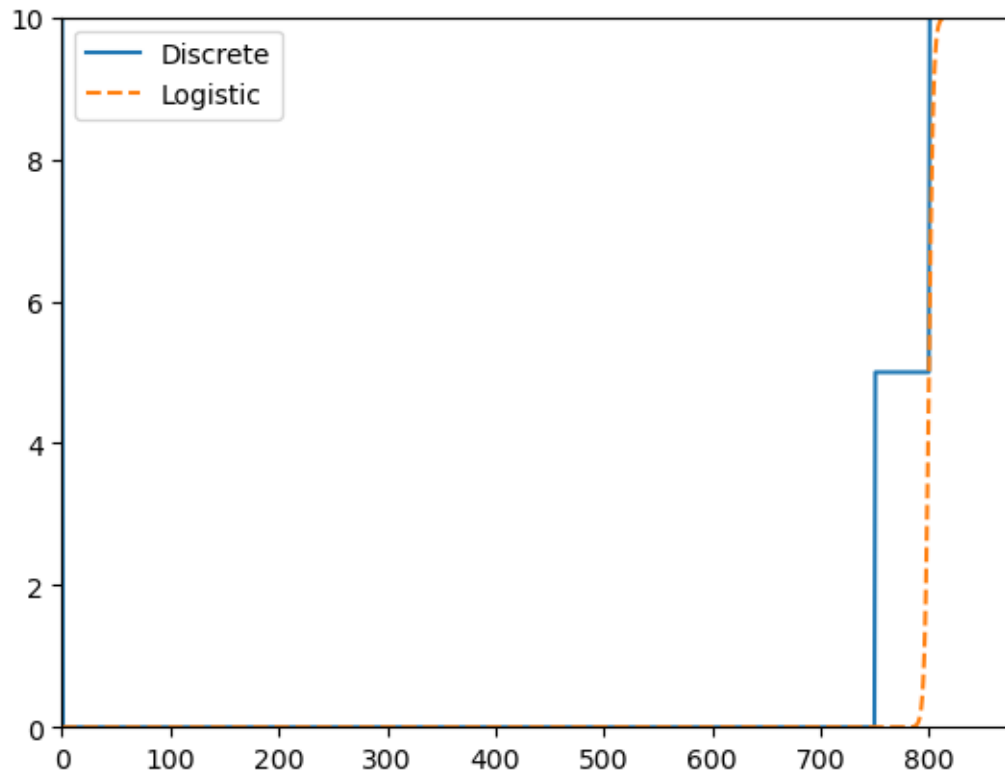
```

```

Payload_Power.k = 0.5
Payload_Power.x0 = 800

Payload_Power.plot_utilities()

```



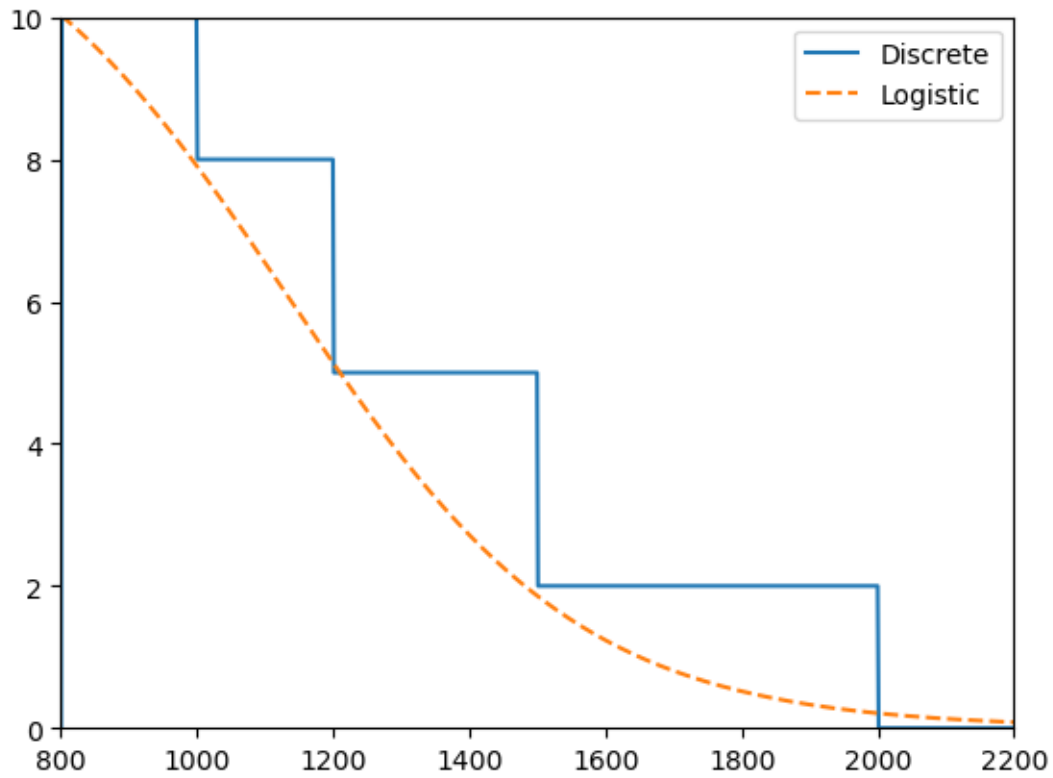
```

[ ]: Payload_Mass = ISST.RiskTable(name='Mass',
                                   units = 'kg',
                                   utility_breakpoints=[800., 1000., 1200., 1500.
↪, 2000.],

                                   utilities=[10., 8., 5., 2., 0.],
                                   utility_names=['200 kg Below Spec',
                                                  'At Spec',
                                                  '200 kg Above Spec',
                                                  '500 kg Above Spec',
                                                  'Launch Vehicle Limit']
                                   )

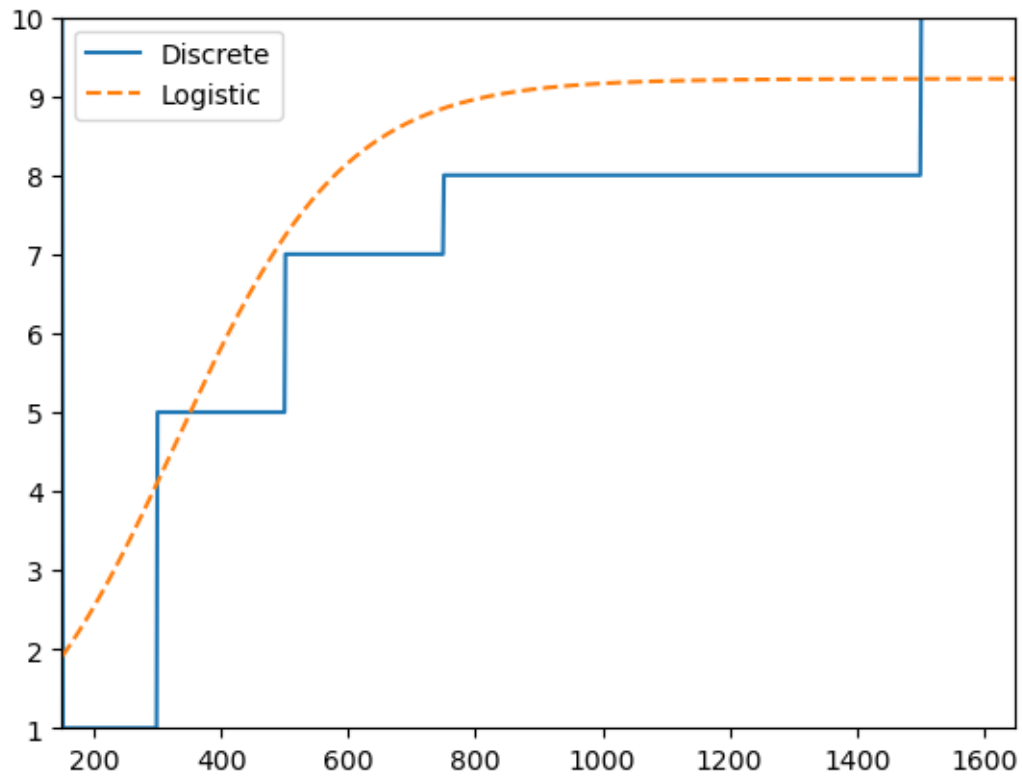
Payload_Mass.plot_utilities()

```



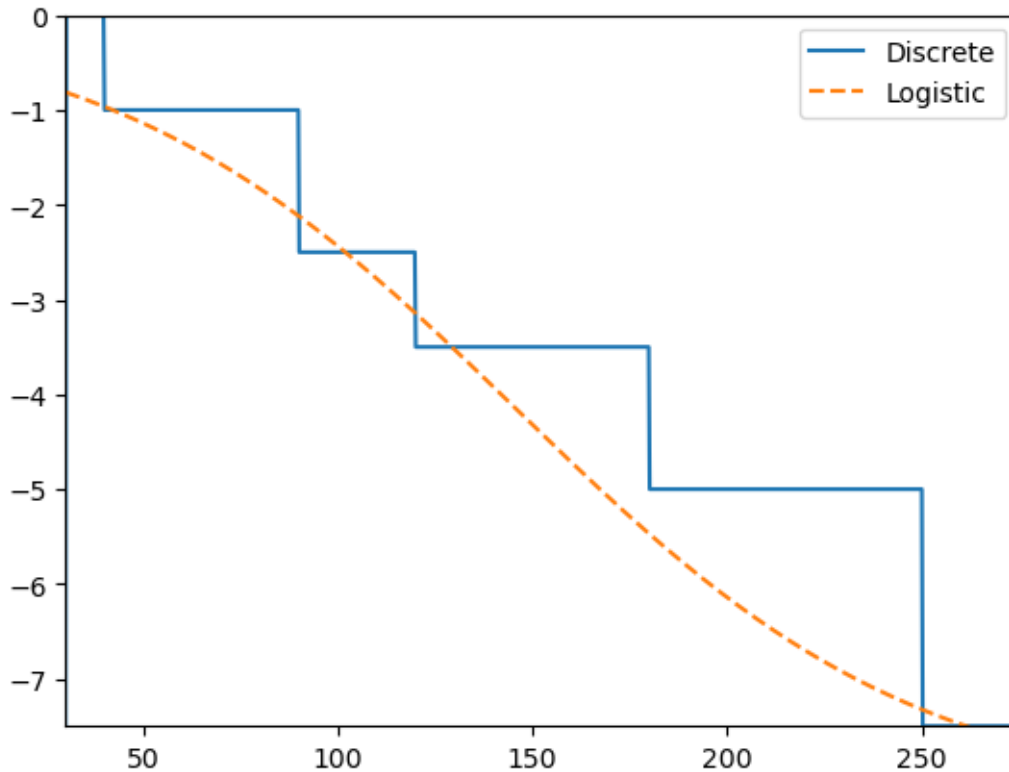
```
[ ]: Payload_Delta_v = ISST.RiskTable(name='Delta V',
                                     units = 'm/s',
                                     utility_breakpoints=[150, 300, 500, 750, 1500],
                                     utilities=[1., 5., 7., 8., 10.],
                                     utility_names=['150 m/s',
                                                    '300 m/s',
                                                    '500 m/s',
                                                    '750 m/s',
                                                    '1500 m/s']
                                     )

Payload_Delta_v.plot_utilities()
```



```
[ ]: GRS_Temp = ISST.RiskTable(name='GRS Temperature',
                                units = 'K',
                                utility_breakpoints=[30, 40, 90, 120, 180, 250],
                                utilities=[0, -1, -2.5, -3.5, -5, -7.5],
                                utility_names=['Design Temperature',
                                                'Mild Degredation',
                                                'Slight Degredation',
                                                'Moderate Degredation',
                                                'Significant Degredation',
                                                'Sensor Failure']
                                )

GRS_Temp.plot_utilities()
```



## 5 Risks

Identify the most important risks to your cost, schedule, and each technical parameter of your design system. You should have at minimum one major risk for each risk table identified above, and no more than three times as many risks as risk tables.

```
[ ]: # Cost Risks
Funding_Risk = ISST.Risk(name='Costs Need to be Spread Out',
    ↳baseline_likelihood = 0.26)
#Schedule Risks
Qual_Risk = ISST.Risk(name='Components Fail During Qualification',
    ↳baseline_likelihood = 0.24)
#GRS Resolution
Cooler_Risk = ISST.Risk(name='GRS Cryocooler Failure', baseline_likelihood = 0.
    ↳08)
Calibration_Risk = ISST.Risk(name='Sensor Calibration Fails',
    ↳baseline_likelihood = 0.04)
#Payload Power
Deployable_Risk = ISST.Risk(name='Mechanisms Fail to Deploy',
    ↳baseline_likelihood = 0.0067)
#Payload Mass
```

```

Manufacturing_Risk = ISST.Risk(name='Assembly Requires Design Modifications',
    ↪baseline_likelihood = 0.03)
#Payload Delta v
Dev_Risk = ISST.Risk(name='Propulsion Maturity is Behind Expectations',
    ↪baseline_likelihood = 0.30)

```

```

[ ]: full_risk_list = [Funding_Risk, Qual_Risk, Cooler_Risk, Calibration_Risk,
    ↪Deployable_Risk, Manufacturing_Risk, Dev_Risk]
full_technical_impact_list = [GRS_Temp, Payload_Power, Payload_Delta_v,
    ↪Payload_Mass]

```

## 6 Design System

Specify your design system

```

[ ]: Design_System = ISST.DesignSystem(name='Example Design System',
    model_context=pm.Model(),
    risks=full_risk_list,
    schedule_risk_table = Schedule_Risk_Table,
    cost_risk_table = Cost_Risk_Table,
    technical_risk_tables =
    ↪full_technical_impact_list)

```

## 7 Risk Specification

Run the `generate_system_specification` method for your design system

```

[ ]: #Design_System.generate_system_specification()

```

You will now have CSV files in a subdirectory which can be used to fill out your risk specification. Once they are filled out, read the specification back into your design system.

```

[ ]: Design_System.read_system_specification()

```

## 8 Analyze System

Run the Monte Carlo simulation of your design system and save them to a file.

```

[ ]: results = Design_System.analyze_system()
results.to_netcdf('Analysis Results.nc')

```

Auto-assigning NUTS sampler...

Initializing NUTS using jitter+adapt\_diag...

Multiprocess sampling (4 chains in 4 jobs)

NUTS: [Costs Need to be Spread Out Cost Scaled Impact, Components Fail During Qualification Cost Scaled Impact, GRS Cryocooler Failure Cost Scaled Impact, Sensor Calibration Fails Cost Scaled Impact, Mecahnisms Fail to Deploy Cost



Scaled Impact, Assembly Requires Design Modifications Cost Scaled Impact, Propulsion Maturity is Behind Expectations Cost Scaled Impact, Costs Need to be Spread Out Schedule Scaled Impact, Components Fail During Qualification Schedule Scaled Impact, GRS Cryocooler Failure Schedule Scaled Impact, Sensor Calibration Fails Schedule Scaled Impact, Mecahnisms Fail to Deploy Schedule Scaled Impact, Assembly Requires Design Modifications Schedule Scaled Impact, Propulsion Maturity is Behind Expectations Schedule Scaled Impact, Costs Need to be Spread Out Technical Parameter 0 Scaled Impact, Costs Need to be Spread Out Technical Parameter 1 Scaled Impact, Costs Need to be Spread Out Technical Parameter 2 Scaled Impact, Costs Need to be Spread Out Technical Parameter 3 Scaled Impact, Components Fail During Qualification Technical Parameter 0 Scaled Impact, Components Fail During Qualification Technical Parameter 1 Scaled Impact, Components Fail During Qualification Technical Parameter 2 Scaled Impact, Components Fail During Qualification Technical Parameter 3 Scaled Impact, GRS Cryocooler Failure Technical Parameter 0 Scaled Impact, GRS Cryocooler Failure Technical Parameter 1 Scaled Impact, GRS Cryocooler Failure Technical Parameter 2 Scaled Impact, GRS Cryocooler Failure Technical Parameter 3 Scaled Impact, Sensor Calibration Fails Technical Parameter 0 Scaled Impact, Sensor Calibration Fails Technical Parameter 1 Scaled Impact, Sensor Calibration Fails Technical Parameter 2 Scaled Impact, Sensor Calibration Fails Technical Parameter 3 Scaled Impact, Mecahnisms Fail to Deploy Technical Parameter 0 Scaled Impact, Mecahnisms Fail to Deploy Technical Parameter 1 Scaled Impact, Mecahnisms Fail to Deploy Technical Parameter 2 Scaled Impact, Mecahnisms Fail to Deploy Technical Parameter 3 Scaled Impact, Assembly Requires Design Modifications Technical Parameter 0 Scaled Impact, Assembly Requires Design Modifications Technical Parameter 1 Scaled Impact, Assembly Requires Design Modifications Technical Parameter 2 Scaled Impact, Assembly Requires Design Modifications Technical Parameter 3 Scaled Impact, Propulsion Maturity is Behind Expectations Technical Parameter 0 Scaled Impact, Propulsion Maturity is Behind Expectations Technical Parameter 1 Scaled Impact, Propulsion Maturity is Behind Expectations Technical Parameter 2 Scaled Impact, Propulsion Maturity is Behind Expectations Technical Parameter 3 Scaled Impact]

<IPython.core.display.HTML object>

<IPython.core.display.HTML object>

Sampling 4 chains for 1\_000 tune and 1\_000 draw iterations (4\_000 + 4\_000 draws total) took 42 seconds.

```
[ ]: 'Analysis Results.nc'
```

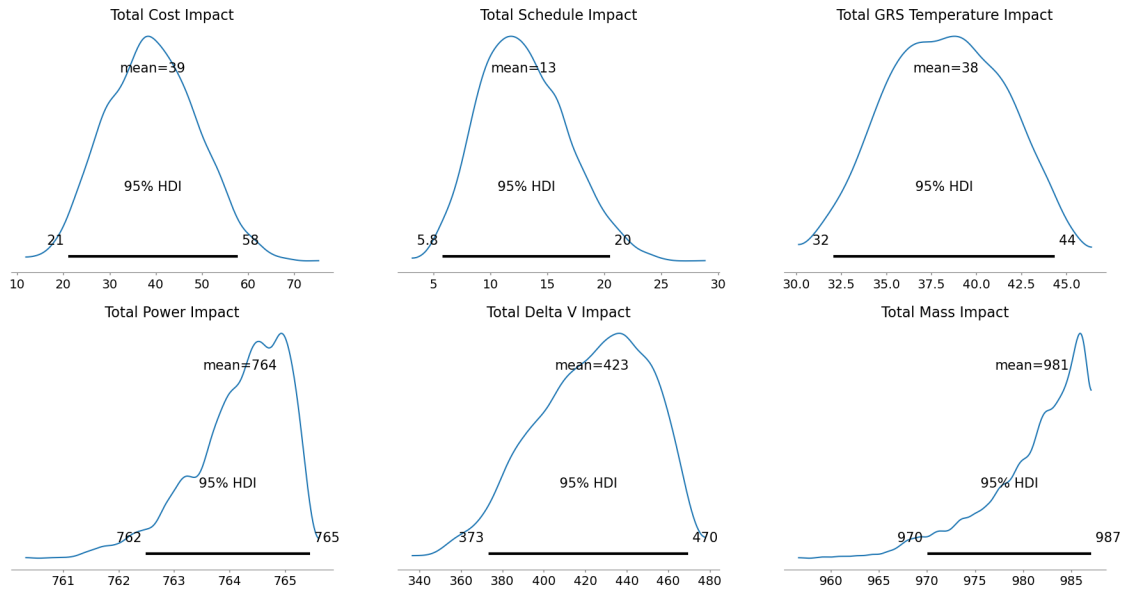
## 9 Results Inspection

First, let's look at the summary of results for your total impacts:

```
[ ]: az.plot_posterior(results,
                        var_names=['Total'],
                        filter_vars='like',
```

```
hdi_prob=0.95)
```

```
[ ]: array([[<AxesSubplot: title={'center': 'Total Cost Impact'}>,
<AxesSubplot: title={'center': 'Total Schedule Impact'}>,
<AxesSubplot: title={'center': 'Total GRS Temperature Impact'}>],
[<AxesSubplot: title={'center': 'Total Power Impact'}>,
<AxesSubplot: title={'center': 'Total Delta V Impact'}>,
<AxesSubplot: title={'center': 'Total Mass Impact'}>]],
dtype=object)
```



```
[ ]: az.summary(results,
var_names=['Total'],
filter_vars="like",
round_to=2,
kind='stats')
```

	mean	sd	hdi_3%	hdi_97%
Total Cost Impact	39.25	9.77	21.47	56.95
Total Schedule Impact	12.91	3.84	5.81	19.95
Total GRS Temperature Impact	38.30	3.32	32.40	44.36
Total Power Impact	764.19	0.84	762.64	765.45
Total Delta V Impact	423.20	27.01	375.81	469.45
Total Mass Impact	980.84	5.21	970.69	986.95

Next, the results for your cost analysis:

```
[ ]: az.plot_posterior(results,
var_names=['Cost'],
```

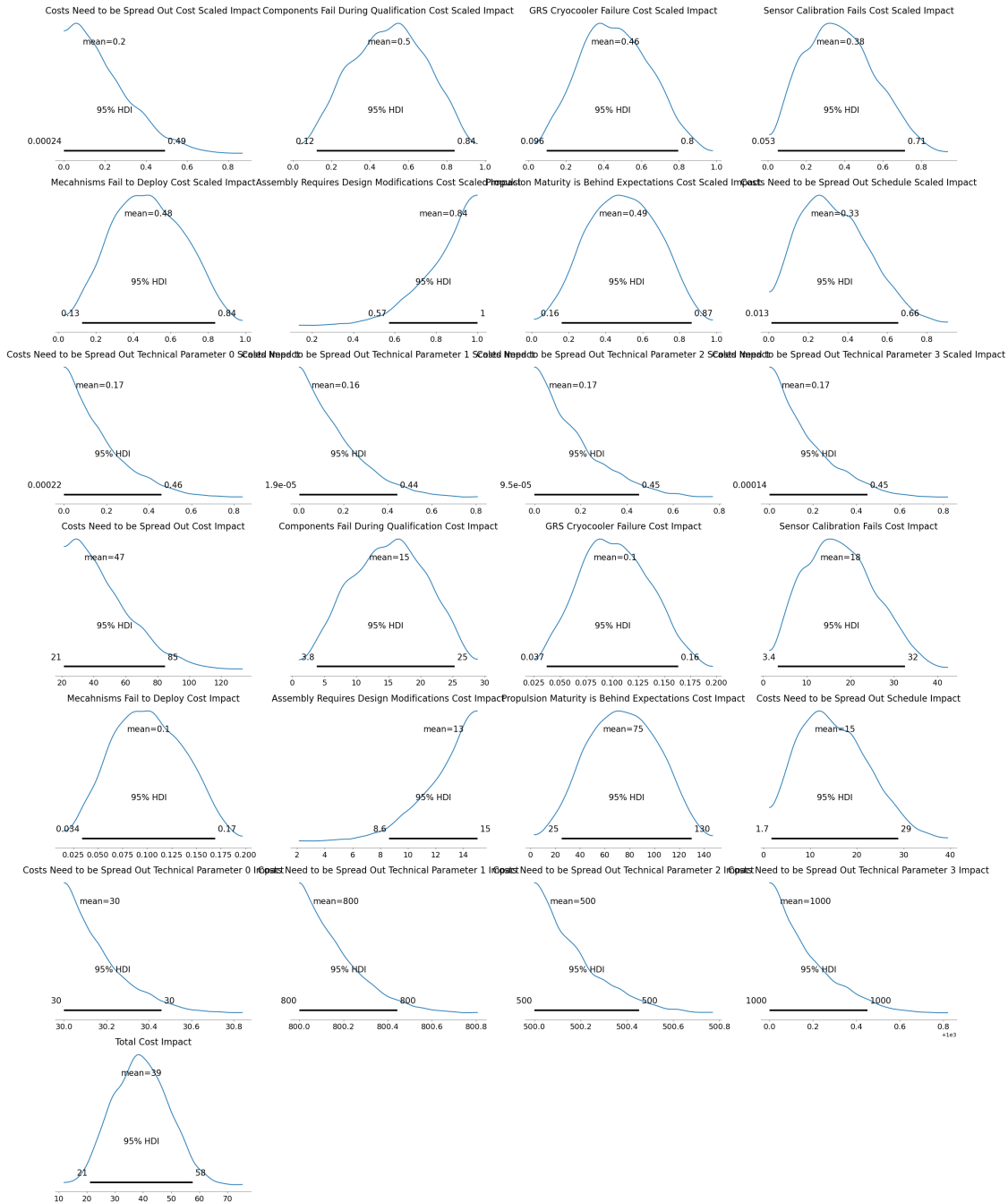
```
filter_vars='like',
hdi_prob=0.95)
```

```
[ ]: array([[<AxesSubplot: title={'center': 'Costs Need to be Spread Out Cost Scaled
Impact'}>],
          [<AxesSubplot: title={'center': 'Components Fail During Qualification
Cost Scaled Impact'}>],
          [<AxesSubplot: title={'center': 'GRS Cryocooler Failure Cost Scaled
Impact'}>],
          [<AxesSubplot: title={'center': 'Sensor Calibration Fails Cost Scaled
Impact'}>]],
          [<AxesSubplot: title={'center': 'Mechanisms Fail to Deploy Cost Scaled
Impact'}>],
          [<AxesSubplot: title={'center': 'Assembly Requires Design Modifications
Cost Scaled Impact'}>],
          [<AxesSubplot: title={'center': 'Propulsion Maturity is Behind
Expectations Cost Scaled Impact'}>],
          [<AxesSubplot: title={'center': 'Costs Need to be Spread Out Schedule
Scaled Impact'}>]],
          [<AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 0 Scaled Impact'}>],
          [<AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 1 Scaled Impact'}>],
          [<AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 2 Scaled Impact'}>],
          [<AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 3 Scaled Impact'}>]],
          [<AxesSubplot: title={'center': 'Costs Need to be Spread Out Cost
Impact'}>],
          [<AxesSubplot: title={'center': 'Components Fail During Qualification
Cost Impact'}>],
          [<AxesSubplot: title={'center': 'GRS Cryocooler Failure Cost Impact'}>],
          [<AxesSubplot: title={'center': 'Sensor Calibration Fails Cost
Impact'}>]],
          [<AxesSubplot: title={'center': 'Mechanisms Fail to Deploy Cost
Impact'}>],
          [<AxesSubplot: title={'center': 'Assembly Requires Design Modifications
Cost Impact'}>],
          [<AxesSubplot: title={'center': 'Propulsion Maturity is Behind
Expectations Cost Impact'}>],
          [<AxesSubplot: title={'center': 'Costs Need to be Spread Out Schedule
Impact'}>]],
          [<AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 0 Impact'}>],
          [<AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 1 Impact'}>],
          [<AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
```

```

Parameter 2 Impact'}>,
  <AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 3 Impact'}>],
[<AxesSubplot: title={'center': 'Total Cost Impact'}>,
  <AxesSubplot: >, <AxesSubplot: >, <AxesSubplot: >]], dtype=object)

```



```
[ ]: az.summary(results,
    var_names=['Cost'],
    filter_vars="like",
    round_to=2,
    kind='stats')
```

```
[ ]:
```

	mean	sd	hdi_3% \
Costs Need to be Spread Out Cost Scaled Impact	0.20	0.15	0.00
Components Fail During Qualification Cost Scale...	0.50	0.19	0.14
GRS Cryocooler Failure Cost Scaled Impact	0.46	0.18	0.10
Sensor Calibration Fails Cost Scaled Impact	0.38	0.18	0.06
Mecahnisms Fail to Deploy Cost Scaled Impact	0.48	0.19	0.12
Assembly Requires Design Modifications Cost Sca...	0.84	0.14	0.59
Propulsion Maturity is Behind Expectations Cost...	0.49	0.19	0.16
Costs Need to be Spread Out Schedule Scaled Impact	0.33	0.18	0.03
Costs Need to be Spread Out Technical Parameter...	0.17	0.14	0.00
Costs Need to be Spread Out Technical Parameter...	0.16	0.14	0.00
Costs Need to be Spread Out Technical Parameter...	0.17	0.14	0.00
Costs Need to be Spread Out Technical Parameter...	0.17	0.14	0.00
Costs Need to be Spread Out Cost Impact	46.62	19.16	21.44
Components Fail During Qualification Cost Impact	15.10	5.83	4.31
GRS Cryocooler Failure Cost Impact	0.10	0.03	0.04
Sensor Calibration Fails Cost Impact	17.70	7.97	3.56
Mecahnisms Fail to Deploy Cost Impact	0.10	0.04	0.03
Assembly Requires Design Modifications Cost Impact	12.55	2.02	8.89
Propulsion Maturity is Behind Expectations Cost...	74.72	28.11	25.07
Costs Need to be Spread Out Schedule Impact	15.25	7.49	2.16
Costs Need to be Spread Out Technical Parameter...	30.17	0.14	30.00
Costs Need to be Spread Out Technical Parameter...	800.16	0.14	800.00
Costs Need to be Spread Out Technical Parameter...	500.17	0.14	500.00
Costs Need to be Spread Out Technical Parameter...	1000.17	0.14	1000.00
Total Cost Impact	39.25	9.77	21.47

	hdi_97%
Costs Need to be Spread Out Cost Scaled Impact	0.46
Components Fail During Qualification Cost Scale...	0.84
GRS Cryocooler Failure Cost Scaled Impact	0.77
Sensor Calibration Fails Cost Scaled Impact	0.70
Mecahnisms Fail to Deploy Cost Scaled Impact	0.81
Assembly Requires Design Modifications Cost Sca...	1.00
Propulsion Maturity is Behind Expectations Cost...	0.84
Costs Need to be Spread Out Schedule Scaled Impact	0.65
Costs Need to be Spread Out Technical Parameter...	0.43
Costs Need to be Spread Out Technical Parameter...	0.42
Costs Need to be Spread Out Technical Parameter...	0.43
Costs Need to be Spread Out Technical Parameter...	0.43
Costs Need to be Spread Out Cost Impact	81.17

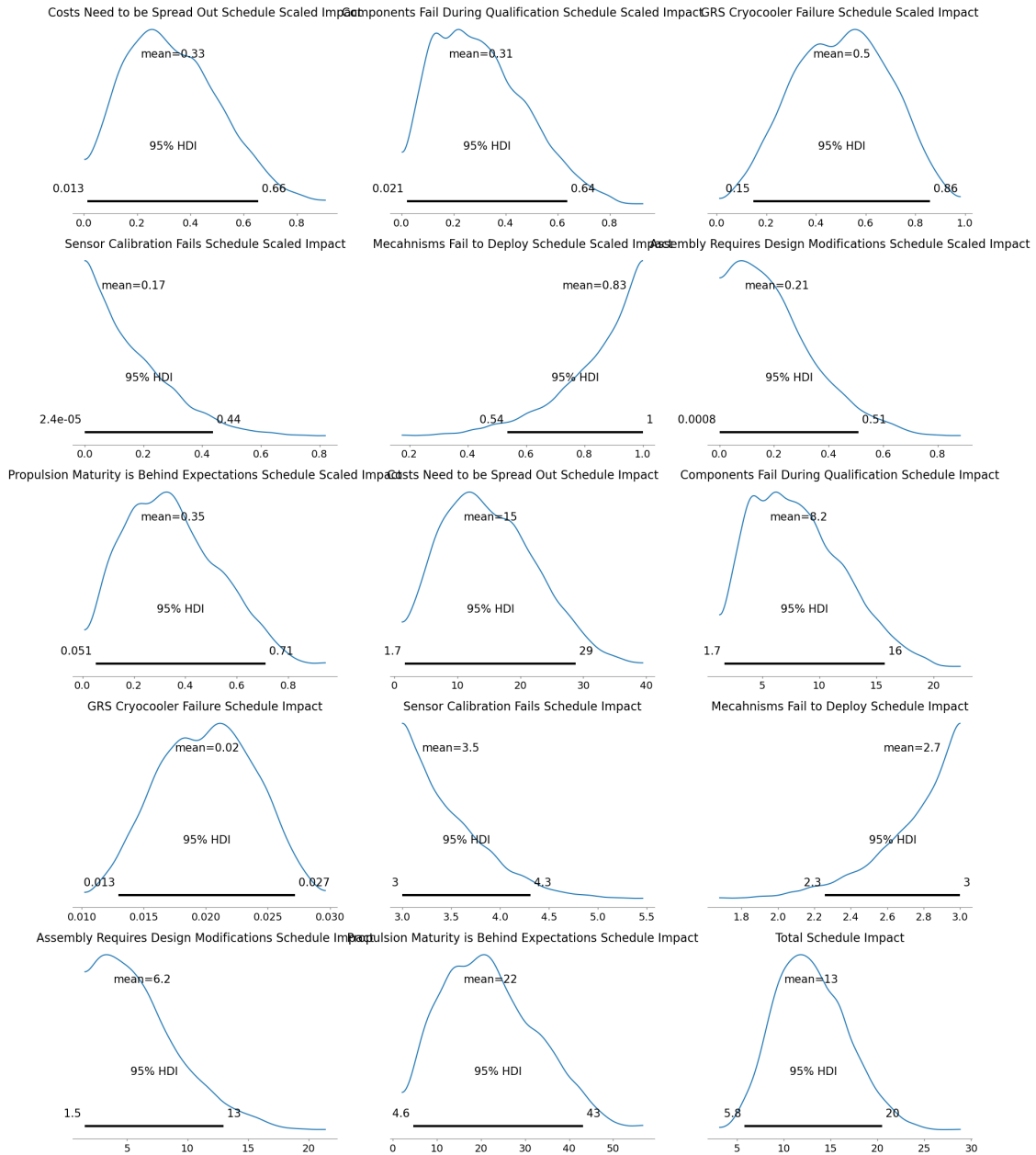
Components Fail During Qualification Cost Impact	25.22
GRS Cryocooler Failure Cost Impact	0.16
Sensor Calibration Fails Cost Impact	31.74
Mecahnisms Fail to Deploy Cost Impact	0.16
Assembly Requires Design Modifications Cost Impact	15.00
Propulsion Maturity is Behind Expectations Cost...	126.30
Costs Need to be Spread Out Schedule Impact	28.50
Costs Need to be Spread Out Technical Parameter...	30.43
Costs Need to be Spread Out Technical Parameter...	800.42
Costs Need to be Spread Out Technical Parameter...	500.43
Costs Need to be Spread Out Technical Parameter...	1000.43
Total Cost Impact	56.95

Next, the results for your schedule analysis:

```
[ ]: az.plot_posterior(results,
                        var_names=['Schedule'],
                        filter_vars='like',
                        hdi_prob=0.95)
```

```
[ ]: array([[<AxesSubplot: title={'center': 'Costs Need to be Spread Out Schedule
Scaled Impact'}>,
            <AxesSubplot: title={'center': 'Components Fail During Qualification
Schedule Scaled Impact'}>,
            <AxesSubplot: title={'center': 'GRS Cryocooler Failure Schedule Scaled
Impact'}>],
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Impact'}>,
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Schedule Scaled Impact'}>],
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Expectations Schedule Scaled Impact'}>,
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Schedule Impact'}>],
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Impact'}>,
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Impact'}>,
            <AxesSubplot: title={'center': 'Mecahnisms Fail to Deploy Schedule
Impact'}>],
            [<AxesSubplot: title={'center': 'Assembly Requires Design Modifications
Schedule Impact'}>,
            <AxesSubplot: title={'center': 'Propulsion Maturity is Behind
Expectations Schedule Impact'}>],
```

```
<AxesSubplot: title={'center': 'Total Schedule Impact'}>]],  
dtype=object)
```



```
[ ]: az.summary(results,  
    var_names=['Schedule'],  
    filter_vars="like",  
    round_to=2,  
    kind='stats')
```

[ ]:		mean	sd	hdi_3%	\
	Costs Need to be Spread Out Schedule Scaled Impact	0.33	0.18	0.03	
	Components Fail During Qualification Schedule S...	0.31	0.17	0.02	
	GRS Cryocooler Failure Schedule Scaled Impact	0.50	0.19	0.17	
	Sensor Calibration Fails Schedule Scaled Impact	0.17	0.14	0.00	
	Mecahnisms Fail to Deploy Schedule Scaled Impact	0.83	0.14	0.56	
	Assembly Requires Design Modifications Schedule...	0.21	0.15	0.00	
	Propulsion Maturity is Behind Expectations Sche...	0.35	0.18	0.05	
	Costs Need to be Spread Out Schedule Impact	15.25	7.49	2.16	
	Components Fail During Qualification Schedule I...	8.15	3.98	1.70	
	GRS Cryocooler Failure Schedule Impact	0.02	0.00	0.01	
	Sensor Calibration Fails Schedule Impact	3.50	0.41	3.00	
	Mecahnisms Fail to Deploy Schedule Impact	2.74	0.23	2.29	
	Assembly Requires Design Modifications Schedule...	6.24	3.41	1.52	
	Propulsion Maturity is Behind Expectations Sche...	22.15	10.69	4.31	
	Total Schedule Impact	12.91	3.84	5.81	

	hdi_97%
Costs Need to be Spread Out Schedule Scaled Impact	0.65
Components Fail During Qualification Schedule S...	0.62
GRS Cryocooler Failure Schedule Scaled Impact	0.86
Sensor Calibration Fails Schedule Scaled Impact	0.42
Mecahnisms Fail to Deploy Schedule Scaled Impact	1.00
Assembly Requires Design Modifications Schedule...	0.49
Propulsion Maturity is Behind Expectations Sche...	0.69
Costs Need to be Spread Out Schedule Impact	28.50
Components Fail During Qualification Schedule I...	15.33
GRS Cryocooler Failure Schedule Impact	0.03
Sensor Calibration Fails Schedule Impact	4.26
Mecahnisms Fail to Deploy Schedule Impact	3.00
Assembly Requires Design Modifications Schedule...	12.50
Propulsion Maturity is Behind Expectations Sche...	41.84
Total Schedule Impact	19.95

And finally, for your technical parameters:

```
[ ]: for idx, risk in enumerate(Design_System.risks):
      print(f'Technical Parameter {idx}: {risk.name}')
```

Technical Parameter 0: Costs Need to be Spread Out  
 Technical Parameter 1: Components Fail During Qualification  
 Technical Parameter 2: GRS Cryocooler Failure  
 Technical Parameter 3: Sensor Calibration Fails  
 Technical Parameter 4: Mecahnisms Fail to Deploy  
 Technical Parameter 5: Assembly Requires Design Modifications  
 Technical Parameter 6: Propulsion Maturity is Behind Expectations



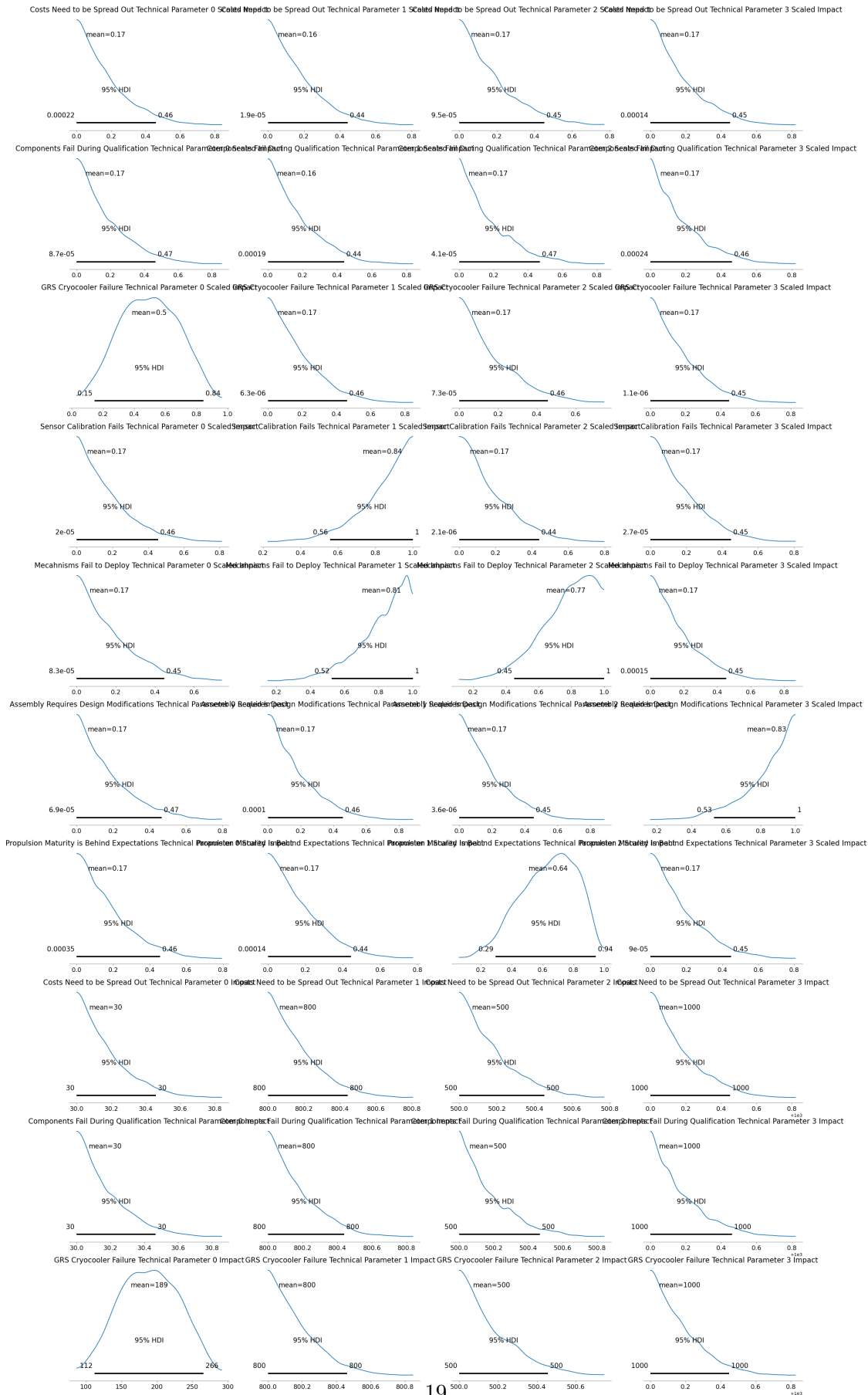
```
[ ]: az.plot_posterior(results,
                        var_names=['Technical'],
                        filter_vars='like',
                        hdi_prob=0.95)

[ ]: array([[<AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 0 Scaled Impact'}>,
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Parameter 1 Scaled Impact'}>,
            <AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 2 Scaled Impact'}>,
            <AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 3 Scaled Impact'}>]],
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Technical Parameter 0 Scaled Impact'}>,
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Technical Parameter 1 Scaled Impact'}>,
            <AxesSubplot: title={'center': 'Components Fail During Qualification
Technical Parameter 2 Scaled Impact'}>,
            <AxesSubplot: title={'center': 'Components Fail During Qualification
Technical Parameter 3 Scaled Impact'}>]],
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Parameter 1 Scaled Impact'}>,
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Parameter 2 Scaled Impact'}>,
            <AxesSubplot: title={'center': 'GRS Cryocooler Failure Technical
Parameter 3 Scaled Impact'}>]],
            [<AxesSubplot: title={'center': 'Sensor Calibration Fails Technical
Parameter 0 Scaled Impact'}>,
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Parameter 1 Scaled Impact'}>,
            <AxesSubplot: title={'center': 'Sensor Calibration Fails Technical
Parameter 2 Scaled Impact'}>,
            <AxesSubplot: title={'center': 'Sensor Calibration Fails Technical
Parameter 3 Scaled Impact'}>]],
            [<AxesSubplot: title={'center': 'Mechanisms Fail to Deploy Technical
Parameter 0 Scaled Impact'}>,
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Parameter 1 Scaled Impact'}>,
            <AxesSubplot: title={'center': 'Mechanisms Fail to Deploy Technical
Parameter 2 Scaled Impact'}>,
            <AxesSubplot: title={'center': 'Mechanisms Fail to Deploy Technical
Parameter 3 Scaled Impact'}>]],
            [<AxesSubplot: title={'center': 'Assembly Requires Design Modifications
Technical Parameter 0 Scaled Impact'}>],
```

```

    <AxesSubplot: title={'center': 'Assembly Requires Design Modifications
Technical Parameter 1 Scaled Impact'}>,
    <AxesSubplot: title={'center': 'Assembly Requires Design Modifications
Technical Parameter 2 Scaled Impact'}>,
    <AxesSubplot: title={'center': 'Assembly Requires Design Modifications
Technical Parameter 3 Scaled Impact'}>]],
    [<AxesSubplot: title={'center': 'Propulsion Maturity is Behind
Expectations Technical Parameter 0 Scaled Impact'}>,
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Expectations Technical Parameter 1 Scaled Impact'}>,
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Expectations Technical Parameter 2 Scaled Impact'}>,
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Expectations Technical Parameter 3 Scaled Impact'}>]],
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Parameter 0 Impact'}>,
    <AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 1 Impact'}>,
    <AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 2 Impact'}>,
    <AxesSubplot: title={'center': 'Costs Need to be Spread Out Technical
Parameter 3 Impact'}>]],
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Technical Parameter 0 Impact'}>,
    <AxesSubplot: title={'center': 'Components Fail During Qualification
Technical Parameter 1 Impact'}>,
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Technical Parameter 2 Impact'}>,
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Technical Parameter 3 Impact'}>]],
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Parameter 0 Impact'}>,
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Parameter 1 Impact'}>,
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Parameter 2 Impact'}>,
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Parameter 3 Impact'}>]],
    dtype=object)

```



```
[ ]: az.summary(results,
    var_names=['Schedule'],
    filter_vars="like",
    round_to=2,
    kind='stats')
```

```
[ ]:
Costs Need to be Spread Out Schedule Scaled Impact    mean    sd  hdi_3%  \
Components Fail During Qualification Schedule S...  0.31  0.17   0.02
GRS Cryocooler Failure Schedule Scaled Impact        0.50  0.19   0.17
Sensor Calibration Fails Schedule Scaled Impact      0.17  0.14   0.00
Mecahnisms Fail to Deploy Schedule Scaled Impact    0.83  0.14   0.56
Assembly Requires Design Modifications Schedule...  0.21  0.15   0.00
Propulsion Maturity is Behind Expectations Sche...  0.35  0.18   0.05
Costs Need to be Spread Out Schedule Impact         15.25  7.49   2.16
Components Fail During Qualification Schedule I...   8.15  3.98   1.70
GRS Cryocooler Failure Schedule Impact              0.02  0.00   0.01
Sensor Calibration Fails Schedule Impact             3.50  0.41   3.00
Mecahnisms Fail to Deploy Schedule Impact           2.74  0.23   2.29
Assembly Requires Design Modifications Schedule...   6.24  3.41   1.52
Propulsion Maturity is Behind Expectations Sche...  22.15 10.69   4.31
Total Schedule Impact                               12.91  3.84   5.81

                                                                    hdi_97%
Costs Need to be Spread Out Schedule Scaled Impact        0.65
Components Fail During Qualification Schedule S...         0.62
GRS Cryocooler Failure Schedule Scaled Impact             0.86
Sensor Calibration Fails Schedule Scaled Impact           0.42
Mecahnisms Fail to Deploy Schedule Scaled Impact         1.00
Assembly Requires Design Modifications Schedule...        0.49
Propulsion Maturity is Behind Expectations Sche...        0.69
Costs Need to be Spread Out Schedule Impact              28.50
Components Fail During Qualification Schedule I...       15.33
GRS Cryocooler Failure Schedule Impact                   0.03
Sensor Calibration Fails Schedule Impact                  4.26
Mecahnisms Fail to Deploy Schedule Impact                3.00
Assembly Requires Design Modifications Schedule...       12.50
Propulsion Maturity is Behind Expectations Sche...      41.84
Total Schedule Impact                                    19.95
```

## 10 Assignment Submission

Once your results are in place for all of the above elements, print the notebook to PDF and submit it to the assignment.