

# **deformsbook**

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# Preface

This is a Quarto book.

To learn more about Quarto books visit <https://quarto.org/docs/books>.

**1 + 1**

[1] 2

# 1 Strength of Materials Problem Workout

To scaffold your learning in this example, we have provided a free body diagram for you and a repeat of the problem statement.

A city planner is installing a new traffic light. Light A weighs 65 lb, while lights B and C weigh 50 lb each. The post at O has a hollow circular cross-section with an outer diameter of 5 inches and a wall thickness of 0.2 inches. It will be made from aluminum alloy with a tensile yield stress of 35 ksi and a compressive yield stress of 20 ksi. A factor of safety of 2 is required with respect to yield. You may ignore the weight of the post.



Figure 1.1: Figure 1: Three traffic light installation with loads

Please work through the problem step by step showing your math in the interactive interface [here](#).

```
#| standalone: true
#| viewerHeight: 600
#| components: [viewer]
```

```
from shiny import App, render, ui, reactive, req
```

```

from sympy import solve, Eq, Symbol
from sympy.parsing.sympy_parser import parse_expr
from shiny.ui import h4

# load equations lists

class eqn:
    def __init__(self, name, inline_math, newline_math, working_sym, working_eqn_latex, working_eqn_solver):
        self.name = name
        self.inline_math = inline_math
        self.newline_math = newline_math
        self.working_sym = working_sym
        self.working_eqn_latex = working_eqn_latex
        self.working_eqn_solver = working_eqn_solver

StaticsSumFx = eqn(
    "Equilibrium Forces in X",
    "\\(\\Sigma F_x=0\\)",
    "$$\\Sigma F_x=0$$",
    "SigmaFx",
    "$$F_{x1}+F_{x2}+F_{x3}+F_{x4}+F_{x5}=0$$",
    "F_x1+F_x2+F_x3+F_x4+F_x5=0"
)

StaticsSumFy = eqn(
    "Equilibrium Forces in Y",
    "\\(\\Sigma F_y=0\\)",
    "$$\\Sigma F_y=0$$",
    "SigmaFy",
    "$$F_{y1}+F_{y2}+F_{y3}+F_{y4}+F_{y5}=0$$",
    "F_y1+F_y2+F_y3+F_y4+F_y5=0"
)

StaticsSumM = eqn(
    "Equilibrium Moments about O",
    "\\(\\Sigma M_O=0\\)",
    "$$\\Sigma M_O=0$$",
    "SigmaM",
    "$$M_1+M_2+M_3+M_4+M_5=0$$",
    "M_1+M_2+M_3+M_4+M_5=0"
)

```

```

)

StressEqn = eqn(
    "Stress Equation",
    "\(\sigma=\frac{F}{A}\)",
    "$$\sigma=\frac{F}{A}$$",
    "sigma,F,A",
    "$$\sigma=\frac{(F)}{(A)}$$",
    "Eq(sigma,(F)/(A))"
)

AxialDeform = eqn(
    "Axial Deformation by Force",
    "\(\delta_l=\frac{P L}{AE}\)",
    "$$\delta_l=\frac{P \cdot L}{A \cdot E}$$",
    "delta_l,P,L,A,E",
    "$$\delta_l=\frac{(P)(L)}{(A)(E)}$$",
    "Eq(delta_l,(P)*(L)/(A)/(E))"
)

ThermalDeform = eqn(
    "Axial Deformation by Thermal",
    "\(\delta_t= \alpha \Delta T L\)",
    "$$\delta_t= \alpha \cdot \Delta T \cdot L$$",
    "delta_t,alpha,DeltaT,L",
    "$$\delta_t= \alpha \Delta T L$$",
    "delta_t= alpha*(Delta_T)*L"
)

AreaTube = eqn(
    "Area of a Tube",
    "\(A_{tube}=\pi(r_o^2-r_i^2)\)",
    "$$A_{tube}=\pi(r_o^2-r_i^2)$$",
    "A_tube,r_o,r_i",
    "$$A_{tube}=\pi(r_o^2-r_i^2)$$",
    "Eq(A_tube,pi*((r_o)**2-(r_i)**2))"
)

ITube = eqn(
    "Moment of Inertia of a Tube",
    "\(I_{tube}=\frac{\pi}{4}(r_o^4-r_i^4)\)",

```

```

    "$$I_{tube}=\frac{\pi}{4}(r_o^4-r_i^4)$$",
    "I_tube,r_o,r_i",
    "$$I_{tube}=\frac{\pi}{4}(r_o^4-r_i^4)$$",
    "Eq(I_tube,pi/4*((r_o)**4-(r_i)**4))"
)

BendingStress = eqn(
    "Bending Stress from a Moment",
    "\(\sigma_b=\frac{M*y}{I}\)",
    "$$\sigma_b=\frac{M*y}{I}$$",
    "sigma_b,M,y,I,",
    "$$\sigma_b=\frac{M*y}{I}$$",
    "Eq(sigma_b,M*y/I)"
)

Compatability1 = eqn(
    "Compatability Equation 1",
    "\((a_1+\ldots=b_1+b_2+\ldots)\)",
    "$$a_1+\ldots=b_1+b_2+\ldots$$",
    "",
    "$$a_1+a_n=b_1+b_n$$",
    "Eq(a_1+a_n=b_1+b_n)"
)

Compatability2 = eqn(
    "Compatability Equation 2",
    "\((c_1+\ldots=d_1+d_2+\ldots)\)",
    "$$c_1+\ldots=d_1+d_2+\ldots$$",
    "",
    "$$c_1+c_n=d_1+d_n$$",
    "Eq(c_1+c_n=d_1+d_n)"
)

statics_eqnbank_inline = {
    StaticsSumFx.name: StaticsSumFx.inline_math,
    StaticsSumFy.name: StaticsSumFy.inline_math,
    StaticsSumM.name: StaticsSumM.inline_math,
}

deforms_eqnbank_inline = {
    StressEqn.name: StressEqn.inline_math,

```

```

    AxialDeform.name: AxialDeform.inline_math,
    ThermalDeform.name: ThermalDeform.inline_math,
}

geom_eqnbank_inline = {
    AreaTube.name: AreaTube.inline_math,
    ITube.name: ITube.inline_math,
}

eqnbank_inline = {
    StaticsSumFx.name: StaticsSumFx.inline_math,
    StaticsSumFy.name: StaticsSumFy.inline_math,
    StaticsSumM.name: StaticsSumM.inline_math,
    StressEqn.name: StressEqn.inline_math,
    BendingStress.name: BendingStress.inline_math,
    AxialDeform.name: AxialDeform.inline_math,
    ThermalDeform.name: ThermalDeform.inline_math,
    AreaTube.name: AreaTube.inline_math,
    ITube.name: ITube.inline_math,
    Compatability1.name: Compatability1.inline_math,
    Compatability2.name: Compatability2.inline_math,
}

eqnbank_newline = {
    StaticsSumFx.name: StaticsSumFx.newline_math,
    StaticsSumFy.name: StaticsSumFy.newline_math,
    StaticsSumM.name: StaticsSumM.newline_math,
    StressEqn.name: StressEqn.newline_math,
    BendingStress.name: BendingStress.newline_math,
    AxialDeform.name: AxialDeform.newline_math,
    ThermalDeform.name: ThermalDeform.newline_math,
    AreaTube.name: AreaTube.newline_math,
    ITube.name: ITube.newline_math,
    Compatability1.name: Compatability1.newline_math,
    Compatability2.name: Compatability2.newline_math,
}

working_equations_solver=reactive.Value([])
working_symbols=reactive.Value([])

```



```

NumForcesY=reactive.Value(2)
F1y=reactive.Value("")
F2y=reactive.Value("")
F3y=reactive.Value("")
F4y=reactive.Value("")
F5y=reactive.Value("")

NumForcesX=reactive.Value(2)
F1x=reactive.Value("")
F2x=reactive.Value("")
F3x=reactive.Value("")
F4x=reactive.Value("")
F5x=reactive.Value("")

NumMoments=reactive.Value(2)
M1=reactive.Value("")
M2=reactive.Value("")
M3=reactive.Value("")
M4=reactive.Value("")
M5=reactive.Value("")

axial_stress_sigma=reactive.Value("")
axial_stress_force=reactive.Value("")
axial_stress_area=reactive.Value("")

bending_stress_sigma=reactive.Value("")
bending_stress_M=reactive.Value("")
bending_stress_y=reactive.Value("")
bending_stress_I=reactive.Value("")

axial_delta_l=reactive.Value("")
axial_P=reactive.Value("")
axial_L=reactive.Value("")
axial_A=reactive.Value("")
axial_E=reactive.Value("")

thermal_delta_t=reactive.Value("")
thermal_alpha=reactive.Value("")
thermal_Delta_T=reactive.Value("")
thermal_L=reactive.Value("")

```

```

area_tube_A_tube=reactive.Value("")
area_tube_Ar_o=reactive.Value("")
area_tube_Ar_i=reactive.Value("")

I_tube_I_tube=reactive.Value("")
I_tube_Ir_o=reactive.Value("")
i_tube_Ir_i=reactive.Value("")

Compatability1_NumLHS=reactive.Value(1)
Compatability1_NumRHS=reactive.Value(2)
Compatability1_a_1=reactive.Value("")
Compatability1_a_2=reactive.Value("")
Compatability1_a_3=reactive.Value("")
Compatability1_a_4=reactive.Value("")
Compatability1_a_5=reactive.Value("")
Compatability1_b_1=reactive.Value("")
Compatability1_b_2=reactive.Value("")
Compatability1_b_3=reactive.Value("")
Compatability1_b_4=reactive.Value("")
Compatability1_b_5=reactive.Value("")

Compatability2_NumLHS=reactive.Value(1)
Compatability2_NumRHS=reactive.Value(2)
Compatability2_c_1=reactive.Value("")
Compatability2_c_2=reactive.Value("")
Compatability2_c_3=reactive.Value("")
Compatability2_c_4=reactive.Value("")
Compatability2_c_5=reactive.Value("")
Compatability2_d_1=reactive.Value("")
Compatability2_d_2=reactive.Value("")
Compatability2_d_3=reactive.Value("")
Compatability2_d_4=reactive.Value("")
Compatability2_d_5=reactive.Value("")

active_eqn_tab=reactive.Value("Instructions")

app_ui = ui.page_fluid(
  ui.head_content(
    ui.tags.script(
      src="https://mathjax.rstudio.com/latest/MathJax.js?config=TeX-AMS-MML_HTMLorMM
    ),

```

```

        ui.tags.script(
            "if (window.MathJax) MathJax.Hub.Queue(['Typeset', MathJax.Hub]);"
        ),
    ),
    ui.panel_title("Interactive Problem Solving Environment"),
    ui.row(
        ui.markdown("Your Equation Workspace"),
        ui.column(3, ui.output_ui("dyn_eqns"), style='margin-bottom:30 px;border-right:1px solid black'),
        ui.column(9, ui.output_ui("dyn_working_eqns"), ui.output_text("txt")),
    ),
    ui.row(ui.output_ui("ui_equation_bookkeeping")),
    #ui.row(ui.input_action_button(
    #            "solveEquations", "Solve Equations", class_="btn-success", width="240px"
    #        )),
    ui.output_ui("ui_solutions"),
    ui.row(
        ui.column(8, ui.output_ui("dyn_ui_nav")),
        ui.column(4,
            ui.navset_tab_card(
                ui.nav("Equation Bank",
                    ui.input_checkbox_group("selected_eqns", "Choose your equations:", eqns_keys)
                ),
            ),
        ),
    ),
),
)

```

```
def server(input, output, session):
```

```
    @output
```

```
    @render.ui
```

```
    def dyn_eqns():
```

```
        eqns_keys = input.selected_eqns()
```

```
        req(eqns_keys)
```

```
        lookup_eqns = [eqnbank_newline[key] for key in eqns_keys]
```

```
        mystring_eqns = "".join(lookup_eqns)
```

```
        return [
```

```
            ui.markdown(mystring_eqns),
```

```

        ui.tags.script(
            "if (window.MathJax) MathJax.Hub.Queue(['Typeset', MathJax.Hub]);"
        ),
    ]

@output
@render.ui
def dyn_working_eqns():
    eqns_keys = input.selected_eqns()
    req(eqns_keys)
    lookup_eqns = [eqnbank_newline[key] for key in eqns_keys]

# Dynamic Filling of Force equations
if StaticsSumFy.newline_math in lookup_eqns:
    StaticsSumFy_list = ["F_y1", "F_y2", "F_y3", "F_y4", "F_y5"]
    StaticsSumFy_list = StaticsSumFy_list[:input.NumForcesY()]
    StaticsSumFy.working_sym = ",".join(StaticsSumFy_list)
    StaticsSumFy.working_eqn_latex = "$$" + "+" .join(StaticsSumFy_list) + "=0$$"
    StaticsSumFy.working_eqn_solver = "+" .join(StaticsSumFy_list)

    if str(input.F1y()) != "" :
        StaticsSumFy.working_eqn_latex = StaticsSumFy.working_eqn_latex.replace("F_y1",str(input.F1y()))
        StaticsSumFy.working_sym = StaticsSumFy.working_sym.replace("F_y1",str(input.F1y()))
        StaticsSumFy.working_eqn_solver = StaticsSumFy.working_eqn_solver.replace("F_y1",str(input.F1y()))
    else:
        StaticsSumFy.working_eqn_latex = StaticsSumFy.working_eqn_latex.replace("F_y1",str(input.F1y()))

    if str(input.F2y()) != "" :
        StaticsSumFy.working_eqn_latex = StaticsSumFy.working_eqn_latex.replace("F_y2",str(input.F2y()))
        StaticsSumFy.working_sym = StaticsSumFy.working_sym.replace("F_y2",str(input.F2y()))
        StaticsSumFy.working_eqn_solver = StaticsSumFy.working_eqn_solver.replace("F_y2",str(input.F2y()))
    else:
        StaticsSumFy.working_eqn_latex = StaticsSumFy.working_eqn_latex.replace("F_y2",str(input.F2y()))

    if str(input.F3y()) != "" :
        StaticsSumFy.working_eqn_latex = StaticsSumFy.working_eqn_latex.replace("F_y3",str(input.F3y()))
        StaticsSumFy.working_sym = StaticsSumFy.working_sym.replace("F_y3",str(input.F3y()))
        StaticsSumFy.working_eqn_solver = StaticsSumFy.working_eqn_solver.replace("F_y3",str(input.F3y()))
    else:
        StaticsSumFy.working_eqn_latex = StaticsSumFy.working_eqn_latex.replace("F_y3",str(input.F3y()))

```

```

if str(input.F4y()) != "" :
    StaticsSumFy.working_eqn_latex = StaticsSumFy.working_eqn_latex.replace("F
    StaticsSumFy.working_sym = StaticsSumFy.working_sym.replace("F_y4",str(inp
    StaticsSumFy.working_eqn_solver = StaticsSumFy.working_eqn_solver.replace(
else:
    StaticsSumFy.working_eqn_latex = StaticsSumFy.working_eqn_latex.replace("F

if str(input.F5y()) != "" :
    StaticsSumFy.working_eqn_latex = StaticsSumFy.working_eqn_latex.replace("F
    StaticsSumFy.working_sym = StaticsSumFy.working_sym.replace("F_y5",str(inp
    StaticsSumFy.working_eqn_solver = StaticsSumFy.working_eqn_solver.replace(
else:
    StaticsSumFy.working_eqn_latex = StaticsSumFy.working_eqn_latex.replace("F

# Dynamic Filling of Force equations
if StaticsSumFx.newline_math in lookup_eqns:
    StaticsSumFx_list = ["F_x1","F_x2","F_x3","F_x4","F_x5"]
    StaticsSumFx_list = StaticsSumFx_list[:input.NumForcesX()]
    StaticsSumFx.working_sym = ",".join(StaticsSumFx_list)
    StaticsSumFx.working_eqn_latex = "$$" + "+" .join(StaticsSumFx_list) + "=0$$"
    StaticsSumFx.working_eqn_solver = "+" .join(StaticsSumFx_list)

if str(input.F1x()) != "" :
    StaticsSumFx.working_eqn_latex = StaticsSumFx.working_eqn_latex.replace("F
    StaticsSumFx.working_sym = StaticsSumFx.working_sym.replace("F_x1",str(inp
    StaticsSumFx.working_eqn_solver = StaticsSumFx.working_eqn_solver.replace(
else:
    StaticsSumFx.working_eqn_latex = StaticsSumFx.working_eqn_latex.replace("F

if str(input.F2x()) != "" :
    StaticsSumFx.working_eqn_latex = StaticsSumFx.working_eqn_latex.replace("F
    StaticsSumFx.working_sym = StaticsSumFx.working_sym.replace("F_x2",str(inp
    StaticsSumFx.working_eqn_solver = StaticsSumFx.working_eqn_solver.replace(
else:
    StaticsSumFx.working_eqn_latex = StaticsSumFx.working_eqn_latex.replace("F

if str(input.F3x()) != "" :
    StaticsSumFx.working_eqn_latex = StaticsSumFx.working_eqn_latex.replace("F
    StaticsSumFx.working_sym = StaticsSumFx.working_sym.replace("F_x3",str(inp
    StaticsSumFx.working_eqn_solver = StaticsSumFx.working_eqn_solver.replace(
else:

```

```

        StaticsSumFx.working_eqn_latex = StaticsSumFx.working_eqn_latex.replace("F
if str(input.F4x()) != "" :
    StaticsSumFx.working_eqn_latex = StaticsSumFx.working_eqn_latex.replace("F
    StaticsSumFx.working_sym = StaticsSumFx.working_sym.replace("F_x4",str(inp
    StaticsSumFx.working_eqn_solver = StaticsSumFx.working_eqn_solver.replace(
else:
    StaticsSumFx.working_eqn_latex = StaticsSumFx.working_eqn_latex.replace("F

if str(input.F5x()) != "" :
    StaticsSumFx.working_eqn_latex = StaticsSumFx.working_eqn_latex.replace("F
    StaticsSumFx.working_sym = StaticsSumFx.working_sym.replace("F_x5",str(inp
    StaticsSumFx.working_eqn_solver = StaticsSumFx.working_eqn_solver.replace(
else:
    StaticsSumFx.working_eqn_latex = StaticsSumFx.working_eqn_latex.replace("F

# Dynamic Filling of Moment equations
if StaticsSumM.newline_math in lookup_eqns:
    StaticsSumM_list = ["M_1","M_2","M_3","M_4","M_5"]
    StaticsSumM_list = StaticsSumM_list[:input.NumMoments()]
    StaticsSumM.working_sym = ",".join(StaticsSumM_list)
    StaticsSumM.working_eqn_latex = "$$" + "+" .join(StaticsSumM_list) + "=0$$"
    StaticsSumM.working_eqn_solver = "+" .join(StaticsSumM_list)

if str(input.M1()) != "" :
    StaticsSumM.working_eqn_latex = StaticsSumM.working_eqn_latex.replace("M_1
    StaticsSumM.working_sym = StaticsSumM.working_sym.replace("M_1",str(input.
    StaticsSumM.working_eqn_solver = StaticsSumM.working_eqn_solver.replace("M
else:
    StaticsSumM.working_eqn_latex = StaticsSumM.working_eqn_latex.replace("M_1

if str(input.M2()) != "" :
    StaticsSumM.working_eqn_latex = StaticsSumM.working_eqn_latex.replace("M_2
    StaticsSumM.working_sym = StaticsSumM.working_sym.replace("M_2",str(input.
    StaticsSumM.working_eqn_solver = StaticsSumM.working_eqn_solver.replace("M
else:
    StaticsSumM.working_eqn_latex = StaticsSumM.working_eqn_latex.replace("M_2

if str(input.M3()) != "" :
    StaticsSumM.working_eqn_latex = StaticsSumM.working_eqn_latex.replace("M_3

```

```

        StaticsSumM.working_sym = StaticsSumM.working_sym.replace("M_3",str(input.
        StaticsSumM.working_eqn_solver = StaticsSumM.working_eqn_solver.replace("M
else:
        StaticsSumM.working_eqn_latex = StaticsSumM.working_eqn_latex.replace("M_3

if str(input.M4()) != "" :
        StaticsSumM.working_eqn_latex = StaticsSumM.working_eqn_latex.replace("M_4
        StaticsSumM.working_sym = StaticsSumM.working_sym.replace("M_4",str(input.
        StaticsSumM.working_eqn_solver = StaticsSumM.working_eqn_solver.replace("M
else:
        StaticsSumM.working_eqn_latex = StaticsSumM.working_eqn_latex.replace("M_4

if str(input.M5()) != "" :
        StaticsSumM.working_eqn_latex = StaticsSumM.working_eqn_latex.replace("M_5
        StaticsSumM.working_sym = StaticsSumM.working_sym.replace("M_5",str(input.
        StaticsSumM.working_eqn_solver = StaticsSumM.working_eqn_solver.replace("M
else:
        StaticsSumM.working_eqn_latex = StaticsSumM.working_eqn_latex.replace("M_5

# Dynamic Filling of A equations
if AreaTube.newline_math in lookup_eqns:
    AreaTube.working_eqn_latex = AreaTube.newline_math
    AreaTube.working_eqn_solver = "Eq(A_tube,pi*((r_o)**2-(r_i)**2))"
    AreaTube.working_sym = "A_tube,r_o,r_i"

    if str(input.A_tube()) != "" :
        AreaTube.working_eqn_latex = AreaTube.working_eqn_latex.replace("A_{tube}"
        AreaTube.working_sym = AreaTube.working_sym.replace("A_tube",str(input.A_t
        AreaTube.working_eqn_solver = AreaTube.working_eqn_solver.replace("A_tube"
    else:
        AreaTube.working_eqn_latex = AreaTube.working_eqn_latex.replace("A_{tube}"
if str(input.Ar_o()) != "" :
    AreaTube.working_eqn_latex = AreaTube.working_eqn_latex.replace("r_o",str(
    AreaTube.working_sym = AreaTube.working_sym.replace("r_o",str(input.Ar_o(
    AreaTube.working_eqn_solver = AreaTube.working_eqn_solver.replace("r_o",st
else:
    AreaTube.working_eqn_latex = AreaTube.working_eqn_latex.replace("r_o","\b
if str(input.Ar_i()) != "" :
    AreaTube.working_eqn_latex = AreaTube.working_eqn_latex.replace("r_i",str(
    AreaTube.working_sym = AreaTube.working_sym.replace("r_i",str(input.Ar_i(

```

```

        AreaTube.working_eqn_solver = AreaTube.working_eqn_solver.replace("r_i",str(input.I_r_i()))
    else:
        AreaTube.working_eqn_latex = AreaTube.working_eqn_latex.replace("r_i","\\boxed{r_i}")

# Dynamic Filling of I equations
if ITube.newline_math in lookup_eqns:
    ITube.working_eqn_latex = ITube.newline_math
    ITube.working_eqn_solver = "Eq(I_tube,pi/4*((r_o)**4-(r_i)**4))"
    ITube.working_sym = "I_tube,r_o,r_i"
    if str(input.I_tube()) != "" :
        ITube.working_eqn_latex = ITube.working_eqn_latex.replace("I_{tube}",str(input.I_tube()))
        ITube.working_sym = ITube.working_sym.replace("I_tube",str(input.I_tube()))
        ITube.working_eqn_solver = ITube.working_eqn_solver.replace("I_tube",str(input.I_tube()))
    else:
        ITube.working_eqn_latex = ITube.working_eqn_latex.replace("I_{tube}", "\\boxed{I_tube}")
    if str(input.I_r_o()) != "" :
        ITube.working_eqn_latex = ITube.working_eqn_latex.replace("r_o",str(input.I_r_o()))
        ITube.working_sym = ITube.working_sym.replace("r_o",str(input.I_r_o()))
        ITube.working_eqn_solver = ITube.working_eqn_solver.replace("r_o",str(input.I_r_o()))
    else:
        ITube.working_eqn_latex = ITube.working_eqn_latex.replace("r_o","\\boxed{r_o}")
    if str(input.I_r_i()) != "" :
        ITube.working_eqn_latex = ITube.working_eqn_latex.replace("r_i",str(input.I_r_i()))
        ITube.working_sym = ITube.working_sym.replace("r_i",str(input.I_r_i()))
        ITube.working_eqn_solver = ITube.working_eqn_solver.replace("r_i",str(input.I_r_i()))
    else:
        ITube.working_eqn_latex = ITube.working_eqn_latex.replace("r_i","\\boxed{r_i}")

# Dynamic Filling of Stress equation
if StressEqn.newline_math in lookup_eqns:
    StressEqn.working_eqn_latex = StressEqn.newline_math
    StressEqn.working_eqn_solver = "Eq(sigma,(F)/(A))"
    StressEqn.working_sym = "sigma,F,A"
    if str(input.sigma()) != "" :
        StressEqn.working_eqn_latex = StressEqn.working_eqn_latex.replace("\\sigma",str(input.sigma()))
        StressEqn.working_eqn_solver = StressEqn.working_eqn_solver.replace("sigma",str(input.sigma()))
        StressEqn.working_sym = StressEqn.working_sym.replace("sigma",str(input.sigma()))
    else:
        StressEqn.working_eqn_latex = StressEqn.working_eqn_latex.replace("\\sigma","\\boxed{sigma}")
    if str(input.force()) != "" :
        StressEqn.working_eqn_latex = StressEqn.working_eqn_latex.replace("F",str(input.force()))

```



```

        StressEqn.working_eqn_solver = StressEqn.working_eqn_solver.replace("F",str(input.force))
        StressEqn.working_sym = StressEqn.working_sym.replace("F",str(input.force))
    else:
        StressEqn.working_eqn_latex = StressEqn.working_eqn_latex.replace("F","\b")
    if str(input.area()) != "" :
        StressEqn.working_eqn_latex = StressEqn.working_eqn_latex.replace("A",str(input.area()))
        StressEqn.working_eqn_solver = StressEqn.working_eqn_solver.replace("A",str(input.area()))
        StressEqn.working_sym = StressEqn.working_sym.replace("A",str(input.area()))
    else:
        StressEqn.working_eqn_latex = StressEqn.working_eqn_latex.replace("A","\b")

# Dynamic Filling of Bending Stress equation
if BendingStress.newline_math in lookup_eqns:
    BendingStress.working_eqn_latex = BendingStress.newline_math
    BendingStress.working_eqn_solver = "Eq(sigma_b,M*y/I)"
    BendingStress.working_sym = "sigma_b,M,y,I"
    if str(input.bendingstress_sigma_b()) != "" :
        BendingStress.working_eqn_latex = BendingStress.working_eqn_latex.replace("sigma_b",str(input.bendingstress_sigma_b()))
        BendingStress.working_eqn_solver = BendingStress.working_eqn_solver.replace("sigma_b",str(input.bendingstress_sigma_b()))
        BendingStress.working_sym = BendingStress.working_sym.replace("sigma_b",str(input.bendingstress_sigma_b()))
    else:
        BendingStress.working_eqn_latex = BendingStress.working_eqn_latex.replace("sigma_b","\b")
    if str(input.bendingstress_M()) != "" :
        BendingStress.working_eqn_latex = BendingStress.working_eqn_latex.replace("M",str(input.bendingstress_M()))
        BendingStress.working_eqn_solver = BendingStress.working_eqn_solver.replace("M",str(input.bendingstress_M()))
        BendingStress.working_sym = BendingStress.working_sym.replace("M",str(input.bendingstress_M()))
    else:
        BendingStress.working_eqn_latex = BendingStress.working_eqn_latex.replace("M","\b")
    if str(input.bendingstress_y()) != "" :
        BendingStress.working_eqn_latex = BendingStress.working_eqn_latex.replace("y",str(input.bendingstress_y()))
        BendingStress.working_eqn_solver = BendingStress.working_eqn_solver.replace("y",str(input.bendingstress_y()))
        BendingStress.working_sym = BendingStress.working_sym.replace("y",str(input.bendingstress_y()))
    else:
        BendingStress.working_eqn_latex = BendingStress.working_eqn_latex.replace("y","\b")
    if str(input.bendingstress_I()) != "" :
        BendingStress.working_eqn_latex = BendingStress.working_eqn_latex.replace("I",str(input.bendingstress_I()))
        BendingStress.working_eqn_solver = BendingStress.working_eqn_solver.replace("I",str(input.bendingstress_I()))
        BendingStress.working_sym = BendingStress.working_sym.replace("I",str(input.bendingstress_I()))
    else:
        BendingStress.working_eqn_latex = BendingStress.working_eqn_latex.replace("I","\b")

```

```

# Dynamic Filling of Axial Deform equation
if AxialDeform.newline_math in lookup_eqns:
    AxialDeform.working_eqn_latex = AxialDeform.newline_math
    AxialDeform.working_eqn_solver = "Eq(delta_l,P*L/A/E)"
    AxialDeform.working_sym = "delta_l,P,L,A,E"
    if str(input.axial_delta_l()) != "" :
        AxialDeform.working_eqn_latex = AxialDeform.working_eqn_latex.replace("\de
        AxialDeform.working_eqn_solver = AxialDeform.working_eqn_solver.replace("d
        AxialDeform.working_sym = AxialDeform.working_sym.replace("delta_l",str(in
    else:
        AxialDeform.working_eqn_latex = AxialDeform.working_eqn_latex.replace("\de
    if str(input.axial_P()) != "" :
        AxialDeform.working_eqn_latex = AxialDeform.working_eqn_latex.replace("P",
        AxialDeform.working_eqn_solver = AxialDeform.working_eqn_solver.replace("P
        AxialDeform.working_sym = AxialDeform.working_sym.replace("P",str(input.ax
    else:
        AxialDeform.working_eqn_latex = AxialDeform.working_eqn_latex.replace("P",
    if str(input.axial_L()) != "" :
        AxialDeform.working_eqn_latex = AxialDeform.working_eqn_latex.replace("L",
        AxialDeform.working_eqn_solver = AxialDeform.working_eqn_solver.replace("L
        AxialDeform.working_sym = AxialDeform.working_sym.replace("L",str(input.ax
    else:
        AxialDeform.working_eqn_latex = AxialDeform.working_eqn_latex.replace("L",
    if str(input.axial_A()) != "" :
        AxialDeform.working_eqn_latex = AxialDeform.working_eqn_latex.replace("A",
        AxialDeform.working_eqn_solver = AxialDeform.working_eqn_solver.replace("A
        AxialDeform.working_sym = AxialDeform.working_sym.replace("A",str(input.ax
    else:
        AxialDeform.working_eqn_latex = AxialDeform.working_eqn_latex.replace("A",
    if str(input.axial_E()) != "" :
        AxialDeform.working_eqn_latex = AxialDeform.working_eqn_latex.replace("E",
        AxialDeform.working_eqn_solver = AxialDeform.working_eqn_solver.replace("E
        AxialDeform.working_sym = AxialDeform.working_sym.replace("E",str(input.ax
    else:
        AxialDeform.working_eqn_latex = AxialDeform.working_eqn_latex.replace("E",

# Dynamic Filling of Thermal Deform equation
if ThermalDeform.newline_math in lookup_eqns:
    ThermalDeform.working_eqn_latex = ThermalDeform.newline_math
    ThermalDeform.working_eqn_solver = "Eq(delta_t,alpha*Delta_T*L)"

```

```

ThermalDeform.working_sym = "delta_t,Delta_T,alpha,L"
if str(input.thermal_delta_t()) != "" :
    ThermalDeform.working_eqn_latex = ThermalDeform.working_eqn_latex.replace(
    ThermalDeform.working_eqn_solver = ThermalDeform.working_eqn_solver.replac
    ThermalDeform.working_sym = ThermalDeform.working_sym.replace("delta_t",st
else:
    ThermalDeform.working_eqn_latex = ThermalDeform.working_eqn_latex.replace(
if str(input.thermal_alpha()) != "" :
    ThermalDeform.working_eqn_latex = ThermalDeform.working_eqn_latex.replace(
    ThermalDeform.working_eqn_solver = ThermalDeform.working_eqn_solver.replac
    ThermalDeform.working_sym = ThermalDeform.working_sym.replace("alpha",str(
else:
    ThermalDeform.working_eqn_latex = ThermalDeform.working_eqn_latex.replace(
if str(input.thermal_Delta_T()) != "" :
    ThermalDeform.working_eqn_latex = ThermalDeform.working_eqn_latex.replace(
    ThermalDeform.working_eqn_solver = ThermalDeform.working_eqn_solver.replac
    ThermalDeform.working_sym = ThermalDeform.working_sym.replace("Delta_T",st
else:
    ThermalDeform.working_eqn_latex = ThermalDeform.working_eqn_latex.replace(
if str(input.thermal_L()) != "" :
    ThermalDeform.working_eqn_latex = ThermalDeform.working_eqn_latex.replace(
    ThermalDeform.working_eqn_solver = ThermalDeform.working_eqn_solver.replac
    ThermalDeform.working_sym = ThermalDeform.working_sym.replace("L",str(inp
else:
    ThermalDeform.working_eqn_latex = ThermalDeform.working_eqn_latex.replace(

# Dynamic Filling of Compatability equation 1
if Compatability1.newline_math in lookup_eqns:
    Compatability1_list__LHS = ["a_1","a_2","a_3","a_4","a_5"]
    Compatability1_list__RHS = ["b_1","b_2","b_3","b_4","b_5"]
    Compatability1_list_LHS = Compatability1_list__LHS[:input.Compatability1_NumLH
    Compatability1_list_RHS = Compatability1_list__RHS[:input.Compatability1_NumRH
    Compatability1_list = Compatability1_list_LHS + Compatability1_list_RHS
    Compatability1.working_sym = ",".join(Compatability1_list)
    Compatability1.working_eqn_latex = "$$" + "+".join(Compatability1_list_LHS) +
    Compatability1.working_eqn_solver = "Eq("+ "+".join(Compatability1_list_LHS) +

if str(input.a_1()) != "" :
    Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replac
    Compatability1.working_sym = Compatability1.working_sym.replace("a_1",str(

```

```

        Compatability1.working_eqn_solver = Compatability1.working_eqn_solver.replace(
    else:
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(

    if str(input.a_2()) != "" :
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(
        Compatability1.working_sym = Compatability1.working_sym.replace("a_2",str(
        Compatability1.working_eqn_solver = Compatability1.working_eqn_solver.replace(
    else:
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(

    if str(input.a_3()) != "" :
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(
        Compatability1.working_sym = Compatability1.working_sym.replace("a_3",str(
        Compatability1.working_eqn_solver = Compatability1.working_eqn_solver.replace(
    else:
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(

    if str(input.a_4()) != "" :
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(
        Compatability1.working_sym = Compatability1.working_sym.replace("a_4",str(
        Compatability1.working_eqn_solver = Compatability1.working_eqn_solver.replace(
    else:
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(

    if str(input.a_5()) != "" :
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(
        Compatability1.working_sym = Compatability1.working_sym.replace("a_5",str(
        Compatability1.working_eqn_solver = Compatability1.working_eqn_solver.replace(
    else:
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(

    if str(input.b_1()) != "" :
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(
        Compatability1.working_sym = Compatability1.working_sym.replace("b_1",str(
        Compatability1.working_eqn_solver = Compatability1.working_eqn_solver.replace(
    else:
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(

    if str(input.b_2()) != "" :
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replace(

```

```

        Compatability1.working_sym = Compatability1.working_sym.replace("b_2",str(
        Compatability1.working_eqn_solver = Compatability1.working_eqn_solver.repl
    else:
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replac

    if str(input.b_3()) != "" :
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replac
        Compatability1.working_sym = Compatability1.working_sym.replace("b_3",str(
        Compatability1.working_eqn_solver = Compatability1.working_eqn_solver.repl
    else:
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replac

    if str(input.b_4()) != "" :
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replac
        Compatability1.working_sym = Compatability1.working_sym.replace("b_4",str(
        Compatability1.working_eqn_solver = Compatability1.working_eqn_solver.repl
    else:
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replac

    if str(input.b_5()) != "" :
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replac
        Compatability1.working_sym = Compatability1.working_sym.replace("b_5",str(
        Compatability1.working_eqn_solver = Compatability1.working_eqn_solver.repl
    else:
        Compatability1.working_eqn_latex = Compatability1.working_eqn_latex.replac

# Dynamic Filling of Compatability equation 2
if Compatability2.newline_math in lookup_eqns:
    Compatability2_list__LHS = ["c_1","c_2","c_3","c_4","c_5"]
    Compatability2_list__RHS = ["d_1","d_2","d_3","d_4","d_5"]
    Compatability2_list_LHS = Compatability2_list__LHS[:input.Compatability2_NumLH
    Compatability2_list_RHS = Compatability2_list__RHS[:input.Compatability2_NumRH
    Compatability2_list = Compatability2_list_LHS + Compatability2_list_RHS
    Compatability2.working_sym = ",".join(Compatability2_list)
    Compatability2.working_eqn_latex = "$$" + "+".join(Compatability2_list_LHS) +
    Compatability2.working_eqn_solver = "Eq("+ "+".join(Compatability2_list_LHS) +

    if str(input.c_1()) != "" :
        Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac
        Compatability2.working_sym = Compatability2.working_sym.replace("c_1",str(
        Compatability2.working_eqn_solver = Compatability2.working_eqn_solver.repl

```

```

else:
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac

if str(input.c_2()) != "" :
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac
    Compatability2.working_sym = Compatability2.working_sym.replace("c_2",str(
    Compatability2.working_eqn_solver = Compatability2.working_eqn_solver.repl
else:
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac

if str(input.c_3()) != "" :
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac
    Compatability2.working_sym = Compatability2.working_sym.replace("c_3",str(
    Compatability2.working_eqn_solver = Compatability2.working_eqn_solver.repl
else:
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac

if str(input.c_4()) != "" :
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac
    Compatability2.working_sym = Compatability2.working_sym.replace("c_4",str(
    Compatability2.working_eqn_solver = Compatability2.working_eqn_solver.repl
else:
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac

if str(input.c_5()) != "" :
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac
    Compatability2.working_sym = Compatability2.working_sym.replace("c_5",str(
    Compatability2.working_eqn_solver = Compatability2.working_eqn_solver.repl
else:
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac

if str(input.d_1()) != "" :
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac
    Compatability2.working_sym = Compatability2.working_sym.replace("d_1",str(
    Compatability2.working_eqn_solver = Compatability2.working_eqn_solver.repl
else:
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac

if str(input.d_2()) != "" :
    Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac
    Compatability2.working_sym = Compatability2.working_sym.replace("d_2",str(

```

```

        Compatability2.working_eqn_solver = Compatability2.working_eqn_solver.repl
    else:
        Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac

    if str(input.d_3()) != "" :
        Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac
        Compatability2.working_sym = Compatability2.working_sym.replace("d_3",str(
        Compatability2.working_eqn_solver = Compatability2.working_eqn_solver.repl
    else:
        Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac

    if str(input.d_4()) != "" :
        Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac
        Compatability2.working_sym = Compatability2.working_sym.replace("d_4",str(
        Compatability2.working_eqn_solver = Compatability2.working_eqn_solver.repl
    else:
        Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac

    if str(input.d_5()) != "" :
        Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac
        Compatability2.working_sym = Compatability2.working_sym.replace("d_5",str(
        Compatability2.working_eqn_solver = Compatability2.working_eqn_solver.repl
    else:
        Compatability2.working_eqn_latex = Compatability2.working_eqn_latex.replac

```

```

eqnbank_working_latex = {
StaticsSumFx.name: StaticsSumFx.working_eqn_latex,
StaticsSumFy.name: StaticsSumFy.working_eqn_latex,
StaticsSumM.name: StaticsSumM.working_eqn_latex,
StressEqn.name: StressEqn.working_eqn_latex,
BendingStress.name: BendingStress.working_eqn_latex,
AxialDeform.name: AxialDeform.working_eqn_latex,
ThermalDeform.name: ThermalDeform.working_eqn_latex,
AreaTube.name: AreaTube.working_eqn_latex,
ITube.name: ITube.working_eqn_latex,
Compatability1.name: Compatability1.working_eqn_latex,
Compatability2.name: Compatability2.working_eqn_latex
}

```

```

eqnbank_working_solver = {

```

```

StaticsSumFx.name: StaticsSumFx.working_eqn_solver,
StaticsSumFy.name: StaticsSumFy.working_eqn_solver,
StaticsSumM.name: StaticsSumM.working_eqn_solver,
StressEqn.name: StressEqn.working_eqn_solver,
BendingStress.name: BendingStress.working_eqn_solver,
AxialDeform.name: AxialDeform.working_eqn_solver,
ThermalDeform.name: ThermalDeform.working_eqn_solver,
AreaTube.name: AreaTube.working_eqn_solver,
ITube.name: ITube.working_eqn_solver,
Compatability1.name: Compatability1.working_eqn_solver,
Compatability2.name: Compatability2.working_eqn_solver
}

```

```

symbank_working = {
StaticsSumFx.name: StaticsSumFx.working_sym,
StaticsSumFy.name: StaticsSumFy.working_sym,
StaticsSumM.name: StaticsSumM.working_sym,
StressEqn.name: StressEqn.working_sym,
BendingStress.name: BendingStress.working_sym,
AxialDeform.name: AxialDeform.working_sym,
ThermalDeform.name: ThermalDeform.working_sym,
AreaTube.name: AreaTube.working_sym,
ITube.name: ITube.working_sym,
Compatability1.name: Compatability1.working_sym,
Compatability2.name: Compatability2.working_sym
}

```

```

working_eqns_latex = [eqnbank_working_latex[key] for key in eqns_keys]
working_eqns_solver = [eqnbank_working_solver[key] for key in eqns_keys]

```

```

temp_working_equations_solver = "#".join(working_eqns_solver)
temp_working_equations_solver = temp_working_equations_solver.replace("Eq", "Wrap_c
temp_working_equations_solver = temp_working_equations_solver.replace("E", "E_clash
temp_working_equations_solver = temp_working_equations_solver.replace("I", "I_clash
temp_working_equations_solver = temp_working_equations_solver.replace("Wrap_clash"
working_eqns_solver = temp_working_equations_solver.split("#")

```

```

#working_eqns_solver=[]
#for j in working_eqns_solver_pre:
#    temp=j.split(",")
#    temp2=temp.replace("I", "I_clash")

```



```

#     temp3=temp2.replace("E","E_clash")
#     working_eqns_solver.append(temp3)

working_syms = [symbank_working[key] for key in eqns_keys]
mystring_working_eqns = "".join(working_eqns_latex)
mystring_working_eqns = mystring_working_eqns.replace("*","\\times")
working_equations_solver.set(working_eqns_solver)

working_syms_only=[]
for j in working_syms:
    temp=j.split(",")
    for k in temp:
        try:
            float(eval(k))
        except:
            temp2=k.replace("I","I_clash")
            temp3=temp2.replace("E","E_clash")
            working_syms_only.append(temp3)
working_syms_only=list(dict.fromkeys(working_syms_only))
working_symbols.set(working_syms_only)

return [
    ui.markdown(mystring_working_eqns),
    ui.tags.script(
        "if (window.MathJax) MathJax.Hub.Queue(['Typeset', MathJax.Hub]);"
    )
]

```

@output

@render.ui

def dyn\_ui\_nav():

```

    tab_Instructions = ui.nav(
        "Instructions",ui.markdown("Please choose the equations you would like to use
    )

    tab_StaticsSumFy = ui.nav(
        str(StaticsSumFy.inline_math),
        ui.input_numeric("NumForcesY","How many terms do you want?",value=NumForce
        ui.input_text("F1y","\\(F_{y_1}=\\)", value=F1y(),placeholder="Please type i
        ui.input_text("F2y","\\(F_{y_2}=\\)", value=F2y(),placeholder="Please type i

```

```

        ui.panel_conditional("input.NumForcesY>=3", ui.input_text("F3y","\(F_{y_3}
        ui.panel_conditional("input.NumForcesY>=4", ui.input_text("F4y","\(F_{y_4}
        ui.panel_conditional("input.NumForcesY>=5", ui.input_text("F5y","\(F_{y_5}
    )

    tab_StaticsSumFx = ui.nav(
        str(StaticsSumFx.inline_math),
        ui.input_numeric("NumForcesX","How many terms do you want?",value=NumForce
        ui.input_text("F1x","\(F_{x_1}=\)", value=F1x(),placeholder="Please type i
        ui.input_text("F2x","\(F_{x_2}=\)", value=F2x(),placeholder="Please type i
        ui.panel_conditional("input.NumForcesX>=3", ui.input_text("F3x","\(F_{x_3}
        ui.panel_conditional("input.NumForcesX>=4", ui.input_text("F4x","\(F_{x_4}
        ui.panel_conditional("input.NumForcesX>=5", ui.input_text("F5x","\(F_{x_5}
    )

    tab_StaticsSumM = ui.nav(
        str(StaticsSumM.inline_math),
        ui.input_numeric("NumMoments","How many terms do you want?",value=NumMomen
        ui.input_text("M1","\(M_1=\)", value=M1(),placeholder="Please type in vari
        ui.input_text("M2","\(M_2=\)", value=M2(),placeholder="Please type in vari
        ui.panel_conditional("input.NumMoments>=3", ui.input_text("M3","\(M_3=\)",
        ui.panel_conditional("input.NumMoments>=4", ui.input_text("M4","\(M_4=\)",
        ui.panel_conditional("input.NumMoments>=5", ui.input_text("M5","\(M_5=\)",
    )

    tab_StressEqn = ui.nav(
        str(StressEqn.inline_math),
        ui.input_text("sigma","\(\sigma\)", value=axial_stress_sigma(),placeholder
        ui.input_text("force","\(F\)", value=axial_stress_force(),placeholder="Ple
        ui.input_text("area","\(A\)", value=axial_stress_area(),placeholder="Pleas
    )

    tab_BendingStress = ui.nav(
        str(BendingStress.inline_math),
        ui.input_text("bendingstress_sigma_b","\(\sigma_b\)", value=bending_stress
        ui.input_text("bendingstress_M","\(M\)", value=bending_stress_M(), placeho
        ui.input_text("bendingstress_y","\(y\)", value=bending_stress_y(), placeho
        ui.input_text("bendingstress_I","\(I\)", value= bending_stress_I(), placeh
    )

    tab_AxialDeform = ui.nav(

```

```

str(AxialDeform.inline_math),
ui.input_text("axial_delta_l", "\\(\\delta_l\\)", value=axial_delta_l(), placeholder="Please type")
ui.input_text("axial_P", "\\(P\\)", value=axial_P(), placeholder="Please type")
ui.input_text("axial_L", "\\(L\\)", value=axial_L(), placeholder="Please type")
ui.input_text("axial_A", "\\(A\\)", value=axial_A(), placeholder="Please type")
ui.input_text("axial_E", "\\(E\\)", value=axial_E(), placeholder="Please type")
)

tab_ThermalDeform = ui.nav(
    str(ThermalDeform.inline_math),
    ui.input_text("thermal_delta_t", "\\(\\delta_t\\)", value=thermal_delta_t(), placeholder="Please type"),
    ui.input_text("thermal_alpha", "\\(\\alpha\\)", value=thermal_alpha(), placeholder="Please type"),
    ui.input_text("thermal_Delta_T", "\\(\\Delta T\\)", value=thermal_Delta_T(), placeholder="Please type"),
    ui.input_text("thermal_L", "\\(L\\)", value=thermal_L(), placeholder="Please type")
)

tab_AreaTube = ui.nav(
    str(AreaTube.inline_math),
    ui.input_text("A_tube", "\\(A_{tube}=\\)", value=area_tube_A_tube(), placeholder="Please type"),
    ui.input_text("Ar_o", "\\(r_o=\\)", value=area_tube_Ar_o(), placeholder="Please type"),
    ui.input_text("Ar_i", "\\(r_i\\)", value=area_tube_Ar_i(), placeholder="Please type")
)

tab_ITube = ui.nav(
    str(ITube.inline_math),
    ui.input_text("I_tube", "\\(I_{tube}=\\)", value=I_tube_I_tube(), placeholder="Please type"),
    ui.input_text("Ir_o", "\\(r_o=\\)", value=I_tube_Ir_o(), placeholder="Please type"),
    ui.input_text("Ir_i", "\\(r_i\\)", value=i_tube_Ir_i(), placeholder="Please type")
)

tab_Compatibility1 = ui.nav(
    str(Compatability1.inline_math),
    ui.input_numeric("Compatability1_NumLHS", "How many 'a' terms do you want?", value=Compatability1_NumLHS(), placeholder="Please type"),
    ui.input_numeric("Compatability1_NumRHS", "How many 'b' terms do you want?", value=Compatability1_NumRHS(), placeholder="Please type"),
    ui.input_text("a_1", "\\(a_1=\\)", value=Compatability1_a_1(), placeholder="Please type"),
    ui.panel_conditional("input.Compatability1_NumLHS>=2", ui.input_text("a_2", "\\(a_2=\\)", value=Compatability1_a_2(), placeholder="Please type")),
    ui.panel_conditional("input.Compatability1_NumLHS>=3", ui.input_text("a_3", "\\(a_3=\\)", value=Compatability1_a_3(), placeholder="Please type")),
    ui.panel_conditional("input.Compatability1_NumLHS>=4", ui.input_text("a_4", "\\(a_4=\\)", value=Compatability1_a_4(), placeholder="Please type")),
    ui.panel_conditional("input.Compatability1_NumLHS>=5", ui.input_text("a_5", "\\(a_5=\\)", value=Compatability1_a_5(), placeholder="Please type")),
    ui.input_text("b_1", "\\(b_1=\\)", value=Compatability1_b_1(), placeholder="Please type"),
    ui.panel_conditional("input.Compatability1_NumRHS>=2", ui.input_text("b_2", "\\(b_2=\\)", value=Compatability1_b_2(), placeholder="Please type")),
    ui.panel_conditional("input.Compatability1_NumRHS>=3", ui.input_text("b_3", "\\(b_3=\\)", value=Compatability1_b_3(), placeholder="Please type")),
    ui.panel_conditional("input.Compatability1_NumRHS>=4", ui.input_text("b_4", "\\(b_4=\\)", value=Compatability1_b_4(), placeholder="Please type")),
    ui.panel_conditional("input.Compatability1_NumRHS>=5", ui.input_text("b_5", "\\(b_5=\\)", value=Compatability1_b_5(), placeholder="Please type"))
)

```

```

        ui.panel_conditional("input.Compatability1_NumRHS>=3",ui.input_text("b_3",
        ui.panel_conditional("input.Compatability1_NumRHS>=4",ui.input_text("b_4",
        ui.panel_conditional("input.Compatability1_NumRHS>=5",ui.input_text("b_5",
        )

tab_Compatability2 = ui.nav(
    str(Compatability2.inline_math),
    ui.input_numeric("Compatability2_NumLHS","How many 'c' terms do you want?",
    ui.input_numeric("Compatability2_NumRHS","How many 'd' terms do you want?",
    ui.input_text("c_1","\ (c_1=\)", value=Compatability2_c_1(),placeholder="Pl
    ui.panel_conditional("input.Compatability2_NumLHS>=2",ui.input_text("c_2",
    ui.panel_conditional("input.Compatability2_NumLHS>=3", ui.input_text("c_3",
    ui.panel_conditional("input.Compatability2_NumLHS>=4", ui.input_text("c_4",
    ui.panel_conditional("input.Compatability2_NumLHS>=5", ui.input_text("c_5",
    ui.input_text("d_1","\ (d_1=\)", value=Compatability2_d_1(),placeholder="Pl
    ui.panel_conditional("input.Compatability2_NumRHS>=2",ui.input_text("d_2",
    ui.panel_conditional("input.Compatability2_NumRHS>=3",ui.input_text("d_3",
    ui.panel_conditional("input.Compatability2_NumRHS>=4",ui.input_text("d_4",
    ui.panel_conditional("input.Compatability2_NumRHS>=5",ui.input_text("d_5",
    )

tab_bank = {
    StaticsSumFx.name: tab_StaticsSumFx,
    StaticsSumFy.name: tab_StaticsSumFy,
    StaticsSumM.name: tab_StaticsSumM,
    StressEqn.name: tab_StressEqn,
    BendingStress.name: tab_BendingStress,
    AxialDeform.name: tab_AxialDeform,
    ThermalDeform.name: tab_ThermalDeform,
    AreaTube.name: tab_AreaTube,
    ITube.name: tab_ITube,
    Compatability1.name: tab_Compatability1,
    Compatability2.name: tab_Compatability2,
}

eqns_keys = input.selected_eqns()
tabs = [tab_bank[key] for key in eqns_keys]
tabs.insert(0,tab_Instructions)
equations = ui.navset_tab_card(*tabs,id="mytab",selected=active_eqn_tab())

return [equations,
        ui.tags.script(

```

```

        "if (window.MathJax) MathJax.Hub.Queue(['Typeset', MathJax.Hub]);"
    ),]

@output
@render.ui
def ui_equation_bookkeeping():
    req(working_equations_solver())
    num_working_equations=len(working_equations_solver())
    num_working_symbols=len(working_symbols())
    string_working_symbols= "\\\\"+"+"\\\\"),\\\\"(" .join(working_symbols())+"\\\\" "
    string_working_symbols=string_working_symbols.replace("I_clash","I")
    string_working_symbols=string_working_symbols.replace("E_clash","E")
    string_working_symbols=string_working_symbols.replace("delta","\delta")
    string_working_symbols=string_working_symbols.replace("Delta","\Delta")
    string_working_symbols=string_working_symbols.replace("sigma","\sigma")
    return [ui.markdown(f"Your equation-solver set up currently has **{num_working_equations} equations and {num_working_symbols} symbols")
            ui.input_action_button(
                "solveEquations", "Solve Equations", class_="btn-success", width="240px")
            ui.tags.script(
                "if (window.MathJax) MathJax.Hub.Queue(['Typeset', MathJax.Hub]);"
            )]

@output
@render.ui
@reactive.event(input.solveEquations)
def ui_solutions():
    for j in working_symbols():
        j=Symbol(j)
    print(working_equations_solver())
    print(working_symbols())
    my_solver_equations=[]
    for m in working_equations_solver():
        m=parse_expr(m)
    solve_eqns = solve(working_equations_solver(),working_symbols(),dict=True)
    answers=[]
    for k in working_symbols():
        try:
            temp=solve_eqns[0][parse_expr(k)]
            temp2="$$"+k+"="+str(temp)+"$$"
            answers.append(temp2)
        except:

```

```

        pass
    mystring_answers="".join(answers)
    mystring_answers=mystring_answers.replace("pi","\pi")
    mystring_answers=mystring_answers.replace("delta","\delta")
    mystring_answers=mystring_answers.replace("Delta","\Delta")
    mystring_answers=mystring_answers.replace("sigma","\sigma")
    mystring_answers=mystring_answers.replace("E_clash","E")
    mystring_answers=mystring_answers.replace("I_clash","I")
    return [ui.markdown(f"Your solution is {mystring_answers}"),
            ui.tags.script(
                "if (window.MathJax) MathJax.Hub.Queue(['Typeset', MathJax.Hub]);"
            )]

#@reactive.Effect
#def _():

#    active_eqn_tab.set(input.mytab())

@reactive.Effect
def _():

    input.selected_eqns()
    active_eqn_tab.set(input.mytab())

    with reactive.isolate():
        if "Equilibrium Forces in Y" in input.selected_eqns():
            NumForcesY.set(input.NumForcesY())
            F1y.set(input.F1y())
            F2y.set(input.F2y())
            F3y.set(input.F3y())
            F4y.set(input.F4y())
            F5y.set(input.F5y())
        else:
            pass

        if "Equilibrium Forces in X" in input.selected_eqns():
            NumForcesX.set(input.NumForcesX())
            F1x.set(input.F1x())
            F2x.set(input.F2x())
            F3x.set(input.F3x())
            F4x.set(input.F4x())
            F5x.set(input.F5x())

```

```

else:
    pass

if "Equilibrium Moments about O" in input.selected_eqns():
    NumMoments.set(input.NumMoments())
    M1.set(input.M1())
    M2.set(input.M2())
    M3.set(input.M3())
    M4.set(input.M4())
    M5.set(input.M5())
else:
    pass

if "Stress Equation" in input.selected_eqns():
    axial_stress_sigma.set(input.sigma())
    axial_stress_force.set(input.force())
    axial_stress_area.set(input.area())
else:
    pass

if "Axial Deformation by Force" in input.selected_eqns():
    axial_delta_l.set(input.axial_delta_l())
    axial_P.set(input.axial_P())
    axial_L.set(input.axial_L())
    axial_A.set(input.axial_A())
    axial_E.set(input.axial_E())
else:
    pass

if "Axial Deformation by Thermal" in input.selected_eqns():
    thermal_delta_t.set(input.thermal_delta_t())
    thermal_alpha.set(input.thermal_alpha())
    thermal_Delta_T.set(input.thermal_Delta_T())
    thermal_L.set(input.thermal_L())
else:
    pass

if "Area of a Tube" in input.selected_eqns():
    area_tube_A_tube.set(input.A_tube())
    area_tube_Ar_o.set(input.Ar_o())
    area_tube_Ar_i.set(input.Ar_i())
else:

```

```

        pass

    if "Moment of Inertia of a Tube" in input.selected_eqns():
        I_tube_I_tube.set(input.I_tube())
        I_tube_Ir_o.set(input.Ir_o())
        i_tube_Ir_i.set(input.Ir_i())
    else:
        pass

    if "Bending Stress from a Moment" in input.selected_eqns():
        bending_stress_sigma.set(input.bendingstress_sigma_b())
        bending_stress_M.set(input.bendingstress_M())
        bending_stress_y.set(input.bendingstress_y())
        bending_stress_I.set(input.bendingstress_I())
    else:
        pass

    if "Compatability Equation 1" in input.selected_eqns():
        Compatability1_NumLHS.set(input.Compatability1_NumLHS())
        Compatability1_NumRHS.set(input.Compatability1_NumRHS())
        Compatability1_a_1.set(input.a_1())
        Compatability1_a_2.set(input.a_2())
        Compatability1_a_3.set(input.a_3())
        Compatability1_a_4.set(input.a_4())
        Compatability1_a_5.set(input.a_5())
        Compatability1_b_1.set(input.b_1())
        Compatability1_b_2.set(input.b_2())
        Compatability1_b_3.set(input.b_3())
        Compatability1_b_4.set(input.b_4())
        Compatability1_b_5.set(input.b_5())
    else:
        pass

    if "Compatability Equation 2" in input.selected_eqns():
        Compatability2_NumLHS.set(input.Compatability2_NumLHS())
        Compatability2_NumRHS.set(input.Compatability2_NumRHS())
        Compatability2_c_1.set(input.c_1())
        Compatability2_c_2.set(input.c_2())
        Compatability2_c_3.set(input.c_3())
        Compatability2_c_4.set(input.c_4())
        Compatability2_c_5.set(input.c_5())
        Compatability2_d_1.set(input.d_1())

```



```
        Compatability2_d_2.set(input.d_2())
        Compatability2_d_3.set(input.d_3())
        Compatability2_d_4.set(input.d_4())
        Compatability2_d_5.set(input.d_5())
    else:
        pass

app = App(app_ui, server)
```

## 2 Workout Example Solution

### 2.1 Worked Out Solution

This demonstrates a worked out solution to the problem. The best way to begin is by drawing a free body diagram.



Figure 2.1: Figure 3: Three traffic light installation with loads

Use equilibrium equations to find the internal loads:

$$\begin{aligned}\Sigma F_y = 0 : N - 65 - 50 - 50 &= 0 \\ N &= 165 \text{ lbs}\end{aligned}$$

$$\begin{aligned}\Sigma M_O = 0 : -M + (50 \times 7) + (50 \times 11) + (65 \times 15) &= 0 \\ M &= 1875 \text{ lb} \cdot \text{ft} = 22500 \text{ lb} \cdot \text{in}\end{aligned}$$

Now, determine the cross-sectional properties:

$$A = \pi(r_o^2 - r_i^2) = \pi(2.5^2 - 2.3^2) = 3.02 \text{ in}^2 \quad I = \frac{\pi}{4}(r_o^4 - r_i^4) = \frac{\pi}{4}(2.5^4 - 2.3^4) = 8.70 \text{ in}^4$$

Calculate stress due to normal force:

$$\sigma_n = \frac{F}{A} = \frac{-165 \text{ } lbs}{3.02 \text{ } in^2} = -54.7 \text{ } psi$$

Calculate maximum stress due to bending moment (will have same magnitude in both tension and compression):

$$\sigma_m = \pm \frac{M_c}{I} = \pm \frac{22500 \times 2.5}{8.70} = \pm 6460 \text{ } psi$$

Determine combined tensile stress:  $\sigma_T = -54.7 + 6460 = 6410 \text{ } psi$

Determine combined compressive stress:  $\sigma_T = -54.7 - 6460 = -6520 \text{ } psi$

## 3 Summary

In summary, this book has no content whatsoever.

`1 + 1`

[1] 2

## References