FRONT end

```
import Link from "next/link";
import Header from "../components/Header";
import Footer from "../components/Footer";


export default function HomePage() {
  return (
    <main className="bg-gray-50 min-h-screen flex flex-col">
      <Header />


      {/* Landing Page*/}
      <section className="flex flex-col items-center text-center py-12
bg-gray-50 flex-grow">
        <h1 className="text-[20px] md:text-[80px] font-bold mb-2
text-black">
          Stati
          <span className="text-[#1848a0]">
            Calcs
          </span>
        </h1>
        <p className="text-gray-600 mb-12 text-[18px]">
          Interactive calculators for learning and solving Statics of
Rigid Bodies.
        </p>


        {/* Chapter List */}
        <div className="w-full max-w-2xl">
          <div className="grid grid-cols-2 gap-4 items-center">
```

```
            {/* Chapter 1 */}
            <p className="text-left text-black text-[18px] font-bold 
font-bold">Chapter 1: Introduction to Statics</p>
            <Link
              href="/Introduction"
              className="bg-[#1848a0] text-white px-6 py-3 rounded-md 
shadow hover:bg-[#163d8a] transition text-[18px]"
            >
              Introduction
            </Link>


            {/* Chapter 2 */}
            <p className="text-left text-black text-[18px] font-bold 
font-bold">Chapter 2: Force Systems</p>
            <Link
              href="/2D-solver"
              className="bg-[#1848a0] text-white px-6 py-3 rounded-md 
shadow hover:bg-[#163d8a] transition text-[18px]"
            >
              2D Resultant Solver
            </Link>


            {/* Chapter 3 */}
            <p className="text-left text-black text-[18px] font-bold 
font-bold">Chapter 3: Equilibrium</p>
            <Link
              href="/Equilibrium"
              className="bg-[#1848a0] text-white px-6 py-3 rounded-md 
shadow hover:bg-[#163d8a] transition text-[18px]"
            >
              Equilibrium Solver
            </Link>


            {/* Chapter 4 */}
            <p className="text-left text-black text-[18px] font-bold 
font-bold font-bold">Chapter 4: Structures</p>
            <Link
              href="/Structures"
              className="bg-[#1848a0] text-white px-6 py-3 rounded-md 
shadow hover:bg-[#163d8a] transition text-[18px]"
            >
```

```
              Truss Calculator
            </Link>


            {/* Chapter 5 */}
            <p className="text-left text-black text-[18px] font-bold
font-bold font-bold">Chapter 5: Distributed Loads</p>
            <Link
              href="/Distributed-Loads"
              className="bg-[#1848a0] text-white px-6 py-3 rounded-md
shadow hover:bg-[#163d8a] transition text-[18px]"
            >
              Structures Solver
            </Link>


            {/* Chapter 6 */}
            <p className="text-left text-black text-[18px] font-bold
font-bold font-bold">Chapter 6: Friction</p>
            <button className="border-2 border-[#1848a0] text-[#1848a0]
px-6 py-3 rounded-md hover:bg-[#163d8a] hover:text-white transition
text-[18px]">
              Coming Soon
            </button>


            {/* Chapter 7 */}
            <p className="text-left text-black text-[18px] font-bold
font-bold font-bold">Chapter 7: Virtual Work</p>
            <button className="border-2 border-[#1848a0] text-[#1848a0]
px-6 py-3 rounded-md hover:bg-[#163d8a] hover:text-white transition
text-[18px]">
              Coming Soon
            </button>


          </div>
        </div>
      </section>


      <Footer />
    </main>
  );
}
```

2D solver code

```
"use client";


import { useRef, useState } from "react";
import Header from "../../components/Header";
import Footer from "../../components/Footer";
import "katex/dist/katex.min.css";
import { BlockMath } from "react-katex";


/* Force System Logic */
class ForceSystem2D {
  vectors: { fx: number; fy: number; magnitude: number; angleDeg: number
}[];


  constructor() {
    this.vectors = [];
  }


  addForce(magnitude: number, angleDeg: number) {
    const angleRad = (angleDeg * Math.PI) / 180;
    const fx = magnitude * Math.cos(angleRad);
    const fy = magnitude * Math.sin(angleRad);
    this.vectors.push({ fx, fy, magnitude, angleDeg });
  }


  stepByStepSolution() {
    const steps: string[] = [];
    steps.push("Step 1: Resolve each force into components:");
    let sumFx = 0;
    let sumFy = 0;


    this.vectors.forEach((v, i) => {
      steps.push(
        `\\text{Force ${i + 1}: } |F|=${v.magnitude}\\,\\text{kN},\\;
\\theta=${v.angleDeg}^\\circ`
      );


      steps.push(`
        \\begin{align*}
        F_{x${i + 1}} &= ${v.magnitude}\\cos(${v.angleDeg}^\\circ) \\\\
                      &= ${v.fx.toFixed(3)}\\,\\text{kN} \\\\
        F_{y${i + 1}} &= ${v.magnitude}\\sin(${v.angleDeg}^\\circ) \\\\
                      &= ${v.fy.toFixed(3)}\\,\\text{kN}
        \\end{align*}
      `);


      sumFx += v.fx;
      sumFy += v.fy;
    });


    steps.push("Step 2: Sum of components:");
    steps.push(`
      \\begin{align*}
      \\Sigma F_x &= ${sumFx.toFixed(3)}\\,\\text{kN} \\\\
      \\Sigma F_y &= ${sumFy.toFixed(3)}\\,\\text{kN}
      \\end{align*}
    `);


    const R = Math.hypot(sumFx, sumFy);
    const theta = (Math.atan2(sumFy, sumFx) * 180) / Math.PI;


    const arrow = theta >= 0 ? "↺" : "↻";


    steps.push("Step 3: Resultant force:");
    steps.push(`
      \\begin{align*}
      R &= \\sqrt{(\\Sigma F_x)^2 + (\\Sigma F_y)^2} \\\\
        &= ${R.toFixed(3)}\\,\\text{kN} \\\\
      \\theta &= \\tan^{-1}\\left(\\tfrac{\\Sigma F_y}{\\Sigma
F_x}\\right) \\\\
              &= ${theta.toFixed(2)}^\\circ ${arrow}\\,\\text{from +x
axis}
      \\end{align*}
    `);


    return { steps, sumFx, sumFy, R, theta };
  }
}


type ForceInput = {
  magnitude: string;
  angle: string;
};


type ForceResult = {
  steps: string[];
  sumFx: number;
  sumFy: number;
  R: number;
  theta: number;
};


/*FULL FBD FOR STEP 4 (all forces + resultant)*/
function ResultantFBD({
  forces,
  result,
}: {
  forces: ForceInput[];
  result: ForceResult;
}) {
  const vectors = forces
    .map((f) => {
      const m = parseFloat(f.magnitude);
      const a = parseFloat(f.angle);
      if (isNaN(m) || isNaN(a)) return null;
      const rad = (a * Math.PI) / 180;
      return { x: m * Math.cos(rad), y: m * Math.sin(rad) };
    })
    .filter(Boolean) as { x: number; y: number }[];


  const R = { x: result.sumFx, y: result.sumFy };


  const magnitudes = [
    ...vectors.map((v) => Math.hypot(v.x, v.y)),
    Math.hypot(R.x, R.y),
  ];
  const maxMag = Math.max(1, ...magnitudes);


  const scale = 90 / maxMag;


  return (
    <svg
      width="300"
      height="300"
      className="border rounded-lg bg-white shadow mx-auto"
    >
      <g transform="translate(150,150)">
        {/* Axes */}
        <line x1={-140} y1={0} x2={140} y2={0} stroke="gray"
strokeWidth="1" />
        <line x1={0} y1={-140} x2={0} y2={140} stroke="gray"
strokeWidth="1" />


        {/* Draw each force */}
        {vectors.map((v, i) => {
          const x = v.x * scale;
          const y = -v.y * scale;


          return (
            <g key={i}>
              <line
                x1={0}
                y1={0}
                x2={x}
                y2={y}
                stroke="#1848a0"
                strokeWidth="3"
                markerEnd="url(#arrowF)"
              />
              <text
                x={x * 0.55}
                y={y * 0.55}
                fontSize="14"
                fill="#1848a0"
                fontWeight="bold"
              >
                F{i + 1}
              </text>
            </g>
          );
        })}


        {/* Draw resultant */}
        <line
          x1={0}
          y1={0}
          x2={R.x * scale}
          y2={-R.y * scale}
          stroke="#009900"
          strokeWidth="4"
          markerEnd="url(#arrowR)"
        />
        <text
          x={(R.x * scale) * 0.55}
          y={(-R.y * scale) * 0.55}
          fontSize="16"
          fill="#009900"
          fontWeight="bold"
        >
          R
        </text>


        {/* Arrow definitions */}
        <defs>
          <marker
            id="arrowF"
            markerWidth="10"
            markerHeight="10"
            refX="5"
            refY="3"
            orient="auto"
          >
            <polygon points="0 0, 6 3, 0 6" fill="#1848a0" />
          </marker>
```

```
          <marker
            id="arrowR"
            markerWidth="12"
            markerHeight="12"
            refX="6"
            refY="3"
            orient="auto"
          >
            <polygon points="0 0, 7 3, 0 6" fill="#009900" />
          </marker>
        </defs>
      </g>
    </svg>
  );
}


/*SVG FBD Component (draggable + resultant)*/
function FBD({ forces, setForces }: { forces: ForceInput[]; setForces: (f:
ForceInput[]) => void }) {
  const svgRef = useRef<SVGSVGElement | null>(null);
  const [dragIndex, setDragIndex] = useState<number | null>(null);


  // Convert forces to vectors (math coords; y positive up)
  const vectors = forces
    .map((f) => {
      const m = parseFloat(f.magnitude);
      const a = parseFloat(f.angle);
      if (isNaN(m) || isNaN(a)) return null;
      const rad = (a * Math.PI) / 180;
      return {
        x: m * Math.cos(rad),
        y: m * Math.sin(rad),
      };
    })
    .filter(Boolean) as { x: number; y: number }[];


  // Determine scale so arrows fit nicely
  const maxMag = Math.max(1, ...vectors.map((v) => Math.hypot(v.x, v.y)));
  const scale = 80 / maxMag; // dynamic scale


  const screenPointToSvg = (clientX: number, clientY: number) => {
```

```
  const svg = svgRef.current;
  if (!svg) return null;
  const pt = svg.createSVGPoint();
  pt.x = clientX;
  pt.y = clientY;
  const ctm = svg.getScreenCTM();
  if (!ctm) return null;
  return pt.matrixTransform(ctm.inverse());
};


const handleMouseMove = (e: React.MouseEvent) => {
  if (dragIndex === null) return;


  const svg = svgRef.current;
  if (!svg) return;


  const pt = svg.createSVGPoint();
  pt.x = e.clientX;
  pt.y = e.clientY;


  // convert cursor to SVG coordinates
  const cursor = pt.matrixTransform(svg.getScreenCTM()?.inverse());
  const x = cursor.x - 150;
  const y = cursor.y - 150;




  const newAngle = (Math.atan2(-y, x) * 180) / Math.PI;


  const newForces = [...forces];


  newForces[dragIndex] = {
    ...newForces[dragIndex],
    angle: newAngle.toFixed(3),  // Only angle changes
  };


  setForces(newForces);
};
```

```
  const stopDrag = () => setDragIndex(null);


  // compute resultant in math coords
  const sum = vectors.reduce((acc, v) => ({ x: acc.x + v.x, y: acc.y + v.y
}), { x: 0, y: 0 });
  const Rx = sum.x * scale;
  const Ry = -sum.y * scale; // svg y inverted


  return (
    <svg
      ref={svgRef}
      width="300"
      height="300"
      className="border rounded-lg bg-white shadow"
      style={{ background: "white" }}
      onMouseMove={handleMouseMove}
      onMouseUp={stopDrag}
      onMouseLeave={stopDrag}
    >
      <g transform="translate(150,150)">
        {/* Axes */}
        <line x1={-140} y1={0} x2={140} y2={0} stroke="gray"
strokeWidth="1" />
        <line x1={0} y1={-140} x2={0} y2={140} stroke="gray"
strokeWidth="1" />


        {/* Force vectors */}
        {vectors.map((v, i) => {
          const x = v.x * scale;
          const y = -v.y * scale; // invert for svg
          return (
            <g key={i}>
              <line
                x1={0}
                y1={0}
                x2={x}
                y2={y}
                stroke="#1848a0"
                strokeWidth="3"
                markerEnd="url(#arrow)"
                className="cursor-pointer"
                onMouseDown={() => setDragIndex(i)}
              />
              <text x={x * 0.55} y={y * 0.55} fontSize="14" fill="black">
                F{i + 1}
              </text>
            </g>
          );
        })}


        {/* Arrow definitions */}
        <defs>
          <marker id="arrow" markerWidth="10" markerHeight="10" refX="5"
refY="3" orient="auto">
            <polygon points="0 0, 6 3, 0 6" fill="#1848a0" />
          </marker>


          <marker id="arrowR" markerWidth="12" markerHeight="12" refX="6"
refY="3" orient="auto">
            <polygon points="0 0, 7 3, 0 6" fill="#009900" />
          </marker>
        </defs>
      </g>
    </svg>


  );
}


/* ===================== MAIN COMPONENT ===================== */
export default function Solver2D() {
  const [forces, setForces] = useState<ForceInput[]>([{ magnitude: "",
angle: "" }]);


  const [result, setResult] = useState<ForceResult | null>(null);


  const handleInputChange = (index: number, field: "magnitude" | "angle",
value: string) => {
    const newForces = [...forces];
    newForces[index][field] = value;
    setForces(newForces);
  };
  const calculateResultant = () => {
    const system = new ForceSystem2D();


    forces.forEach((f) => {
      const mag = parseFloat(f.magnitude);
      const ang = parseFloat(f.angle);
      if (!isNaN(mag) && !isNaN(ang)) system.addForce(mag, ang);
    });


    setResult(system.stepByStepSolution());
  };


  return (
    <div className="flex flex-col min-h-screen bg-gray-50 text-gray-900
text-[18px]">
      <Header />


      <main className="flex-grow flex flex-col items-center px-4 py-10">
        <h1 className="text-[32px] font-bold mb-6">2D Resultant Force
Calculator</h1>


        {/* FBD Live Preview */}
        <div className="mb-8">
          <h2 className="text-[20px] font-semibold text-center
mb-2">Real-Time Free Body Diagram</h2>
          <FBD forces={forces} setForces={setForces} />
        </div>


        {/* Inputs */}
        <div className="w-full max-w-xl bg-white rounded-2xl shadow p-6
space-y-6">
          <h2 className="text-[20px] font-semibold">Force setup</h2>


          <div className="grid grid-cols-2 gap-4">
            {forces.map((f, i) => (
              <div key={i} className="col-span-2 flex gap-4 items-end">
                <div className="flex-1">
                  <label className="block font-medium text-[18px]">
                    Force {i + 1} (kN)
                  </label>
                  <input
                    type="number"
                    value={f.magnitude}
                    onChange={(e) =>
                      handleInputChange(i, "magnitude", e.target.value)
                    }
                    placeholder="Magnitude (kN)"
                    className="w-full mt-1 rounded-lg border-gray-300
text-[18px] p-2"
                  />
                </div>
                <div className="flex-1">
                  <label className="block font-medium text-[18px]">
                    Angle {i + 1} (°)
                  </label>
                  <input
                    type="number"
                    value={f.angle}
                    onChange={(e) =>
                      handleInputChange(i, "angle", e.target.value)
                    }
                    placeholder="Angle (deg)"
                    className="w-full mt-1 rounded-lg border-gray-300
text-[18px] p-2"
                  />
                </div>
                {forces.length > 1 && (
                  <button
                    onClick={() =>
                      setForces(forces.filter((_, idx) => idx !== i))
                    }
                    className="px-3 py-1 bg-red-500 text-white rounded-lg
hover:bg-red-600 text-[18px]"
                  >
                    −
                  </button>
                )}
              </div>
            ))}
          </div>
          <button onClick={() => setForces([...forces, { magnitude: "",
angle: "" }])} className="w-full bg-[#008409] text-white py-3 rounded-lg
hover:bg-[#15711b] transition text-[18px]">
            + Add Force
          </button>
```

```
          <button onClick={calculateResultant} className="w-full
bg-[#1848a0] text-white py-3 rounded-lg hover:bg-[#163d8a] transition
text-[18px]">
            Calculate
          </button>
        </div>


        {/* Output */}
        {result && (
          <div className="w-full max-w-xl mt-6 bg-white rounded-2xl shadow
p-6 space-y-4">
            <h2 className="text-[20px] font-semibold">Resultant Force
(kN)</h2>
            <div>
              <label className="block font-medium text-[18px]">Horizontal
component (Fx)</label>
              <input type="text" value={`${result.sumFx.toFixed(3)} kN`}
readOnly className="w-full mt-1 rounded-lg border-gray-300 text-[18px]
p-2" />
            </div>


            <div>
              <label className="block font-medium text-[18px]">Vertical
component (Fy)</label>
              <input type="text" value={`${result.sumFy.toFixed(3)} kN`}
readOnly className="w-full mt-1 rounded-lg border-gray-300 text-[18px]
p-2" />
            </div>


            <div>
              <label className="block font-medium text-[18px]">Magnitude
of resultant force (R)</label>
              <input type="text" value={`${result.R.toFixed(3)} kN`}
readOnly className="w-full mt-1 rounded-lg border-gray-300 text-[18px]
p-2" />
            </div>


            <div>
              <label className="block font-medium text-[18px]">Direction
of resultant force (θ)</label>
```

```
              <input type="text" value={`${result.theta.toFixed(2)}°`}
readOnly className="w-full mt-1 rounded-lg border-gray-300 text-[18px]
p-2" />
            </div>
          </div>
        )}


        {/* Step-by-Step Solution */}
        {result && (
          <div className="w-full max-w-xl mt-6 bg-white rounded-2xl shadow
p-6">
            <h2 className="text-[20px] font-semibold mb-2">Step-by-Step
Solution</h2>




            <div className="space-y-4">
              {result.steps.map((line, i) =>
                line.startsWith("Step") ? (
                  <p key={i} className="font-medium text-[18px]">
                    {line}
                  </p>
                ) : (
                  <div key={i} className="text-[18px]">
                    <BlockMath>{line}</BlockMath>
                  </div>
                )
              )}
            </div>


            {/* Step 4 */}
            <div className="mt-8">
              <p className="font-medium text-[18px] mb-2">
                Step 4: Final Free Body Diagram
              </p>
              <ResultantFBD forces={forces} result={result} />
            </div>
          </div>
        )}
      </main>


      <Footer />
    </div>
```

```
  );
}


"use client";


import { useRef, useState } from "react";
import Header from "../../components/Header";
import Footer from "../../components/Footer";
import "katex/dist/katex.min.css";
import { BlockMath } from "react-katex";


/* ===================== Force System Logic ===================== */
class ForceSystem2D {
  vectors: { fx: number; fy: number; magnitude: number; angleDeg: number
}[];


  constructor() {
    this.vectors = [];
  }


  addForce(magnitude: number, angleDeg: number) {
    const angleRad = (angleDeg * Math.PI) / 180;
    const fx = magnitude * Math.cos(angleRad);
    const fy = magnitude * Math.sin(angleRad);
    this.vectors.push({ fx, fy, magnitude, angleDeg });
  }


  stepByStepSolution() {
    const steps: string[] = [];
    steps.push("Step 1: Resolve each force into components:");


    let sumFx = 0;
    let sumFy = 0;


    this.vectors.forEach((v, i) => {
      steps.push(
        `\\text{Force ${i + 1}: } |F|=${v.magnitude}\\,\\text{kN},\\;
\\theta=${v.angleDeg}^\\circ`
      );
      steps.push(`
        \\begin{align*}
        F_{x${i + 1}} &= ${v.magnitude}\\cos(${v.angleDeg}^\\circ) \\\\
                      &= ${v.fx.toFixed(3)}\\,\\text{kN} \\\\
        F_{y${i + 1}} &= ${v.magnitude}\\sin(${v.angleDeg}^\\circ) \\\\
                      &= ${v.fy.toFixed(3)}\\,\\text{kN}
        \\end{align*}
      `);


      sumFx += v.fx;
      sumFy += v.fy;
    });


    steps.push("Step 2: Sum of components:");
    steps.push(`
      \\begin{align*}
      \\Sigma F_x &= ${sumFx.toFixed(3)}\\,\\text{kN} \\\\
      \\Sigma F_y &= ${sumFy.toFixed(3)}\\,\\text{kN}
      \\end{align*}
    `);


    const R = Math.hypot(sumFx, sumFy);
    const theta = (Math.atan2(sumFy, sumFx) * 180) / Math.PI;


    const arrow = theta >= 0 ? "↺" : "↻";


    steps.push("Step 3: Resultant force:");
    steps.push(`
      \\begin{align*}
      R &= \\sqrt{(\\Sigma F_x)^2 + (\\Sigma F_y)^2} \\\\
        &= ${R.toFixed(3)}\\,\\text{kN} \\\\
      \\theta &= \\tan^{-1}\\left(\\tfrac{\\Sigma F_y}{\\Sigma
F_x}\\right) \\\\
              &= ${theta.toFixed(2)}^\\circ ${arrow}\\,\\text{from +x
axis}
      \\end{align*}
    `);


    return { steps, sumFx, sumFy, R, theta };
```

```
  }
}


type ForceInput = {
  magnitude: string;
  angle: string;
};


type ForceResult = {
  steps: string[];
  sumFx: number;
  sumFy: number;
  R: number;
  theta: number;
};


/*FULL FBD FOR STEP 4 (all forces + resultant)*/
function ResultantFBD({
  forces,
  result,
}: {
  forces: ForceInput[];
  result: ForceResult;
}) {
  const vectors = forces
    .map((f) => {
      const m = parseFloat(f.magnitude);
      const a = parseFloat(f.angle);
      if (isNaN(m) || isNaN(a)) return null;
      const rad = (a * Math.PI) / 180;
      return { x: m * Math.cos(rad), y: m * Math.sin(rad) };
    })
    .filter(Boolean) as { x: number; y: number }[];


  const R = { x: result.sumFx, y: result.sumFy };


  const magnitudes = [
    ...vectors.map((v) => Math.hypot(v.x, v.y)),
    Math.hypot(R.x, R.y),
  ];
  const maxMag = Math.max(1, ...magnitudes);
  const scale = 90 / maxMag;


  return (
    <svg
      width="300"
      height="300"
      className="border rounded-lg bg-white shadow mx-auto"
    >
      <g transform="translate(150,150)">
        {/* Axes */}
        <line x1={-140} y1={0} x2={140} y2={0} stroke="gray"
strokeWidth="1" />
        <line x1={0} y1={-140} x2={0} y2={140} stroke="gray"
strokeWidth="1" />


        {/* Draw each force */}
        {vectors.map((v, i) => {
          const x = v.x * scale;
          const y = -v.y * scale;


          return (
            <g key={i}>
              <line
                x1={0}
                y1={0}
                x2={x}
                y2={y}
                stroke="#1848a0"
                strokeWidth="3"
                markerEnd="url(#arrowF)"
              />
              <text
                x={x * 0.55}
                y={y * 0.55}
                fontSize="14"
                fill="#1848a0"
                fontWeight="bold"
              >
                F{i + 1}
              </text>
            </g>
          );
        })}
```

```
{/* Draw resultant */}
<line
  x1={0}
  y1={0}
  x2={R.x * scale}
  y2={-R.y * scale}
  stroke="#009900"
  strokeWidth="4"
  markerEnd="url(#arrowR)"
/>
<text
  x={(R.x * scale) * 0.55}
  y={(-R.y * scale) * 0.55}
  fontSize="16"
  fill="#009900"
  fontWeight="bold"
>
  R
</text>


{/* Arrow definitions */}
<defs>
  <marker
    id="arrowF"
    markerWidth="10"
    markerHeight="10"
    refX="5"
    refY="3"
    orient="auto"
  >
    <polygon points="0 0, 6 3, 0 6" fill="#1848a0" />
  </marker>


  <marker
    id="arrowR"
    markerWidth="12"
    markerHeight="12"
    refX="6"
    refY="3"
    orient="auto"
  >
    <polygon points="0 0, 7 3, 0 6" fill="#009900" />
  </marker>
```

```
        </defs>
      </g>
    </svg>
  );
}


/*SVG FBD Component (draggable + resultant)*/
function FBD({ forces, setForces }: { forces: ForceInput[]; setForces: (f:
ForceInput[]) => void }) {
  const svgRef = useRef<SVGSVGElement | null>(null);
  const [dragIndex, setDragIndex] = useState<number | null>(null);


  // Convert forces to vectors (math coords; y positive up)
  const vectors = forces
    .map((f) => {
      const m = parseFloat(f.magnitude);
      const a = parseFloat(f.angle);
      if (isNaN(m) || isNaN(a)) return null;
      const rad = (a * Math.PI) / 180;
      return {
        x: m * Math.cos(rad),
        y: m * Math.sin(rad),
      };
    })
    .filter(Boolean) as { x: number; y: number }[];


  // Determine scale so arrows fit nicely
  const maxMag = Math.max(1, ...vectors.map((v) => Math.hypot(v.x, v.y)));
  const scale = 80 / maxMag; // dynamic scale


  const screenPointToSvg = (clientX: number, clientY: number) => {
    const svg = svgRef.current;
    if (!svg) return null;
    const pt = svg.createSVGPoint();
    pt.x = clientX;
    pt.y = clientY;
    const ctm = svg.getScreenCTM();
    if (!ctm) return null;
    return pt.matrixTransform(ctm.inverse());
  };


  const handleMouseMove = (e: React.MouseEvent) => {
    if (dragIndex === null) return;


    const svg = svgRef.current;
    if (!svg) return;


    const pt = svg.createSVGPoint();
    pt.x = e.clientX;
    pt.y = e.clientY;


    // convert cursor to SVG coordinates
    const cursor = pt.matrixTransform(svg.getScreenCTM()?.inverse());
    const x = cursor.x - 150;
    const y = cursor.y - 150;




    const newAngle = (Math.atan2(-y, x) * 180) / Math.PI;


    const newForces = [...forces];


    newForces[dragIndex] = {
      ...newForces[dragIndex],
      angle: newAngle.toFixed(3),  // Only angle changes
    };


    setForces(newForces);
  };




  const stopDrag = () => setDragIndex(null);


  // compute resultant in math coords
  const sum = vectors.reduce((acc, v) => ({ x: acc.x + v.x, y: acc.y + v.y
}), { x: 0, y: 0 });
  const Rx = sum.x * scale;
  const Ry = -sum.y * scale; // svg y inverted
  return (
    <svg
      ref={svgRef}
      width="300"
      height="300"
      className="border rounded-lg bg-white shadow"
      style={{ background: "white" }}
      onMouseMove={handleMouseMove}
      onMouseUp={stopDrag}
      onMouseLeave={stopDrag}
    >
      <g transform="translate(150,150)">
        {/* Axes */}
        <line x1={-140} y1={0} x2={140} y2={0} stroke="gray"
strokeWidth="1" />
        <line x1={0} y1={-140} x2={0} y2={140} stroke="gray"
strokeWidth="1" />


        {/* Force vectors */}
        {vectors.map((v, i) => {
          const x = v.x * scale;
          const y = -v.y * scale; // invert for svg
          return (
            <g key={i}>
              <line
                x1={0}
                y1={0}
                x2={x}
                y2={y}
                stroke="#1848a0"
                strokeWidth="3"
                markerEnd="url(#arrow)"
                className="cursor-pointer"
                onMouseDown={() => setDragIndex(i)}
              />
              <text x={x * 0.55} y={y * 0.55} fontSize="14" fill="black">
                F{i + 1}
              </text>
            </g>
          );
        })}


        {/* Arrow definitions */}
        <defs>
```

```
          <marker id="arrow" markerWidth="10" markerHeight="10" refX="5"
refY="3" orient="auto">
            <polygon points="0 0, 6 3, 0 6" fill="#1848a0" />
          </marker>


          <marker id="arrowR" markerWidth="12" markerHeight="12" refX="6"
refY="3" orient="auto">
            <polygon points="0 0, 7 3, 0 6" fill="#009900" />
          </marker>
        </defs>
      </g>
    </svg>


  );
}


/* MAIN COMPONENT */
export default function Solver2D() {
  const [forces, setForces] = useState<ForceInput[]>([{ magnitude: "",
angle: "" }]);


  const [result, setResult] = useState<ForceResult | null>(null);


  const handleInputChange = (index: number, field: "magnitude" | "angle",
value: string) => {
    const newForces = [...forces];
    newForces[index][field] = value;
    setForces(newForces);
  };


  const calculateResultant = () => {
    const system = new ForceSystem2D();


    forces.forEach((f) => {
      const mag = parseFloat(f.magnitude);
      const ang = parseFloat(f.angle);
      if (!isNaN(mag) && !isNaN(ang)) system.addForce(mag, ang);
    });
    setResult(system.stepByStepSolution());
  };


  return (
    <div className="flex flex-col min-h-screen bg-gray-50 text-gray-900
text-[18px]">
      <Header />


      <main className="flex-grow flex flex-col items-center px-4 py-10">
        <h1 className="text-[32px] font-bold mb-6">2D Resultant Force
Calculator</h1>


        {/* FBD Live Preview */}
        <div className="mb-8">
          <h2 className="text-[20px] font-semibold text-center
mb-2">Real-Time Free Body Diagram</h2>
          <FBD forces={forces} setForces={setForces} />
        </div>


        {/* Inputs */}
        <div className="w-full max-w-xl bg-white rounded-2xl shadow p-6
space-y-6">
          <h2 className="text-[20px] font-semibold">Force setup</h2>


          <div className="grid grid-cols-2 gap-4">
            {forces.map((f, i) => (
              <div key={i} className="col-span-2 flex gap-4 items-end">
                <div className="flex-1">
                  <label className="block font-medium text-[18px]">
                    Force {i + 1} (kN)
                  </label>
                  <input
                    type="number"
                    value={f.magnitude}
                    onChange={(e) =>
                      handleInputChange(i, "magnitude", e.target.value)
                    }
                    placeholder="Magnitude (kN)"
                    className="w-full mt-1 rounded-lg border-gray-300
text-[18px] p-2"
                  />
                </div>
                <div className="flex-1">
                  <label className="block font-medium text-[18px]">
                    Angle {i + 1} (°)
                  </label>
                  <input
                    type="number"
                    value={f.angle}
                    onChange={(e) =>
                      handleInputChange(i, "angle", e.target.value)
                    }
                    placeholder="Angle (deg)"
                    className="w-full mt-1 rounded-lg border-gray-300
text-[18px] p-2"
                  />
                </div>
                {forces.length > 1 && (
                  <button
                    onClick={() =>
                      setForces(forces.filter((_, idx) => idx !== i))
                    }
                    className="px-3 py-1 bg-red-500 text-white rounded-lg
hover:bg-red-600 text-[18px]"
                  >
                    -
                  </button>
                )}
              </div>
            ))}
          </div>
          <button onClick={() => setForces([...forces, { magnitude: "",
angle: "" }])} className="w-full bg-[#008409] text-white py-3 rounded-lg
hover:bg-[#15711b] transition text-[18px]">
            + Add Force
          </button>


          <button onClick={calculateResultant} className="w-full
bg-[#1848a0] text-white py-3 rounded-lg hover:bg-[#163d8a] transition
text-[18px]">
            Calculate
          </button>
        </div>


        {/* Output */}
        {result && (
          <div className="w-full max-w-xl mt-6 bg-white rounded-2xl shadow
p-6 space-y-4">
            <h2 className="text-[20px] font-semibold">Resultant Force
(kN)</h2>
            <div>
              <label className="block font-medium text-[18px]">Horizontal
component (Fx)</label>
              <input type="text" value={`${result.sumFx.toFixed(3)} kN`}
readOnly className="w-full mt-1 rounded-lg border-gray-300 text-[18px]
p-2" />
            </div>


            <div>
              <label className="block font-medium text-[18px]">Vertical
component (Fy)</label>
              <input type="text" value={`${result.sumFy.toFixed(3)} kN`}
readOnly className="w-full mt-1 rounded-lg border-gray-300 text-[18px]
p-2" />
            </div>


            <div>
              <label className="block font-medium text-[18px]">Magnitude
of resultant force (R)</label>
              <input type="text" value={`${result.R.toFixed(3)} kN`}
readOnly className="w-full mt-1 rounded-lg border-gray-300 text-[18px]
p-2" />
            </div>


            <div>
              <label className="block font-medium text-[18px]">Direction
of resultant force (θ)</label>
              <input type="text" value={`${result.theta.toFixed(2)}°`}
readOnly className="w-full mt-1 rounded-lg border-gray-300 text-[18px]
p-2" />
            </div>
          </div>
        )}


        {/* Step-by-Step Solution */}
        {result && (
          <div className="w-full max-w-xl mt-6 bg-white rounded-2xl shadow
p-6">
```

```
            <h2 className="text-[20px] font-semibold mb-2">Step-by-Step
Solution</h2>




            <div className="space-y-4">
              {result.steps.map((line, i) =>
                line.startsWith("Step") ? (
                  <p key={i} className="font-medium text-[18px]">
                    {line}
                  </p>
                ) : (
                  <div key={i} className="text-[18px]">
                    <BlockMath>{line}</BlockMath>
                  </div>
                )
              )}
            </div>


            {/* Step 4 */}
            <div className="mt-8">
              <p className="font-medium text-[18px] mb-2">
                Step 4: Final Free Body Diagram
              </p>
              <ResultantFBD forces={forces} result={result} />
            </div>
          </div>
        )}
      </main>


      <Footer />
    </div>
  );
}
```

Footer

```
"use client";


import Link from "next/link";


type NavLink = { label: string; href: string };


interface FooterProps {
  links?: NavLink[];
}


export default function Footer({
  links = [
    { label: "About", href: "/about" },
    { label: "References", href: "/reference" },
    { label: "Contact", href: "/contact" },
    { label: "Developer", href: "/developers" },
  ],
}: FooterProps) {
  return (
    <footer className="bg-white border-t mt-auto">
      <div className="max-w-7xl mx-auto px-6 py-4 text-center
text-gray-700 text-[18px]">
        {/* Desktop: horizontal links with | separator */}
        <div className="hidden sm:flex justify-center flex-wrap gap-4">
          {links.map((link, idx) => (
            <span key={link.href} className="flex items-center
text-[18px]">
```

```
              <Link href={link.href} className="hover:text-blue-600">
                {link.label}
              </Link>
              {idx < links.length - 1 && (
                <span className="mx-2 text-gray-400">|</span>
              )}
            </span>
          ))}
        </div>


        {/* Mobile: stacked links */}
        <div className="flex flex-col sm:hidden gap-2">
          {links.map((link) => (
            <Link
              key={link.href}
              href={link.href}
              className="hover:text-blue-600 text-[18px]"
            >
              {link.label}
            </Link>
          ))}
        </div>
      </div>
    </footer>
  );
}
```

```
"use client";


import Link from "next/link";


export default function Header() {
  return (
    <header className="bg-white shadow">
      <div className="max-w-7xl mx-auto px-6 py-4 flex flex-col
sm:flex-row sm:items-center sm:justify-between gap-4">


        {/* Logo + Title */}
        <Link
          href="/"
          className="flex items-center gap-3 justify-center
sm:justify-start hover:text-[#1848a0] transition"
        >
          <div className="w-10 h-10 border-2 border-black rounded-full" />
          <span className="font-bold text-[30px] text-black">Statics
Calculator</span>
        </Link>


        {/* Desktop Navigation */}
        <nav className="hidden sm:flex items-center space-x-6
text-gray-700 relative text-[18px]">
          <Link href="/" className="hover:text-[#1848a0]">Home</Link>
          <span>|</span>
          {/* Topics Dropdown */}
          <div className="group relative">
            <button className="hover:text-[#1848a0]">Topics ▾</button>
            <div
              className="absolute left-1/2 -translate-x-1/2 mt-2 w-56
bg-white border rounded-lg shadow-lg
                opacity-0 group-hover:opacity-100 invisible
group-hover:visible transition text-[18px]"
            >
              <div className="flex flex-col p-2 text-gray-700">
                <Link href="/Introduction" className="hover:text-[#1848a0]
p-2">
                  Chapter 1: Introduction to Statics
                </Link>
                <Link href="/2D-solver" className="hover:text-[#1848a0]
p-2">
                  Chapter 2: Force Systems
                </Link>
                <Link href="/Equilibrium" className="hover:text-[#1848a0]
p-2">
                  Chapter 3: Equilibrium
                </Link>
                <Link href="/Structures" className="hover:text-[#1848a0]
p-2">
                  Chapter 4: Structures
                </Link>
                <Link href="/Distributed-Loads"
className="hover:text-[#1848a0] p-2">
                  Chapter 5: Distributed Loads
                </Link>
              </div>
            </div>
          </div>


          <span>|</span>
          <Link href="/about"
className="hover:text-[#1848a0]">About</Link>
        </nav>


        {/* Mobile Navigation */}
        <nav className="flex flex-col sm:hidden items-center gap-2
text-gray-700 text-[18px]">
```

```
          <Link href="/" className="hover:text-[#1848a0]">Home</Link>


          <details className="w-full">
            <summary className="cursor-pointer text-center
hover:text-[#1848a0]">Topics</summary>
            <div className="flex flex-col mt-2 gap-2">
              <Link href="/Introduction" className="hover:text-[#1848a0]
p-2">
                Chapter 1: Introduction to Statics
              </Link>
              <Link href="/2D-solver" className="hover:text-[#1848a0]
p-2">
                Chapter 2: Force Systems
              </Link>
              <Link href="/Equilibrium" className="hover:text-[#1848a0]
p-2">
                Chapter 3: Equilibrium
              </Link>
              <Link href="/Structures" className="hover:text-[#1848a0]
p-2">
                Chapter 4: Structures
              </Link>
              <Link href="/Distributed-Loads"
className="hover:text-[#1848a0] p-2">
                Chapter 5: Distributed Loads
              </Link>
            </div>
          </details>


          <Link href="/about"
className="hover:text-[#1848a0]">About</Link>
        </nav>
      </div>
    </header>
  );
}
```

About page

```
import Header from "<Ian>/components/Header";
import Footer from "<Ian>/components/Footer";


export default function AboutPage() {
  return (
    <div className="min-h-screen flex flex-col bg-gray-50">
      <Header />


      {/* Main Content */}
      <main className="flex flex-1 items-center justify-center px-6
py-12">
        <div className="max-w-3xl text-center">
          <h1 className="text-2xl font-semibold text-gray-800 mb-6">
            About{" "}
            <span className="text-[#1848a0]">StatiCalcs</span>
          </h1>


          <p className="text-[18px] text-gray-700 leading-relaxed mb-6">
            <span className="font-bold">
              Stati<span className="text-[#1848a0]">Calcs</span>
            </span>{" "}
            is an interactive web-based learning tool created to support
            engineering students in their study of Statics of Rigid
Bodies. It
            combines essential concepts with integrated calculators to
help
            users practice problem-solving more effectively.
          </p>
```

```
         <p className="text-[18px] text-gray-700 leading-relaxed">
  Designed specifically for engineering students of MSU-Gensan,{" "}
  <span className="font-bold">
    Stati<span className="text-[#1848a0]">Calcs</span>
  </span>{" "}
  serves as a supplementary academic tool that enhances classroom
learning,
  encourages independent study, and fosters a deeper understanding of
  statics principles.
</p>


        </div>
      </main>


      <Footer />
    </div>
  );
}
```

Page Contact

```
import Header from "<Ian>/components/Header";
import Footer from "<Ian>/components/Footer";


export default function ContactPage() {
  return (
    <div className="min-h-screen flex flex-col bg-gray-50">
      <Header />


      {/* Main Content */}
      <main className="flex flex-1 items-center justify-center px-6
py-12">
        <div className="max-w-3xl text-center">
          <h1 className="text-2xl font-semibold text-gray-800 mb-4">
            Contact
          </h1>
          <p className="text-[18px] text-gray-700 mb-8">
            For feedback or inquiries, please reach out through the
following:
          </p>
          <div className="space-y-8 text-left">
            {/* First Contact */}
            <div>
              <h2 className="font-semibold text-[18px] text-gray-800">
                Ian Carl P. Cona
              </h2>
              <p className="text-[18px] text-gray-700">
                Email: iancarl.cona@msugensan.edu.ph
              </p>
              <p className="text-[18px] text-gray-700">
                Mindanao State University – General Santos
              </p>
              <p className="text-[18px] text-gray-700">
                Fatima, General Santos City, Philippines
              </p>
            </div>


            {/* Second Contact */}
            <div>
              <h2 className="font-semibold text-[18px] text-gray-800">
                Sophia Daphne C. Faelnar
              </h2>
              <p className="text-[18px] text-gray-700">
                Email: sophiadaphne.faelnar@msugensan.edu.ph
              </p>
              <p className="text-[18px] text-gray-700">
                Mindanao State University – General Santos
              </p>
              <p className="text-[18px] text-gray-700">
                Fatima, General Santos City, Philippines
              </p>
            </div>
          </div>
        </div>
      </main>


      <Footer />
    </div>
  );
}
```