1. (15%) Find the local extreme values and saddle point(s)(if any) of the function $x^2 e^{x \cos y}$, where $x \in \mathbb{R}$, $-\frac{\pi}{2} < y < 2\pi$.

2. (10%) Find the tangent plane to $x^4 + y^4 + z^4 = 9xyz$ at $(1, 1, 2)$.

3. (15%) Find the absolute minimum value of the function $\sqrt{x^2 + 4y^2}$ on the curve $xy = 2$ by using Lagrange multiplier method.

4. (10%) Calculate $I = \int_{-1}^{1} \int_{-1}^{1} (e^{x^2} \sin y + x^2 y^4) dx dy$.

5. (15%) Evaluate $I = \iint_T (x + y)^{10} dx dy$ where T is the triangle with vertices $(0, 0), (1, 1), (2, 0)$

6. (10%) Compute the integrals $I = \int_0^2 \int_{-\sqrt{4-y^2}}^{\sqrt{4-y^2}} x^2 y^2 dx dy$.

7. (10%) Calculate $I = \int_0^1 \int_{\sqrt{y}}^{1} e^{x^3} dx dy$.

8. (15%) Let $f(x, y) = \ln \sqrt{x^2 + y^2}$.

   (a) Find the directional derivative of f at the point $(3, 4)$ in the direction to point $(2, 6)$.

   (b) At what direction is the function f changing fastest at the point $(3, 4)$? What is the rate of change along this direction?