Closed book. No calculators. No formula sheets. Answer all questions. Each problem has equal mark - 5 points. Total number of points: 35.

Problem 1: Find the derivatives of the functions:

(a) $f(x) = \int_{x}^{1} \ln t \, dt$, (b) $g(s) = \int_{1}^{\sin s} (z + \cos z) \, dz$.

Problem 2: Evaluate the following integrals or explain why they don't exist:

- (a) $\int_{2}^{3} (4 + x^2 \sqrt{x}) dx$, (b) $\int_{-7}^{-5} (\sin(\pi \sqrt{y})) dy$, (c) $\int (3e^z + \sec^2 z) dz$, (d) $\int_0^{\sqrt[3]{999}} (\frac{4 \cdot t^2}{\sqrt[3]{1+t^3}}) dt$,
- (e) $\int_0^{\frac{\pi}{2}} \cos u \tan(\sin u) \, \mathrm{d} \mathbf{u}.$

Problem 3: Find the area of the region enclosed by the curves $y = x^3 - 3x$ and y = x.

Problem 4: Find the volume of the solid obtained by revolving about the x axis the region bounded by the curves $y = -x^2$ and y = x.

Problem 5: Find the volume of the solid S, whose base is the ellipse $\frac{x^2}{4} + \frac{y^2}{9} =$ 1 and cross-sections perpendicular to the x axis are equilateral triangles.

Problem 6: Use any method to find the volume generated by rotating the region bounded by the curves $y = 2x^2$, y = 0 and x = 1 about the y axis.

Problem 7: A chain that weighs 1000 kg is used to lift 2.5 tones of coal up a mineshaft 200 meters deep. Find the work done.